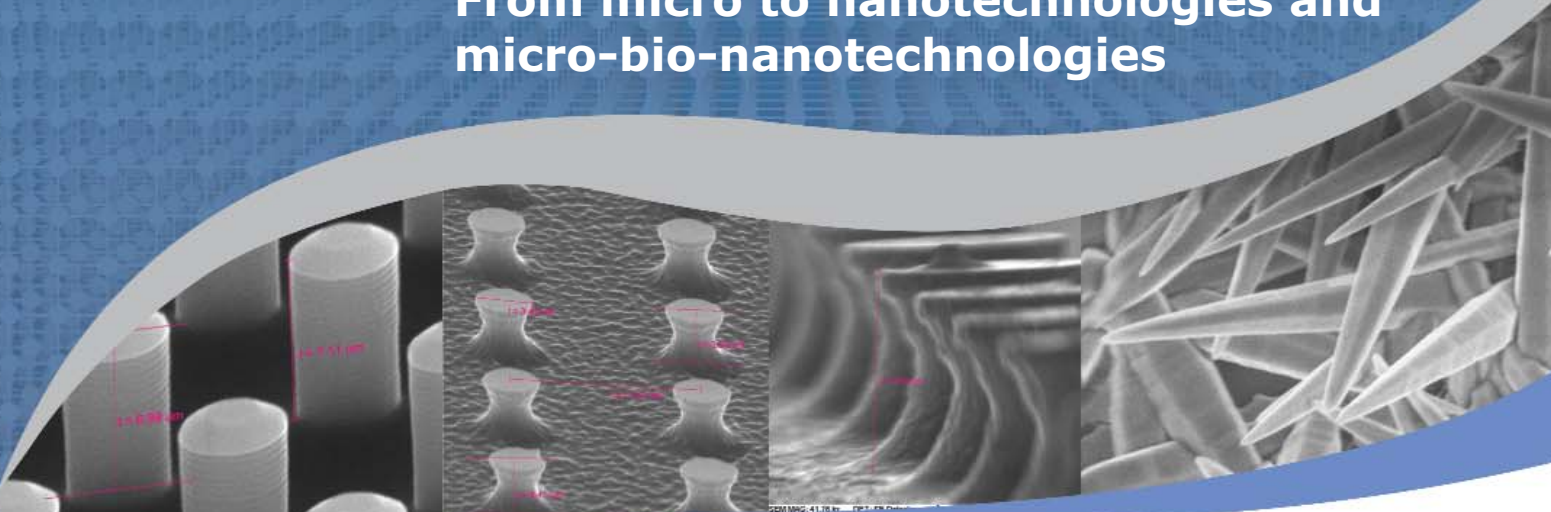
National Institute for Research and Development in Microtechnologies

IMT Bucharest

Scientific Report 2012

From micro to nanotechnologies and micro-bio-nanotechnologies



Ministry of National Education

MINISTERUL EDUCAȚIEI NAȚIONALE

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National Institute for Research and Development in Microtechnologies

IMT Bucharest

SCIENTIFIC REPORT 2012

Research and Technological development and experimental infrastructure

Design: IMT Bucharest

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INTRODUCTION

The National Institute for Research and Development in Microtechnologies – IMT Bucharest was set up, at the end of 1996, from two institutes that joined together: Institute for Microtechnologies - IMT (founded in 1993) and the Research Institute for Electronic Components - ICCE (founded in 1969).

Scientific Research and Technological Development

The field of activity of IMT-Bucharest corresponds today to **micro and nanotechnologies**. The main research domain are: **RF-MEMS, photonics, nano-bio-technologies, sensors for different market oriented applications, graphene based nanodevices, wide bandgap semiconductors, microfluidics, rapid prototyping**. The institute is coordinated by the **Ministry of National Education**, through the National Authority for Scientific Research (ANCS), acting basically as an autonomous, non-profit research company. As far as the participation to national and European projects is concerned, the institute is assimilated to a public research institution.

IMT-Bucharest became visible at the national level, especially by coordinating diverse projects, financed from the National Programmes MATNANTECH (New Materials, Micro and Nanotechnologies) (2001-2006), from CEEX (Excellence in Research) (2005-2008) and the Second National Plan PN II (since 2007). Between 2003 and 2012, the institute was involved in more than 25 European projects in FP6 and FP7, as well as in other categories of EU projects from ENIAC, Leonardo, ERANET, COST, etc.

In 2010, two projects led by IMT-Bucharest and financed by **Structural Funds** were launched, covering new scientific subjects: carbon-based integrated systems & nanomaterials and microfluidics for nanosystem self-assembling.

As a follow-up of the European project MIMOMEMS (RF and Opto MEMS), a European Centre of Excellence financed by the EC (2008-2011), in December 2009, the European Associated Laboratory (LEA) was inaugurated, with IMT-Bucharest, LAAS/CNRS Toulouse and FORTH, Heraklion. The LEA lab is acting in the field of RF MEMS/NEMS.

The 2011 Report of EC on Innovation placed IMT among the first five organizations (and the only national institute) as far as funding from EU programmes was concerned.

Resources

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, EBL nanolitography) and testing equipments (including a reliability laboratory). Most of these resources are now grouped in the IMT-Bucharest centre for Micro- and NAnoFABrication (**IMT-MINAFAB**).

IMT-MINAFAB is 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: www.imt.ro/MINAFAB.

Technology Transfer and Innovation

Since 2005, IMT-Bucharest 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 two partners: IMT-Bucharest (housing most of the park area) and University "Politehnica" Bucharest. The facilities provided to the companies in the park (including Honeywell Romania) are: propriety access to scientific and technological services provided by IMT-Bucharest, as well as the possibility to install their own equipments in technological area of the institute, housing for working points.

Education and Training

IMT-Bucharest is open for educational activities in cooperation with universities all over the country (and not only): undergraduate, M.Sc. and Ph.D. studies, and also for "hands-on training". IMT was active in a Marie Curie training by a research network and also in Leonardo programme and in "Eurotraining". Since October 2009, IMT-Bucharest is covering fully a number of disciplines in the new M.Sc. program, organized by the **University "Politehnica" of Bucharest**. Since 2010, IMT-Bucharest is coordinating a program POSDRU of postdoctoral studies in micro- and nanotechnologies, financed from structural funds (2010-2013). Our institute in 2012 was active in training students at all levels, giving access to practical activities for undergraduated students, MS dissertations, PhD thesis and internships. Students from Belgium, Italy, France, South Africa, visited us for shorter or longer periods.

Conferences and Publications

Since 1978, IMT-Bucharest is organizing the "Annual Conference for Semiconductors (CAS)", which became in 1991 an IEEE event, now largely devoted to micro- and nanotechnologies. IMT is also co-organizer (together with the Romanian Academy) of the "National Seminar for Nanoscience and Nanotechnologies" (the 11th edition in 2012).

The institute is co-editing (in English) the series of volumes Micro- and Nanoengineering", in the Publishing House of the Romanian Academy (20 volumes until 2012).

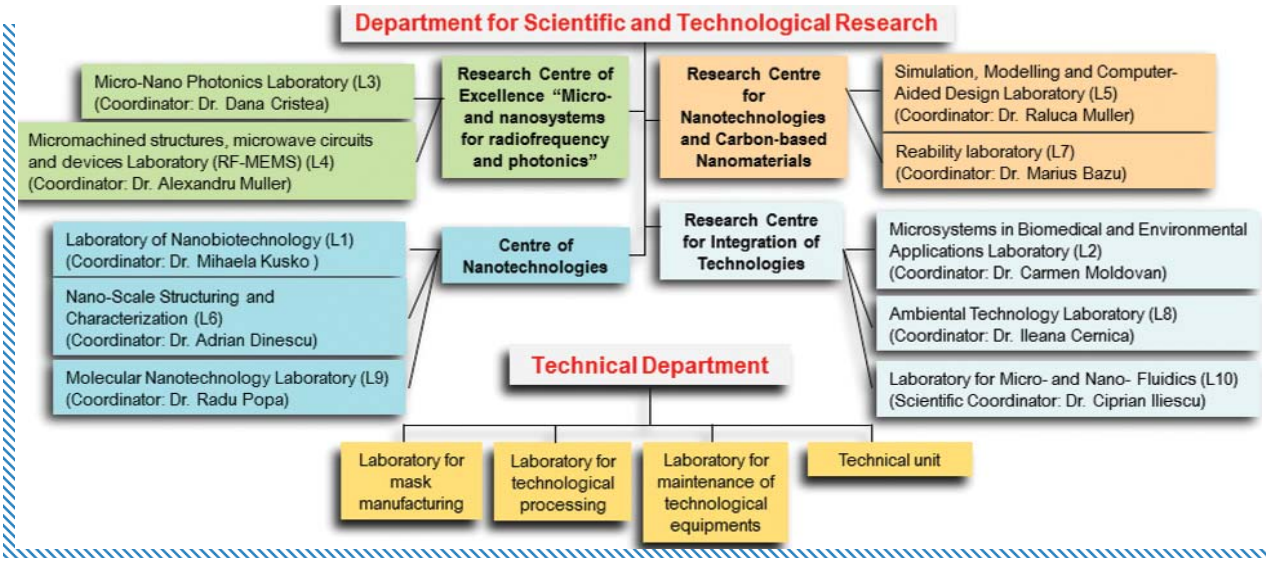
About present report

The Scientific Report 2012 starts with the organizational chart and continues with the basic figures in human and financial. The second part is devoted to the R&D labs, presenting the development in new processes, use of new material, characterization techniques and design methods in 2012, obtained in the ongoing national and international projects. Brief presentation of other activities: education, organization of scientific events, important visits are highlighted. A list of main scientific publications concludes the report.

I would like to thank to all the staff for their support and high level work during 2012.

Dr. Raluca Müller, *CEO and President of the Board*

Organization: Scientific and Technical Departments



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 was Scientific Director starting with 2009 and ***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).

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.

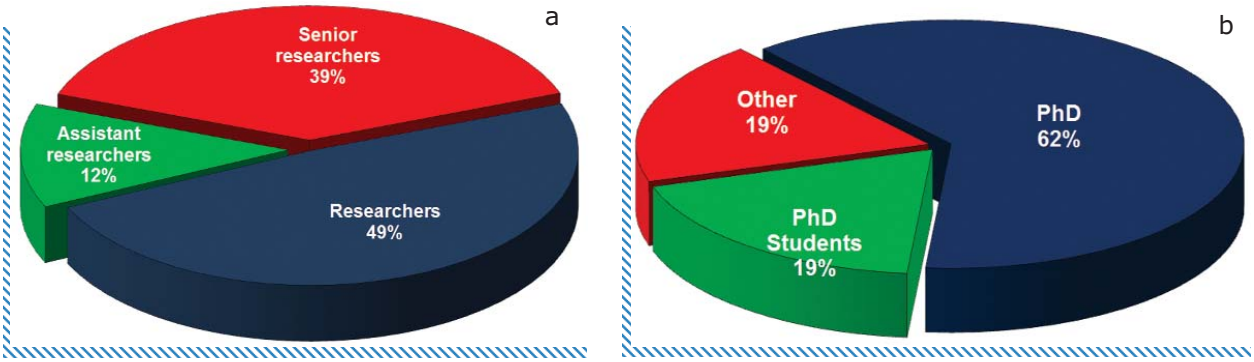


Fig 1 - Researchers active in IMT (76)

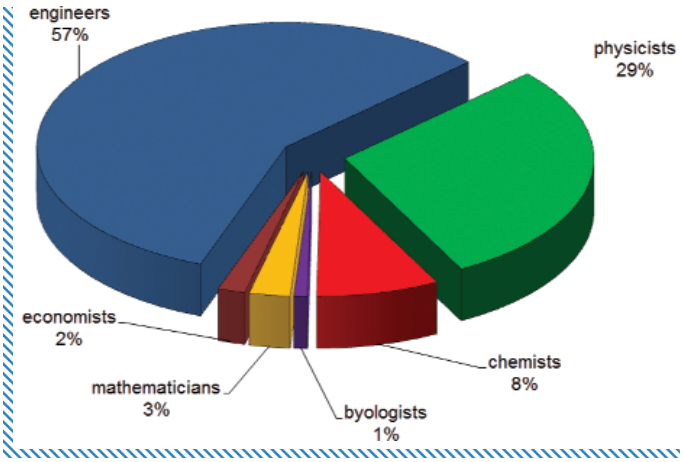


Fig 1 - Researchers active in IMT (76)

Figure 1 (a, b) provides information about the number and distribution of researchers active in IMT in 2012 (80 persons). 39% of them are senior reserchers and 12% are young assistant reserchers. Compared with 2011 the people which own a PhD or being a PhD students is higher.

The average age of our researcher and young assistent researchers is 43.

Fig.2 gives information about the total number of specialists active in IMT in 2012 (113 people): researchers and engineers providing technical services. Their multidisciplinary background is shown in Fig.2. The male (59) - female (54) number is relatively balanced.

Funding sources and investments

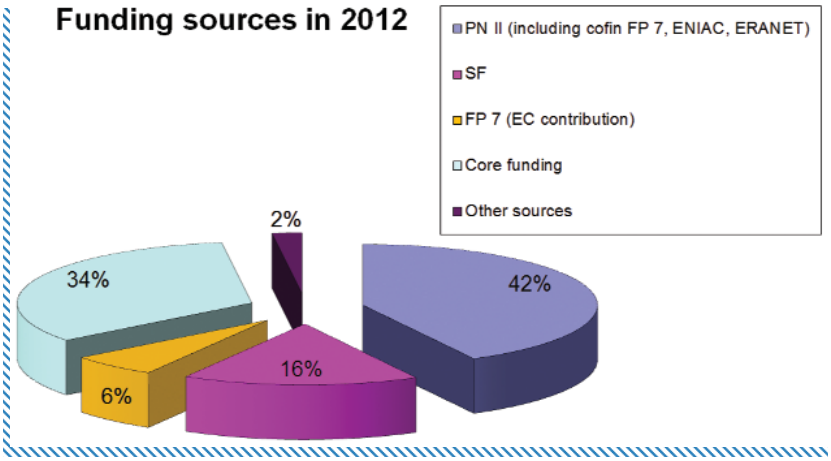


Fig 3 Funding sources in 2012

Fig. 3 present the funding sources in 2012, excluding investments.

The funding comes from different sources: national R&D programs (competitive funding, through open calls): 37% , this percent includes also the funding from related FP7 projects as ENIAC (Nano-electronics) and ERA-NET projects, where IMT is partner, Structural Funds 18%, European Projects 7% and other.

The next figure (fig.4) presents information about the evolution of the turnover of the last period and the information about the investments in various equipments in 2012.
Core funding evolution of the last 5 years as percent of the turnover of the previous year is shown in figure 5.

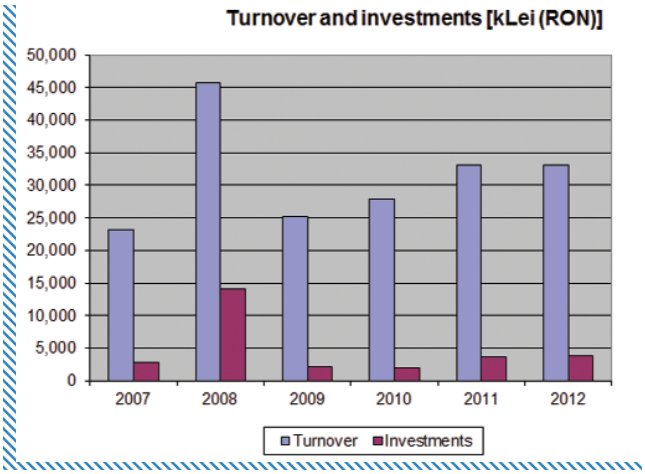


Fig 4 Turnover and investments (kLei (RON))

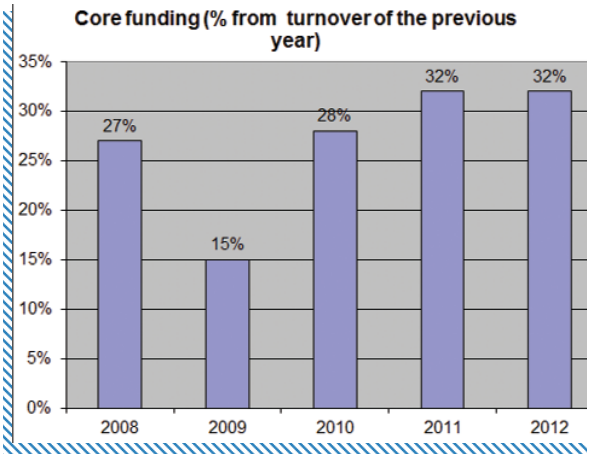
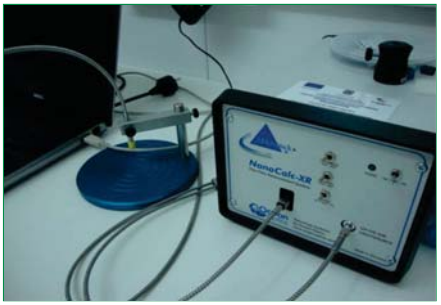


Fig. 5 Core funding evolution in the last 5 years, as percent of the turnover of the previous year

A new source of financing: structural funding

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 one.
F**inancing 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.

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 are: Deep Reactive Ion Etching (Oxford Plasma Technology), Andoing bonding (Suss MicroTech) and Refractometer for layer thickness measurements (Mikropack).



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, research stages abroad, and attendance to scientific events, in a postdoctoral programme in the micro- and nanotechnologies domain. These 35 postdoctoral students are grouped along seven research directions, supervised by seven professors. The directions are the following (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 micronanosystems; (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 project); 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 2012 the postdoctoral researchers of POSDRU project published an important number of paers in ISI journal and presented communictaions at prestigious conferences.

Three post-docs participated at research internships at European Universities or Research Institutes. The scientific activities are supported by the open acces at IMT Bucharest MINAFAB Facility (AFM, SEM, EBL, XRD, etc), INFLPR, University „Politehnica" of Bucharest etc.

In the frame of POSDRU project were organised dedicated courses, and 2 Scientific events in order to present the results and scientific activities of the postdoctoral fellows.

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).

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.

Laboratory of Micro-Nano Photonics

The Laboratory of Micro/Nano Photonics is recognized at national level, and funded between 2001 and 2004, as a Centre of Excellence in Micro and 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 Opto-electronics- National Program "Partnership"
• Multifunctional molecular architectures for organic electronics and nano-technology 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**;

Characterization:
• spectrophotometers for UV-VIS-NIR&IR spectral range;
• spectroscopic ellipsometer
• High Resolution Raman Spectrometers LabRAM HR
• Alpha300 S System combines the characterization methods of Scanning Near-field Optical Microscope (SNOM), Confocal Microscopy (CM), Atomic Force Microscopy (AFM) and Raman Spectrometry
• experimental set-up for optoelectric characterization in UV-VIS-IR spectral range of optoelectronic and photonic components, circuits

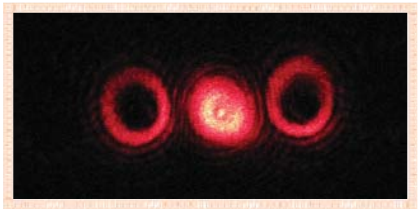
Technology: Lab with glove box, spinner, hot plates, oven for preparation and deposition of nano-composites and organic layers.

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

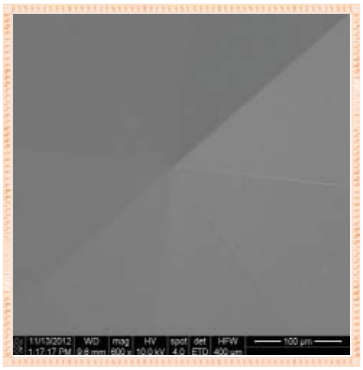
Dr. Dana Cristea obtained the MSc in Electronics (1982) and PhD in Optoelectronics and Materials for Electronics from "Politehnica" University, Bucharest, Romania. From 1982 until 1994 she was a research scientist in the Department of Optoelectronics and Sensors from the Research & Development Institute 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 and bilateral projects and participated in five FP6 and FP7 as workpackage/team leader.

Secured high volume free space optical communications based on computer generated holograms

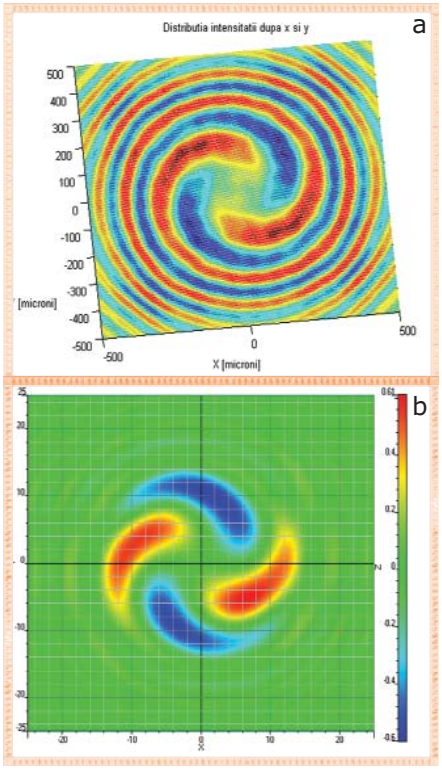
This project aims to validate a novel concept into a potential free space optical communication (FSOC) technology that allows to dramatically increase the volume of the transmitted information over a free space link by modulating a particular class of laser beam configurations called optical vortices (OV). These appear as a result of reshaping a laser Gaussian beam by a computer generated hologram and they carry orbital angular momentum an additional photon's degree of freedom used for data encoding. Besides the high volume of information, this concept provides an intrinsic secure character of the free space optical link without relying to the mathematical encryption of data.



Optical vortices obtained by sending a Gaussian laser through a computer generated hologram (IMT-Bucharest).



SEM image of an eight level spiral phase mask fabricated from PMMA by EBL (IMT-Bucharest)

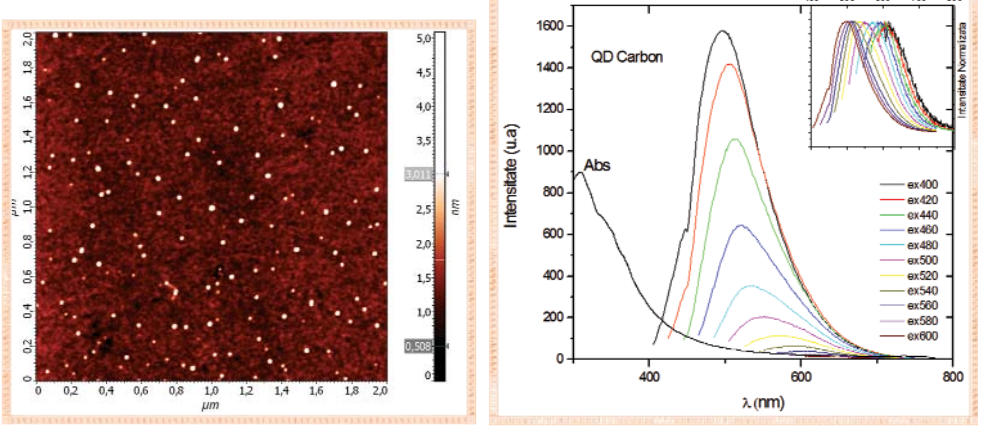


Simulations of optical vortices with the angular orbital momentu OAM=2 obtained by a) solving the diffraction equation, b) employing beam propagation method.

Project HOLLCOM- PCCA II (2012-2015),
Project Director Dr. Cristian Kusko, cristian.kusko@imt.ro
Partners: Optoelectronica SA 2001, Polytechnic University Bucharest.

Carbon quantum dots: exploring a new concept for next generation opto-electronic devices

This project aims to explore a novel nanomaterial with potential aplications in optoelectronics and photonics, namely carbon quantum dots (CQD). The laboratory of micro and nanophotonics is responsible for the following activities: i) Investigation of the optical and electronic properties of the CQD; ii) Preparation of high quality layer of optically active CQD possessing appropriate transport properties for C-based optoelectronic devices iii) assess the optical, electronic and morphology of the obtained layers by employing a series of spectroscopy, electrochemical, and scanning probe microscopy techniques iv) Device characterization of the q-LED consists in the determination of the temperature dependent L-I-V curves, spectral characteristics of the emitted radiation, v) theoretical understanding of the interface carbon nanodot-organic ligand and the quantum confined effects occurred within CQD.



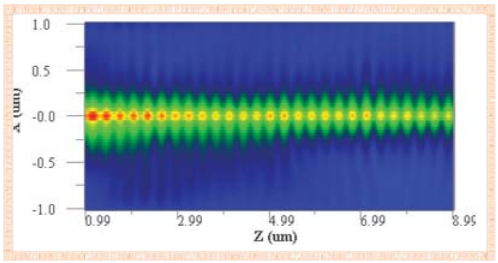
UV-Vis absorbtion and photoluminescence spectra of the CQD obtained in IMT-Bucharest Laboratory of micro and nanophotonics. AFM image of the CQD deposited on a silicon substrate (left).

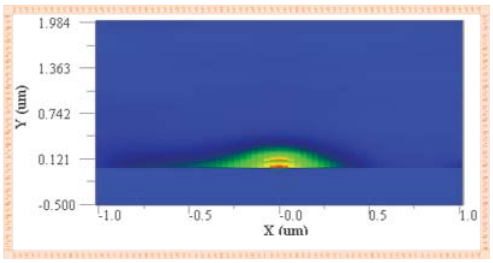
Cooperation with Molecular Nanotechnology Lab, Dr. Monica Veca. Laboratory contact person Dr. Cristian Kusko (cristian.kusko@imt.ro) and Cosmin Obreja (cosmin.obreja@imt.ro).

Optical nanoconfinement studies in plasmonic systems

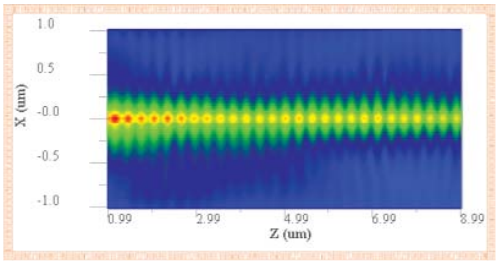
Designs and simulations of plasmonic structures:

- Opti-FDTD simulations, of a dielectric waveguide positioned on a metallic thin substrate, at a wavelength of 635 nm. The waveguide is from PMMA and has 100 nm in thickness and width, and 10 μm in length. The thin metal layer is silver or aluminum with a width of 100 nm.

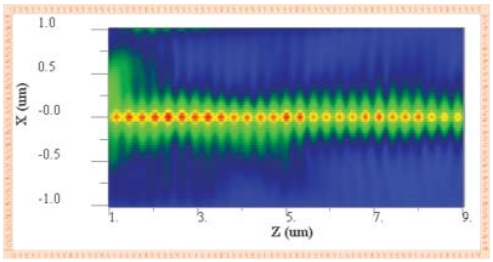




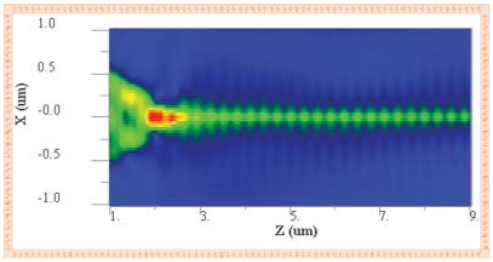
Coupling analisys: to determine the equilibrium between the input radiation that in coupling in the plasmonic waveguide and the radiation transmited in the waveguide were analised three tipes of coupling methods: direct coupling, coupling through air, and couplic through a tapered waveguide. : Even if the direct coupling mechanism is the ideal one, it is impossible to achieve it experimentally. That is letting us choose between the other two coupling methods. This choice is done according to the applications that are developed using plasmonic systems (coupling through air if we want to develop a sensor based on evanescent field or coupling with a tapered waveguide if we need to transmit a large quantity of information on a really shot distance).



Direct coupling

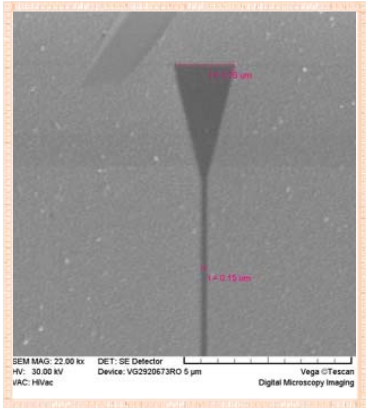


coupling through air

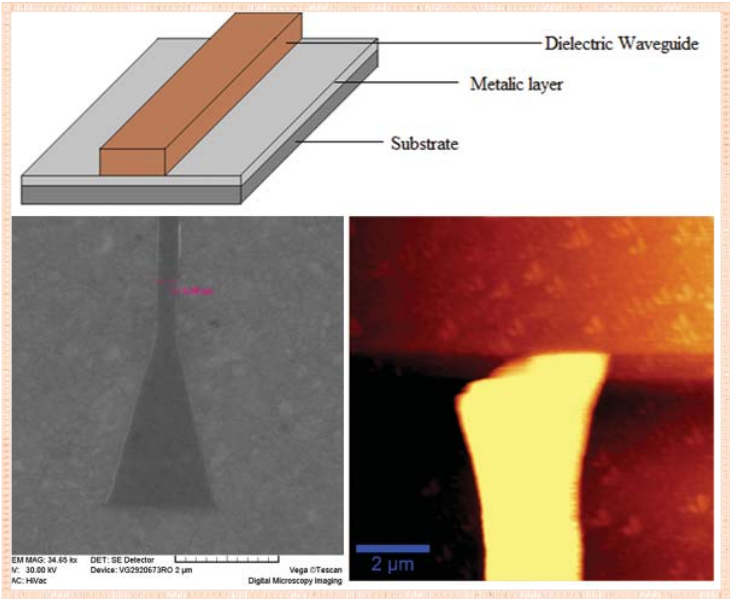


Coupling with a tapered waveguide

Fabrication process: Electron-beam deposition for the silver layer and sputtering for the aluminum layer. The PMMA waveguides were patterned using EBL.
These structures can be used for the development of plasmonic sensors.

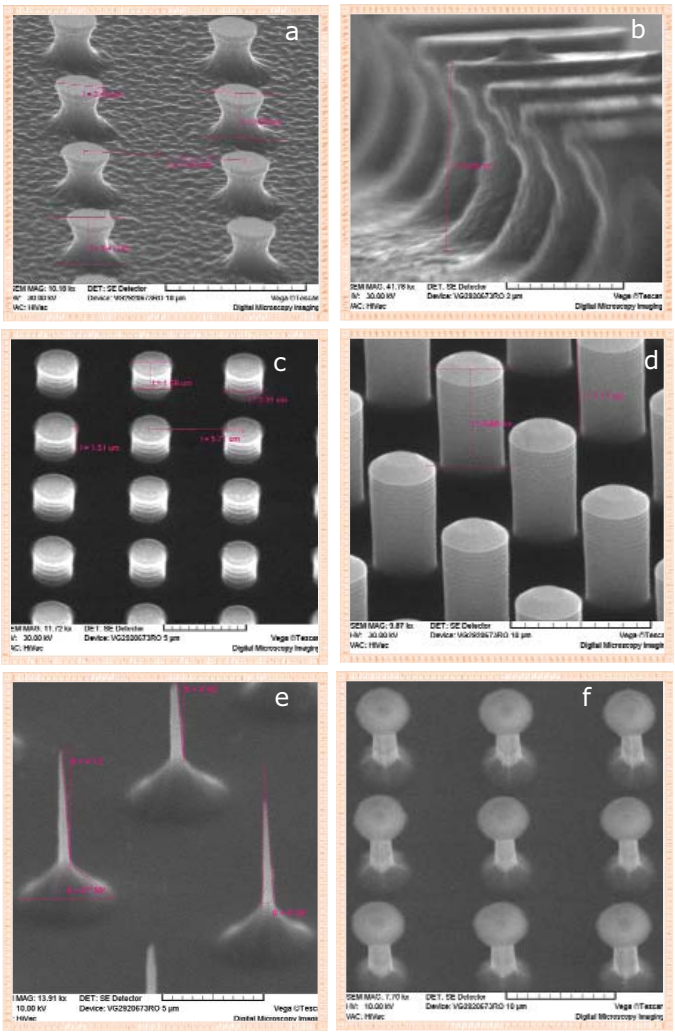


SEM image of the structure that uses aluminum as metallic film



SEM and AFM images of the structure using silver as metallic layer

IMT-Core Program, project PN 09290210
Contact : PhD stdent Roxana Tomescu (Roxana.Tomescu@imt.ro)



Silicon Plasma Processing for Front Surface Textured Solar Cells

The fabrication of silicon pillars and was done using ICP (Plasmalab System 100 from Oxford Instruments) dry etching processes with different parameter variations: pressure, gas debit, etching chemical species in order to obtained the specific etched profile. The high aspect ratio tips were obtained by wet anisotropic etching of the silicon cylinders previously etched in plasma.

The silicon pillars have been used for textured solar cells, to lower the loses by surface reflection of the incident radiation and increase the optical active region of the solar cell, hence increasing device's conversion efficiency. The influence of pillars with different shape, diameter and heights (shown in figures below) has been investigated by recording the reflectance spectra on the silicon textured wafers in the spectral range (200–900) nm using double way UV-VIS-NIR spectro-photometer. The spectra analysis has shown that the reflectivity of the textured silicon surface using pillars has decreased to < 10% compared with the value of 35% for the Si untextured surface.

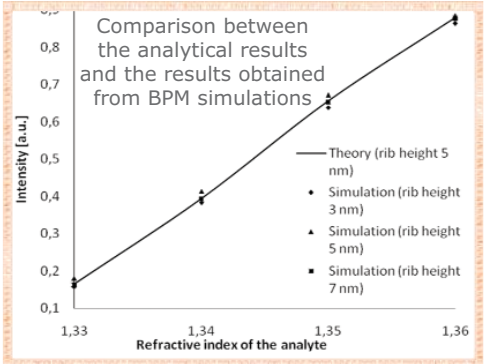
Cooperation with Micro- and Nano- fluidics Lab, Phys Andrei Avram.
Laboratory Contact: PhD student Roxana Rebigan (Roxana.Rebigan@imt.ro)

Silicon pillars with different shapes&sizes obtained using ICP plasma etching [a)-d)] and combined dry and wet etching [e)–g)].

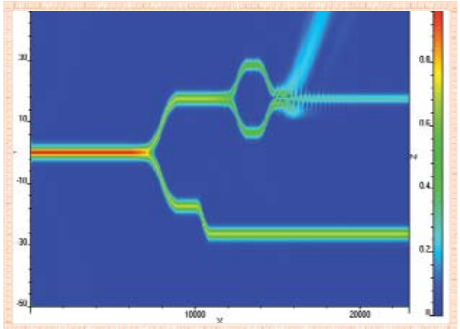
Design of microphotonic sensors for biomedical and or environmental applications

A refractometric sensor based on an integrated Mach-Zehnder interferometer with calibration waveguide has been designed and simulated using BPM software in order to optimise this type of sensor. The silicon nitride rib waveguides have been optimized to present single-mode behaviour even for fair fabrication tolerances. The length of the sensing window has been selected with the use of the analytical expressions so that one can obtain a monotonic and more preferable a quasi-linear dependence. The theoretical predicted sensor response has been confirmed by numerical simulations even if the fabrication errors have been considered.

The role of input and output Cr thin film sections for the improvement of the sensor performances has been also investigated. It has been obtained a strong attenuation of the effects associated with radiation input coupling misalignment if input Cr thin film blocking zones have been used in conjunction with the consideration of a reasonably long input waveguide. Also, the use of output Cr thin film sections may block the output scattered radiation (especially at destructive interference) so that one can avoid the crosstalk between the sensing signal and the calibration signal.



Postdoctoral grants POSDRU/89/1.5/S/63700

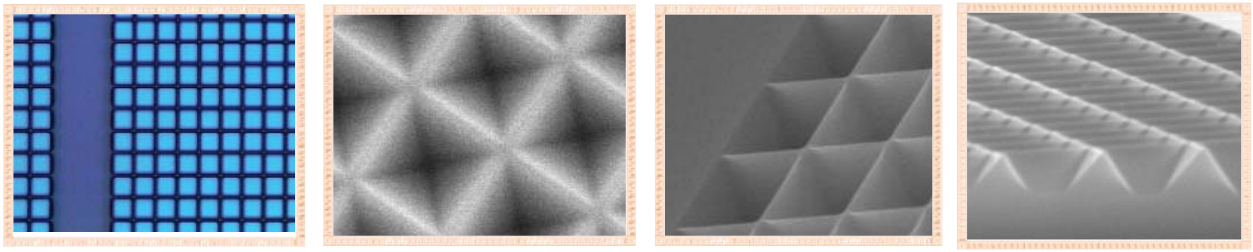


BPM simulation of radiation propagation in the sensor structure by considering the influence of the output Cr section.

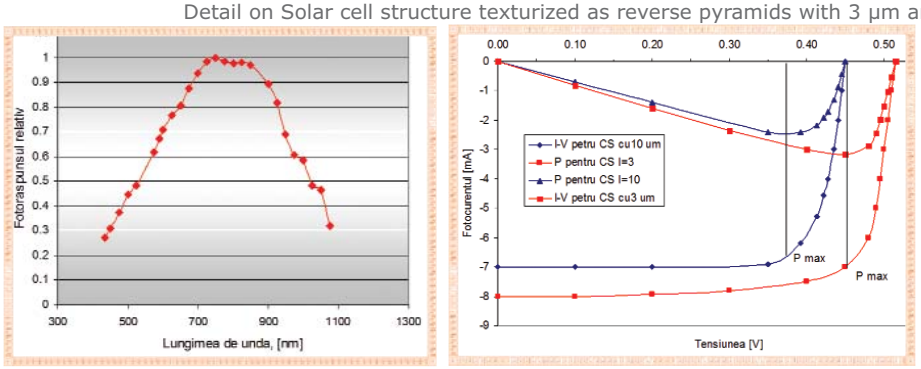
Contact person: Dr. Mihai Kusko (mihai.kusko@imt.ro)

Technology for high-efficiency solar cells manufacturing

The main objective is to realize new silicon-based devices using unconventional technologies – photovoltaic cells displaying high conversion rates, made on texturized silicon surfaces. Texturizing process applied upon the optically active surface leads to increasing both the maximal output power and the conversion efficiency. Main parameters of texturized solar cell under standard illumination - AM1,5 :



Detail on Solar cell structure texturized as reverse pyramids with 3 μm and 10μm edge



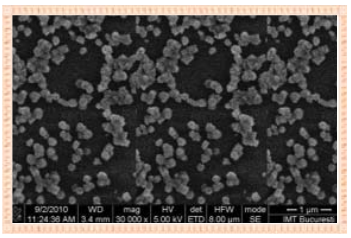
Spectral characteristics of texturized solar cells structures.
I-V and P_{ie} characteristics for the 3 and 10 μm texturized solar cells.

- Short-circuit photocurrent: I_{SC} = 195 mA;
– Open-circuit voltage: V_{OC} = 0,5 V;
– Fill factor: FF = 77%
– Conversion efficiency: η=18.8 %;
– Spectral range: λ∈ 350 - 1100nm;

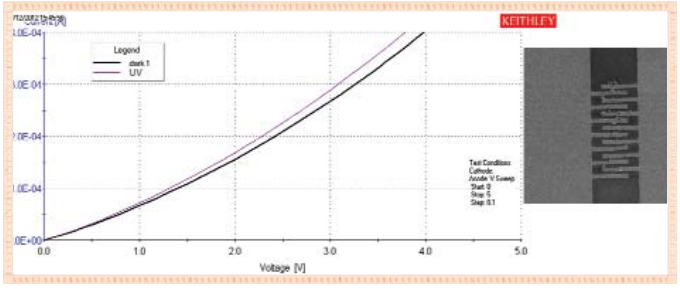
Cooperation with Molecular Nanotechnology Laboratory;
Contact: Dr. Elena Manea (elena.manea@imt.ro)

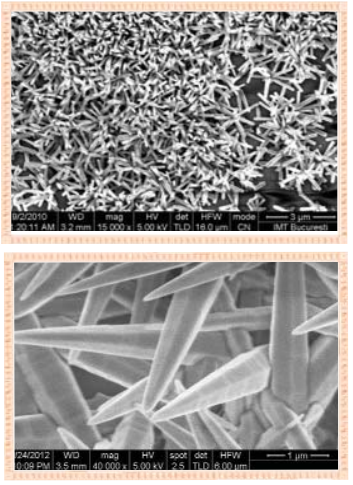
ZnO interconnected nanowire networks grown from solution on patterned substrate

Localized growth of ZnO nanowires (NWs) on transparent substrates such as glass, quartz, ITO/glass was achieved combining low temperature (<100 °C) hydrothermal method for ZnO NWs growth with electron-beam lithography (EBL) for defining the growth region in PMMA in desired area.
ZnO NWs patterned growth consists of the three step process:
- Configuration of interdigitated metallic electrodes (Cr/Au of 20/150 nm) and contact pads; - Defining the growth region in PMMA using EBL in the electrodes area; - Seeding the substrate with discontinuous dispersed ZnO nanoparticles and growth of ZnO interconnected nanowires networks in aqueous solution of Zn nitrate hydrate and hexamethylenetetramine at 90 °C for 3h.
ZnO NWs of typically ~ 100 nm diameter and ~ 2 μm long grew on the substrates along the c axis of the wurtzite crystal with different growth orientations. The ZnO NWs connect the two adjacent gold electrodes through forming complex interconnected nanowire networks as can be observed in the figure below. Current-voltage characteristics showed a photoconductive behavior and UV radiation sensitivity.



SEM image of ZnO nanoparticules seeding





SEM images of ZnO interconnected nanowire networks grown on quartz

Cooperation with University "Dunarea de Jos" Galati in the project MNT ERA NET Project "Multifunctional Zinc-Oxide based nanostructures: from materials to a new generation of devices (MULTINANOWIRES)"

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

Laboratory of Micromachined Structures, Microwave Circuits and Devices

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

TThe laboratory is one of the promoters of the RF– MEMS topics in Europe. It 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 2 FP7 IPs (**NANOTEC, SMARTPOWER**), 2 FP7STREPs **(MEMS-4-MMIC, NANO RF**) and FP7 INCO action (**MOLDONANONET**).

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**.

Main areas of expertise: • Development of a new generation of circuits devoted to the 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: • **MEMS-4-MMIC** - FP7-ICT-2007-2, No.204101-"Enabling MEMS-MMIC technology for cost-effective multifunctional RF-system integration", (2008-2012), Coordinator: IMST GmbH Germany

SMARTPOWER – FP7-ICT-2011-7, No 288801 - « Smart integration of high power electronics for industrial and RF applications » - Coordinator 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

• **NANO RF** - FP7-ICT-2011-8, No 318352 "Carbon based smart systems for wireless applications", Coord. Thales Research & Technology, France, 2012-2015

• **MOLDONANONET** - FP7, INCO.2011-6.1, No 294953 "Enhancing the capacities of the ELIRI Research Institute in applied research to enable the integration of Moldova in the European Research Area on the basis of scientific excellence " Coordinator: ELIRI, Republic of Moldova, 2011 - 2014

ENIAC-JU: MERCURE (ENIAC-2009-1) "Micro and Nano Technologies Based on WBG Materials for Future Transmitting Receiving and Sensing Systems" (2010 – 2013); **NANOCOM** (ENIAC-2010-1) "Reconfigurable Microsystem Based on WBG Materials, Miniaturized and Nanostructured RF-MEMS" (2011 – 2013)

COST Action: MP0805. "Novel Gain Materials and Devices Based on III-V-N Compounds";

MNT-ERANET project: MEMIS - "MEMS Based Millimeterwave Imaging System" (2010-2012);

National Projects: 3 projects in the IDEAS programme (2011 – 2014): "Nanoelectronic devices based on grapheme for high frequency applications" (coord. Dr M. Dragoman), "Novel technologies based on micromachining and nano-processing of GaN/Si, for advanced microwave and photonic devices" (coord. Dr. A. Muller) and „Millimeter-wave Front-End for Imaging in Security and Medical Applications" (coord. Dr. D. Neculoiu) and two project as partner in Partnership (PN II) programme (2012 – 2015).

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 five 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" (2001);

Research team has multidisciplinary expertise in physics and electronics of microsystems and is composed of 12 senior researchers (10 of them with PhD in physics, electronics, microwave and chemistry), one PhD student in electronics and one master student.

Specific facilities: "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, cryostat set-up for measurements in the 5-500K temperature range.

Computers and software for microwave electromagnetic simulations (IE3D, Fidelity, CST and AWR software packages).

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 for GaAs MMICs, design, modeling and manufacturing of microwave passive membrane supported circuits (1997-European priority), micromachined inductors, filters and antennae, monolithically and 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.

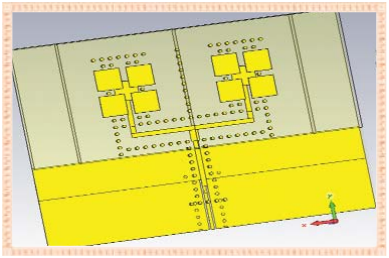
Main achievements:

FP7 Project MEMS-4-MMIC

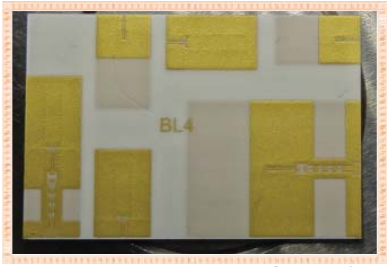
Enabling MEMS-MMIC technology for cost-effective multifunctional RF-system integration" - MEMS-4-MMIC, FP7-ICT-2007-2, No.204101

Partners: IMST GmbH, Germany (coordinator), Swedish Defence Research Agency- FOI, Sweden, Technical Research Centre of Finland-VTT, Finland, OMMIC, France, IMT Bucharest, Romania, Institut d'Electronique de Microélectonique et de Nanotechnologie, IEMN, France.

Responsible of IMT team *Dr Dan Neculoiu*, dan.neculoiu@imt.ro



2x1 antenna array for 77 GHz



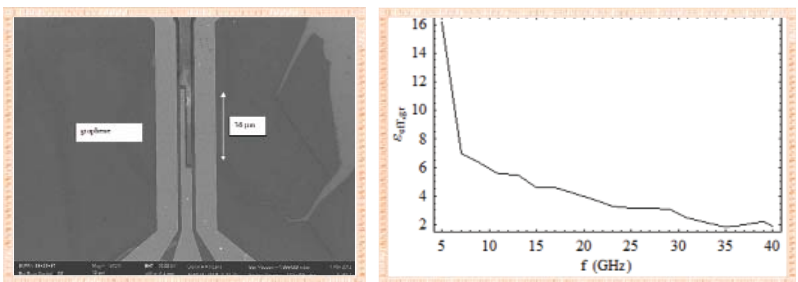
Antennae structures manufactured in LTCC technology

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 and in design, realisation & measurement of antenna arrays on LTCC including MEMS MMIC components.

FP7 STREP NANO RF (2012 – 2015)

Partners: Thales SA - Thales Research & Technology France (coordinator), Chalmers University, Sweden, FORTH, Greece, LAAS Toulouse France, Université Pierre et Marie Curie France, IMT-Bucharest, Romania , Graphene Industries U.K., Thales Systemes Aeroportes, France, SHT Smart High-Tech AB, Swedish, Università Politecnica delle Marche Italy, Linköping University Sweden, Catalan Institute of Nanotechnology Spain, Tyndall Institute Ireland

Responsible of IMT team Dr. Mircea Dragoman, mircea.dragoman@imt.ro



SEM image of the CPW line over grapheme and the extracted electrical permittivity

The IMT role is the design of CNT and graphene devices and circuits. We have started to design a coupled coplanar line over graphene from which we have extracted the electrical permittivity of graphene.

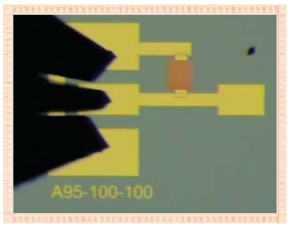
Results

FP7 IP SMARTPOWER (2011-2014)

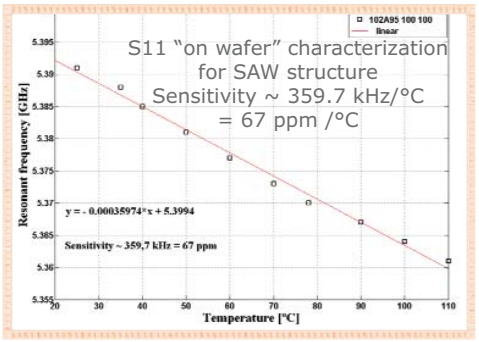
*Partners: T*hales SA - Thales Research & Technology France (coordinator), Thales Systemes Aeroportes, France, CEA - LITEN, France, Schneider Electric Industries, France, Infineon Technologies AG, Germany, Micropelt GmbH, Germany, Fraunhofer-IZM, Germany, Technische Universitaet Chemnitz, Germany, TAIPRO Engineering SA, Belgium, SHT Smart High-Tech AB, Swedish, Chalmers Technical University, Sweden*, IMT-Bucharest, Romania,* FORTH, Greece, Budapest University of Technology and Economics, Hungary.

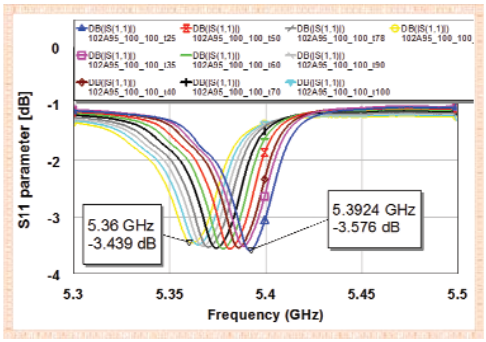
Responsible of IMT team Dr Alexandru Müller

The IMT team is 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 sensing system will be placed close to the MMIC in a radar developed by Thales Systemes Aeroportes to measure the temperature which has to be read far from the radar. Determinations for the frequency shift for the SAW sensor have been done.

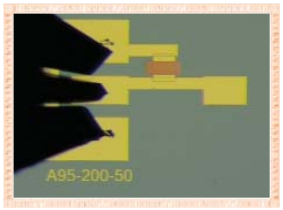


SAW structure having 100 µm finger length and IDTs with 100 finger/interdigit spacing

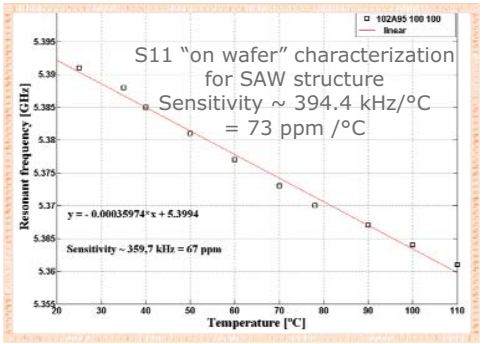


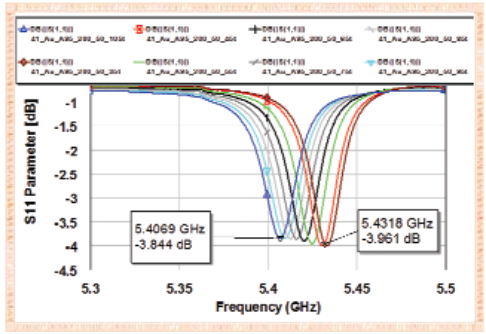


The temperature dependence of the resonance frequency obtained from S11



SAW resonator having 50µm finger length and IDTs with 200 finger/interdigit spacing



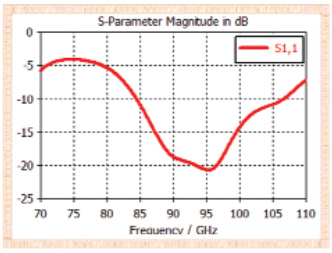


The temperature dependence of the resonance frequency obtained from S11

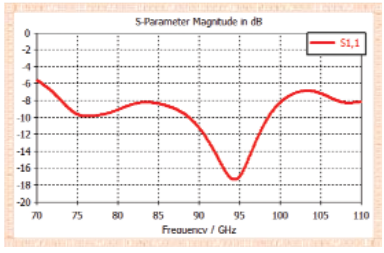
FP7 IP NANOTEC (2011-2014)

Partners: Thales SA - Thales Research & Technology France (coordinator), EADS GmbH, Germany, IHP GmbH, Germany, Silicon Radar GmbH, Germany, FOI-Swedish Defence Research Agency, Thales Systemes Aeroportes, France, Uppsala University Sweden , Coventor SARL France, Fraunhofer-IZM, Germany , OMMIC SAS France, Alfa Imaging S.A. Spain , Ulm Univ. Germany, *IMT-Bucharest, Romania,* FORTH, Greece, TopGaN Ltd. Poland, SHT Smart High-Tech AB Sweden, NKUA Greece.

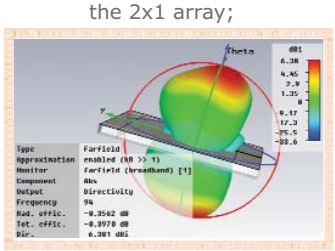
Responsible of IMT team Dr Alexandru Müller



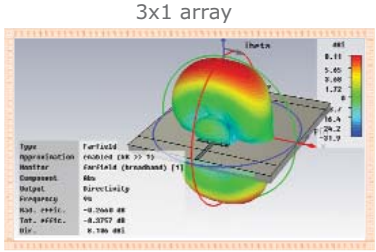
Simulated reflection losses for the 2x1 array;



Simulated reflection losses for the 3x1 array



3D radiation pattern for the 2x1 array;



3D radiation pattern for the the 3x1 array

IMT is involved in design and characterization of 94 GHz front ends manufactured on GaAs and SiGe and in characterization MEMS and NEMS based millimeter wave switches. IMT has investigated on-chip antennas supported by thin dielectric membranes as key building blocks for the 94 GHz high-sensitivity antenna front-end for passive imaging. Double folded slot antenna arrays consisting of two and three radiating elements were designed and simulated.

FP7 INCO Project MOLDONANONET

Responsible of IMT team: Dr. Mircea Dragoman

During 2012, MOLDNONET in the period 25.06-30.06.2012 a summer school was organized at Chisinau, where M.Dragoman has teached the students from various of universities in Moldavia 4 hour/day. Also, Dr. Sircu and Dr.Ojegov from ELIRI-Chisinau have visited IMT at the end of April 2012.

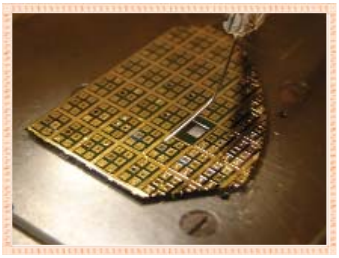
ENIAC Project MERCURE

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

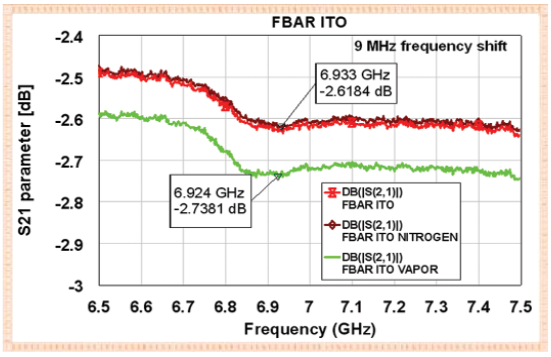
Responsible of IMT team: Dr Alexandru Müller

IMT results for the humidity sensor structure

Details of the experimental set-up for the humidification of the structures



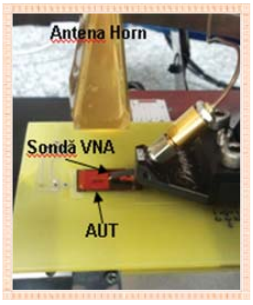
FBAR wafer under test



Simulated reflection losses for the 2x1 array;

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

Coordinator: LAAS Toulouse; partners IMT-Bucharest, VTT Helsinki, 31 Degree France.

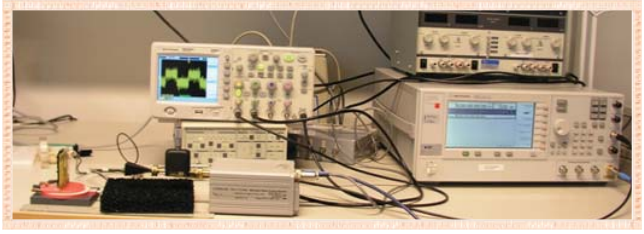


Detail of the measuring set-up for the transmission characteristics measurements

Optical photo of the hybrid integrated receiver front-end at 60 GHz

Responsible of IMT team Dr Dan Neculoiu

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



The experimental set-up for sensitivity determination (imaging sensor for 94 GHz)

Novel technologies based on micromachining and nano-processing of GaN/Si, for advanced microwave and photonic devices

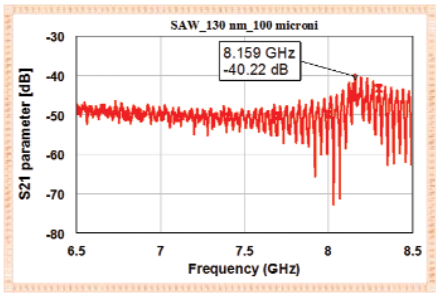
National Project PN2 - IDEI, 2011-2014. *Project leader: Dr. A Muller (alexandru.muller@imt.ro)*

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

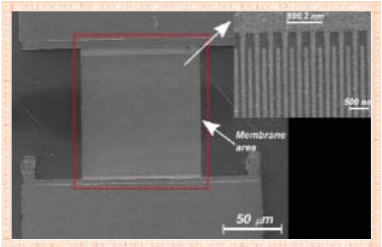
(i) GaN membrane supported UV photodetectors, with IDT (interdigitated transducers) having fingers and interdigits about 100 nm wide, devoted to applications where backside illumination is necessary,

(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



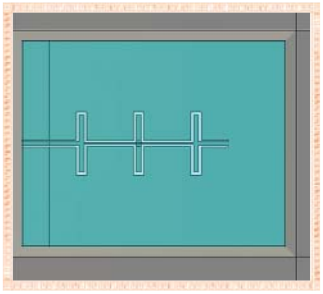
S21 parameter vs frequency for a SAW structure having the distance between IDTs d=100 μm



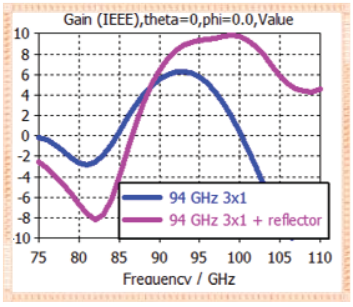
SEM image of the UV photodetector structure having 100 nm wide digit/interdigits (A. Müller, G. Konstantinidis, et al., Thin Solid Films, 520, 2158, 2012)

Millimeter-wave Front-End for Imaging in Security and Medical Applications

National Project PN2 - IDEI, 2011-2014. *Project leader: Dr. D Neculoiu (dan.neculoiu@imt.ro)*



Layout of the 3x1 antennae array for 94 GHz

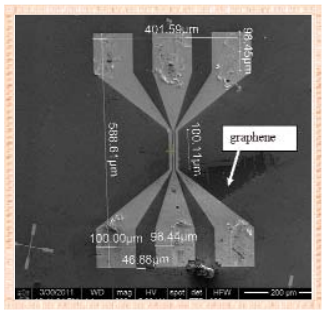


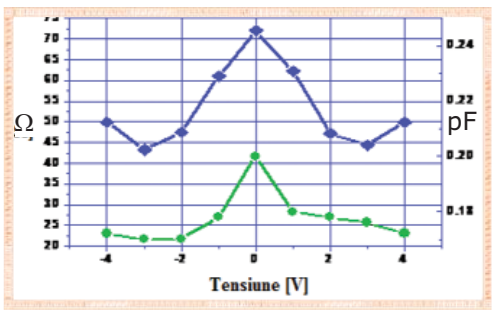
The gain vs frequency for the 3x1 antennae array at 94 GHz

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 micro-machining 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.

Nanoelctronic devices based on graphene for high frequency applications

National Project PN2 - IDEI, 2011-2014. *Project leader: Dr. M.Dragoman (mircea.deagoman@imt.ro)*





In 2012 we have demonstrated a coplanar line CPW line based on graphene. This device behaves very different compared to a similar device based on semiconductors. The transmission depends on an applied dc bias over 0.004-110 GHz and is acting as a natural matching circuit.

Advanced Tools and Methodologies for the Multiphysics Modelling and Simulation of RF MEMS Switches

National Project PN2– Partnership, 2012-2015. *Coordinator: "Politehnica" University Bucharest*
IMT project leader: Dr Alexandra Stefanescu (alexandra.stefanescu@imt.ro)

The main goal is the development of knowledge in the RF-MEMS domain by fundamental and applicative research finalized with a new modelling methodology validated by experiments, aiming to efficiently couple electromagnetic, mechanical and fluid flow phenomena for the design of RF-MEMS switches. Models of manageable size for a set of benchmarks will be manufactured and characterized. The models will account for the dependence on relevant design or operating parameters and their behavior will be experimentally validated.

The project aims to demonstrate potential benefits of using supercomputing in the design of RF-MEMS devices, improve design capabilities for RF-MEMS MMIC technology in Romania and achieve an efficient transfer of knowledge in both directions between a research institute which is more industry oriented (IMT) and a university team specialized in high frequency modelling and high performance computing (UPB).

Novel nanostructured semiconductor materials based on Ge nanoparticules in different oxide for applications in VIS–NIR photodetectors and nonvolatile memory devices.

National Project PN2– Partnership, 2012-2015. *Coordinator: National Institute for Material Physics Bucharest. IMT project leader: Dr. Mircea Dragoman*

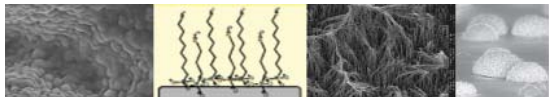
The primary aim of this project is to obtain novel nanostructured semiconductor materials based on Ge nanoparticules with optimized properties to be used in VIS-NIR photodetectors and also in NV memory devices. For application in VIS-NIR photodetectors, we will use Ge nps embedded in different oxides, such as SiO_2, TiO_2, HfO_2.

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).

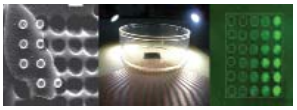
More specifically:

FUNCTIONAL NANOMATERIALS



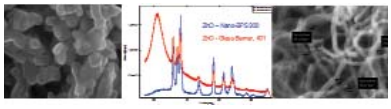
Preparation and characterization of
• metallic / semiconducting nanoparticles;
• polymeric multilayer structures;
• Si based nanocomposite materials, looking also to appropriate surface functionalisation.

NANOMEDICINE



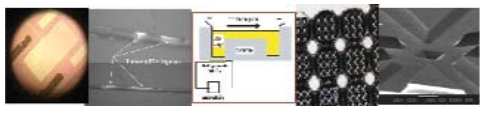
• **drug delivery:** Si based integrated devices and nanoSi based microcarriers
• **diagnosis:** DNA and protein biochips designed in microarray technology

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.

European Projects:

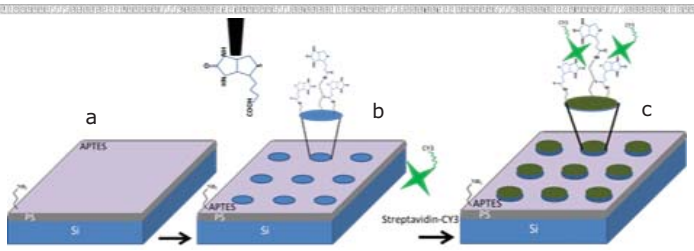
- NanoSustain – FP7-NMP-ENV-2009 (Collaborative Small or Medium-scale focused Research Project, contract: 247989) „Development of sustainable solutions for nanotechnology based products based on hazard characterization and LCA" (2010 – 2013) – coordinator NordMiljö AB;
- NanoValid – FP7-NMP.2010.1.3-1 (Large-scale Integrating Collaborative Project, contract: 263147) "Reference methods for managing the risk of engineered nanoparticles" has been launched on the 1st of November 2011, as one of the "flagship" nanosafety projects (2011-2015) – coordinator NordMiljö AB.

National Projects - PN II Partnership Projects:

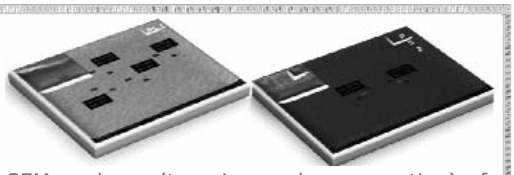
- SiC SET - High Temperature Silicon Carbide (SiC) Smart Sensor for Harsh Environment Industrial Applications (2012-2014) – coordinator Politehnica University Bucharest, Contact person for IMT: F. Craciunoiu (florea.craciunoiu@imt.ro);
- SiC Gas - Environmental toxic and flammable gas detector based on silicon carbide MOS sensor array (2012-2014), coordinator ICPE-CA Bucharest, Contact person for IMT: F. Craciunoiu (florea.craciunoiu@imt.ro);
- HCarrys - Array structures for prevention, individualized diagnosis and treatment in cancers with high risk of incidence and mortality" (2012-2014) - coordinator Institute of Oncology Bucharest, Contact person for IMT: A. Bragaru (adina.bragaru@imt.ro).

The laboratory had finished two MNT-ERA FP7 projects as partners, five Partnership (PN II) projects, one PN-II-Capacities project for development of the public infrastructure, two PN-II-IDEAS projects, and three PNII-Partnership projects as coordinators.

Design and fabrication of dual Detection Biosensor Based on Porous Silicon Substrate

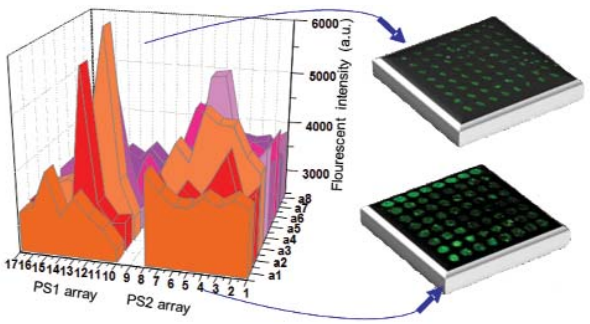


Schematic representation of typical microarray experiment: (a) surface functionalization (b) immobilization of the capture molecules - biotin; (c) hybridization with the fluorescently-labeled analyte of interest or biological sample containing the analyte of interest - steptavidin;

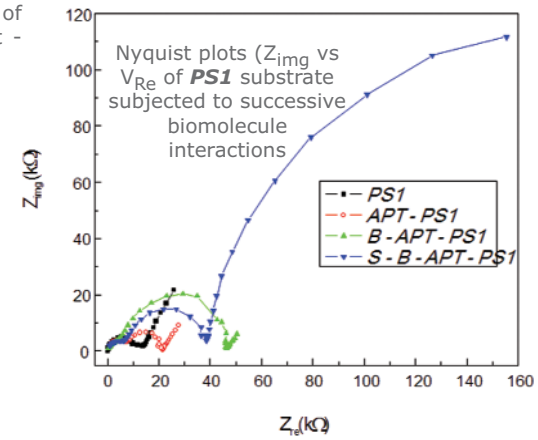


SEM analyses (top-view and cross-section) of different ***porous silicon test substrates***

Fluorescence intensity of the Strepavidin



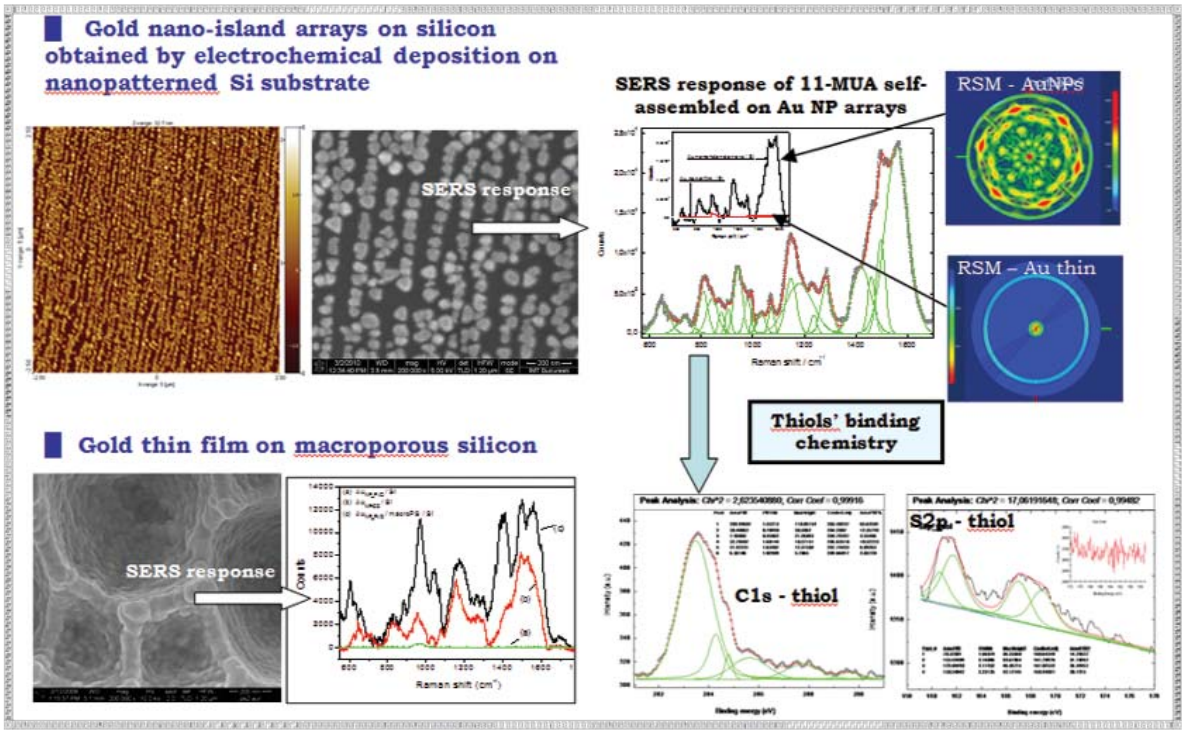
Impedance spectroscopy label free intensity biodetection



A novel platform for surface based sensors with different detection schemes has been achieved by silicon surface nanostructuration and appropriate functionalization processes. Besides fluorescence based detection, it can be used also to label free electrochemical impedance. Our tests have shown that the extension of the active sensor area due to the porous layer structure increases the measured capacitance and thus allows a scaling down of the sensor. Related to this, we have obtained more than five times increase in sensitivity for nano-silicon capacitive immunosensor compared to polished silicon immunosensor, which will allow greater sensitivities.

Contact person: Dr. Monica Simion (monica.simion@imt.ro)

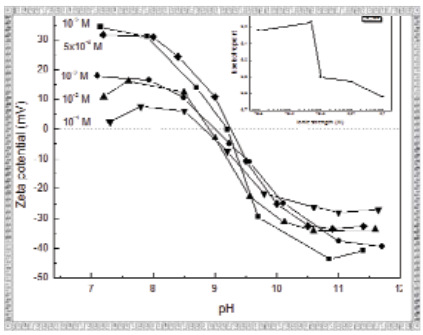
Development of novel technologies for fabrication of SERS active substrates for organic molecule detection

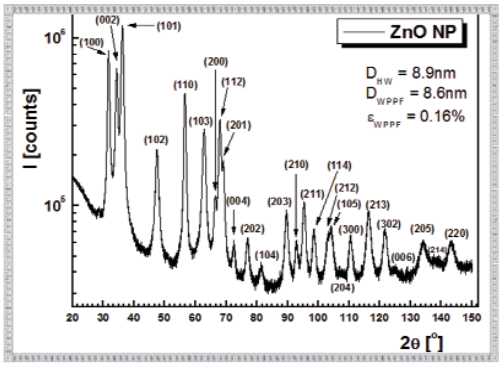


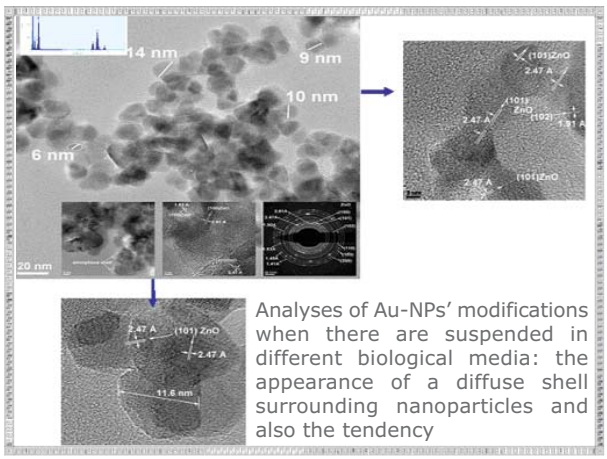
Contact person: Dr. Teodora Ignat (teodora.ignat@imt.ro)

Study of the physico-chemical properties of different nanomaterial based dispersions' and their hydrodinamic diameter and surface charging modifications, relevant for evaluation of their toxicological potential

The DLS observations have been supported by HR-TEM sugestive images of **ZnO-NPs** dispersed in different IS solutions, revealing the ***aggregation process***

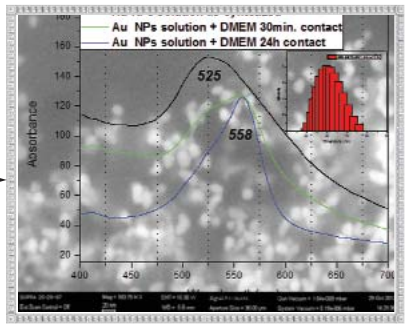






Analyses of Au-NPs' modifications when there are suspended in different biological media: the appearance of a diffuse shell surrounding nanoparticles and also the tendency

The results suggest that solution chemistry exerts a strong influence on ZnO dissolution stability, the complete set of analyses providing useful information towards better control of dosaging during biotoxicological tests.
(J Nanopart Res 15, 2013, 1352).



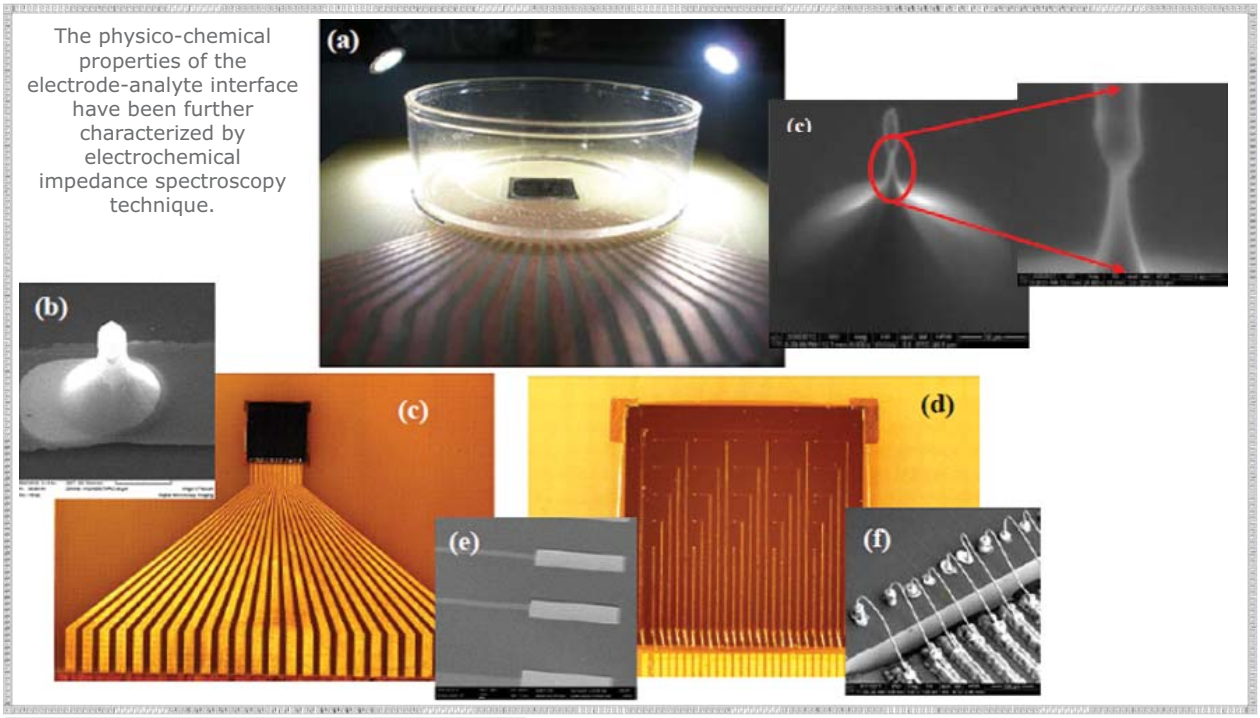
Contact person: Dr. Adina Bragaru (adina.bragaru@imt.ro)

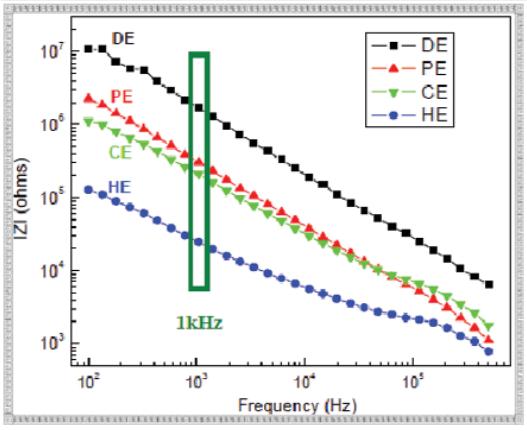
Design, Fabrication and Characterization of Low-Impedance 3D Electrode Array System for Neuro-Electrophysiology

Starting from our group previous experience in fabrication of microelectrode arrays for electrochemical sensors and cell-based biosensors, we have gone beyond towards the development of a novel silicon based multi-electrode array (Si-MEA) microchip that could meet the requirements for recording electrophysiological signals of neuronal networks at multiple points simultaneously.

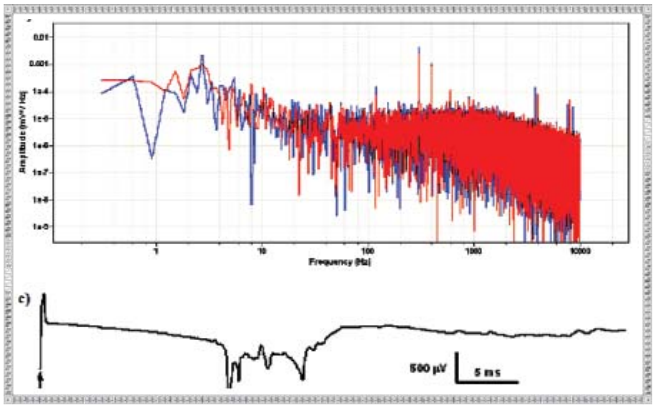
Relevant images of the structures resulted during the process flow:

The physico-chemical properties of the electrode-analyte interface have been further characterized by electrochemical impedance spectroscopy technique.





The EIS results indicate that the impedance modulus features the lowest values for the high aspect ratio electrodes (HE), more than sixty-fold lower compared to the planar ones (DE), from MΩ to kΩ, being in the range of 20–30 kΩ, on the order of the best reported ones and thus, stimulation currents up to ±500 μA could be delivered.



Preliminary tests on acute newborn rat hippocampal slices yielded satisfactory results, similar to those previously reported using similar devices and types of experiments. Given the relative accessibility of silicon-processing technology and flexibility in design and manufacturing, we conclude that this class of MEA devices represents a promising development in several areas of fundamental and applied biomedical research.

Contact person: Dr. Mihaela Kusko (mihaela.kusko@imt.ro)

Nano-Scale Structuring and Characterization Laboratory

Mission: The mission of the laboratory consists in research and development in the field of characterization and structuring for materials and processes at mesoscopic scales. The final aim is to support research and manufacturing activities in IMT Bucharest by providing high resolution surface investigation capabilities and nanoscale patterning through electron beam lithography-based techniques.

Main areas of expertise:

• Nanoscale characterization of surfaces and interfaces by Scanning Probe Microscopy. We have been the first team in Romania to use an Atomic Force Microscope (since 1996).

• Scanning Electron Microscopy (conventional and field emission) and Energy Dispersive X-ray Spectrometry

• Nanoscale patterning by Gaussian beam Electron Beam Lithography (EBL). Our lab was the promoter of this nanolithographic technique at the national level, through the installation in 2006 of the first EBL system in Romania.

• Small-scale mechanical characterization by depth-sensing nano-indentation techniques (first Nano Indenter ever installed and operated in Romania).

Research team: is composed of 2 senior researchers with background in Physics, two Ph.D students - early stage researchers with background in Electronic Engineering and one MSc. student in Physics.

Specific facilities: In the last five years we have equipped our lab with state-of-the-art facilities worth about two million euros, mainly through funds from research grants.

• **Multifunctional Scanning Probe Microscope (SPM) Ntegra Aura – NT-MDT.**
It performs measurements of the topography and maps various physical properties of the surfaces (force, current-sensing and surface potential measurements etc); Built-in capacitive sensors, active antivibrational table; fluid cells and environmental hood for operation under different environments: air, liquid, controlled gaseous atmosphere, low vacuum (10-2 torr); Scan range: 100x100x10 µm, noise level, XY: 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 both E-T and in lens, 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 uses low vacuum atmosphere (nitrogen) up to 150 Pa. Equipped with Energy Dispersive X Ray Spectrometer with Si(Li) detector – EDAX

• **Raith e_Line - Electron beam lithography and nanoengineering workstation**. It is a versatile e-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. 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, but could be equally applied to investigate bulk samples. 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.

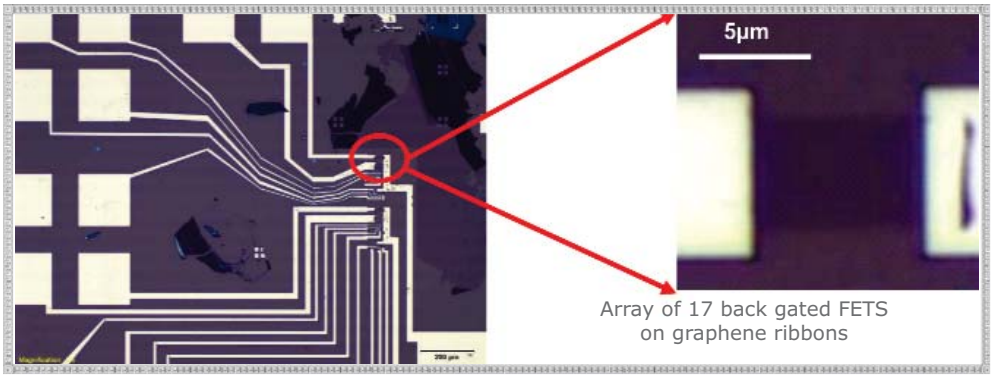
Dr. Adrian Dinescu coordinated 10 national research projects and was the coordinator from the Romanian part of the FP-7 STREP project - CATHERINE. He co-authored about 25 papers in refereed international journals.

► **Partner in national projects: STAR- Technology – Strategic project, National Program "Space Technology and Advanced Research")**

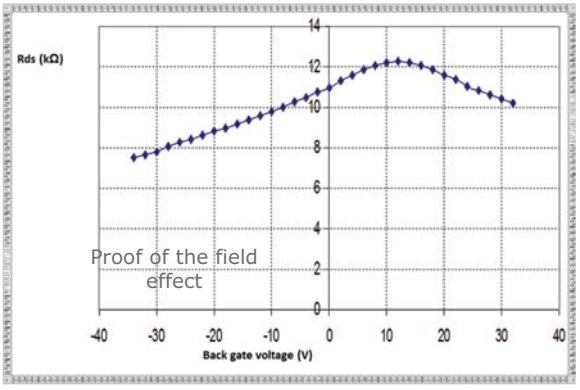
► **Cooperations at the national level – companies: Zoomsoft S.R.L., Honeywell, Romquartz**

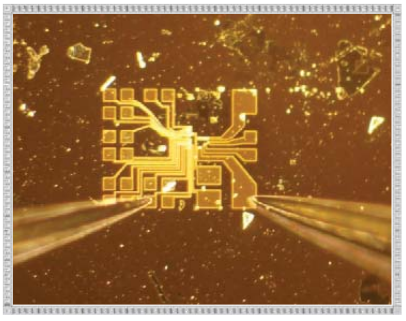
► First graphene-based Back Gated Field Effect Transistor at national level

A back-gated Field Effect Transistor device has been manufactured from single layer graphene for the first time at national level. A commercial graphene sheet on top of silicon oxide was patterned to ribbons by Electron Beam Lithography and Reactive Ion Etching. The metal contacts for Source and Drain were defined by electron beam lithography and lift-off. The back-gate has been used to modulate the drain current, confirming the field effect of the graphene device.



Array of 17 back gated FETS on graphene ribbons



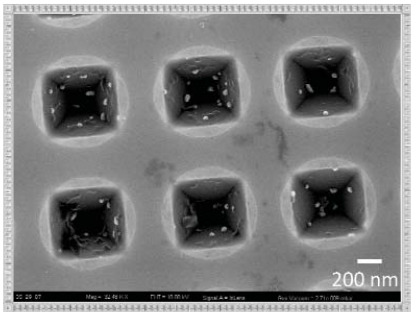


The device under test, on the probing station

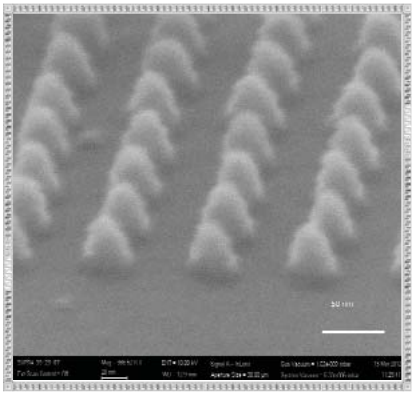
► Nanoscale texturing of silicon surface by electron beam lithography and wet etching for applications to high efficiency photovoltaic conversion

► Nanoscale structuring using Electron Beam Lithography

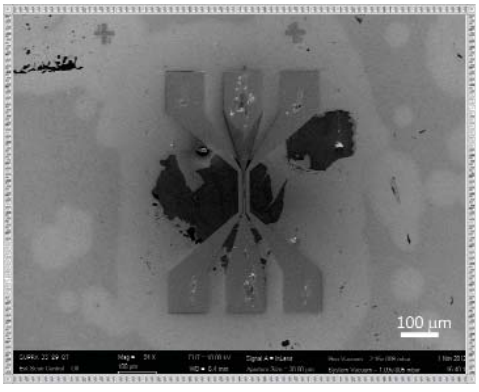
Combining the strengths (resolution and flexibility) of Gaussian beam electron beam lithography with some other nanofabrication technologies (wet and dry etching, thin film deposition and lift-off) we have fabricated a variety of nanostructures with applications in photonics, SPM calibration, DUV lithography,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



SEM micrograph of inverted pyramids produced by anisotropic etching of Si



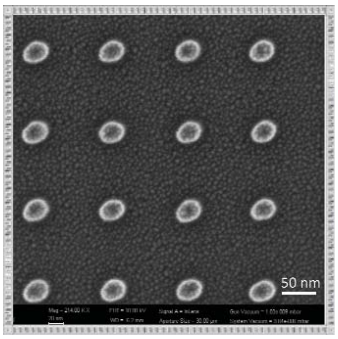
Gold nanodots for SERS applications (cooperation with the Laboratory of Nanobiotechnology)

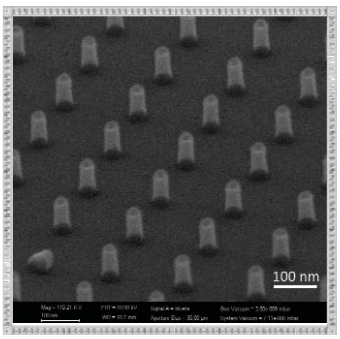


CPW structure on graphene (cooperation with the Micromachined structures, microwave circuits and devices Laboratory (RF-MEMS))

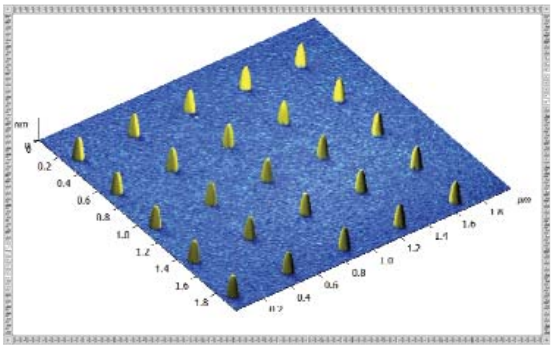
► Three dimensional structures with scale in the nanometer range and > 2 aspect ratio fabricated by Electron Beam Induced Deposition (EBID)

By using Electron Beam Induced Deposition in combination with local etching of PMMA (polymethyl methacrylate) we have produced various 3D nanometric structures with >2 aspect ratio-dots, columns, lines of the SPL (Single Pixel Line) type, holes and etched lines. All these basic geometries could be further combined in complex structures for various applications in micro and nanofabrication: test structures for measuring mechanical and/or electrical properties of carbon nanotubes and graphene, master structures for Nano Imprint Lithography or for replication in PDMS, photonic components (photonic crystals and waveguides) etc.
Platinum (Pt) columns and lines with various geometries were deposited under the action of the electron beam using (Me3)MeCpPt as a precursor. Holes and lines with dimensions in the nm range and aspect ratio greater than 2 have been fabricated in PMMA by electron beam induced etching in the presence of water vapors.





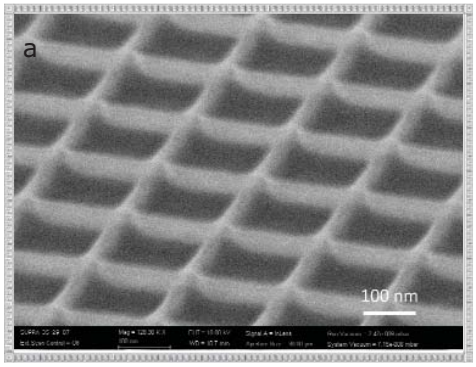
SEM images of two patterns etched in PMMA of 50 nm thickness by EBIE consisting in (a) holes (25 diameter, 100 nm pitch); (b) lines (35 nm width, 400 nm pitch)

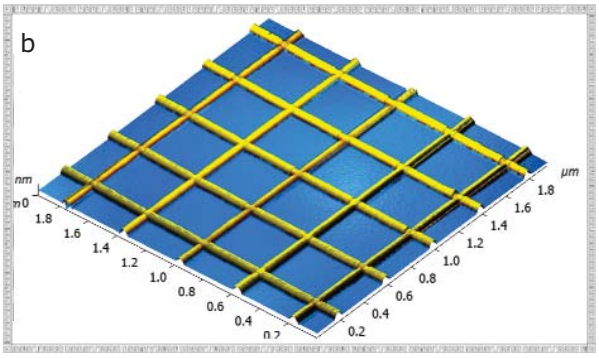


Pt columns deposited by EBID on Si - a) SEM micrograph, top view,100 nm pitch; b) SEM micrograph, 45 deg. tilt angle, 200 nm pitch,; c) AFM scan, 200 nm pitch, 2μm x2μm scan area

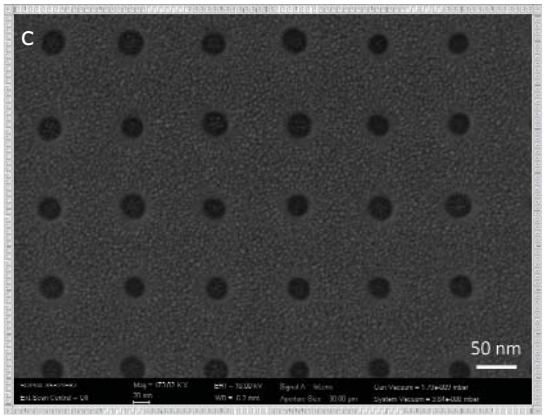
Developing new techniques for nanoscale structuring and characterization

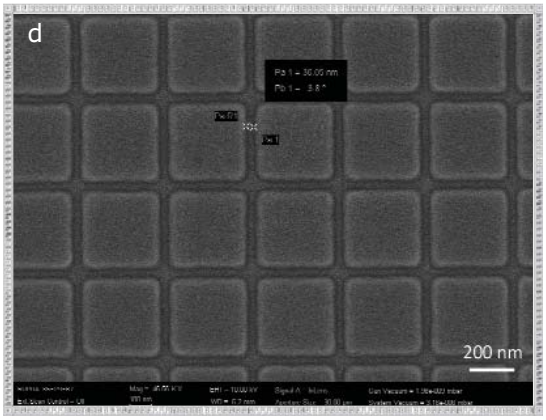
National basic funding project: IMT core program Convert - project PN 09290306





a) and b) SEM and AFM images of two areas with crossed lines generated by EBID at 200 nm and respectively 400 nm pitch

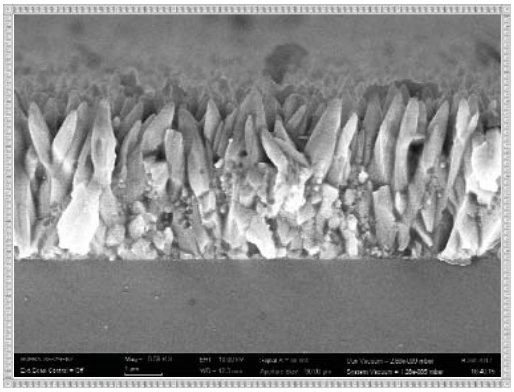




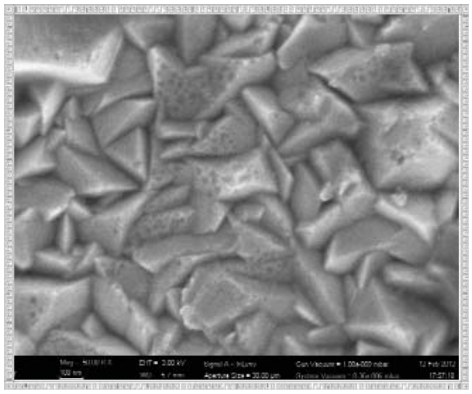
SEM images of two patterns etched in PMMA of 50 nm thickness by EBIE consisting in (c) holes (25 diameter, 100 nm pitch); (d) lines (35 nm width, 400 nm pitch)

► High resolution - LV- SEM imaging

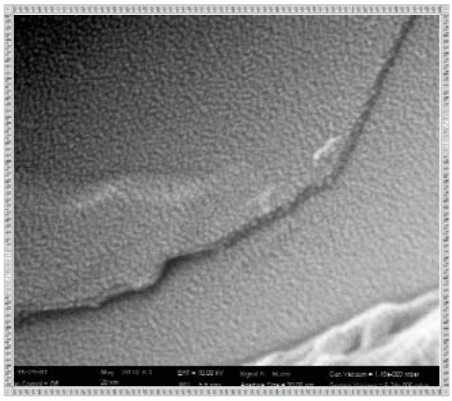
Low Voltage SEM (FEI Nova NanoSEM 630 and Raith_Line) has been used to investigate a large variety of samples at the nano-scale. We are able to perform true surface imaging for low atomic number or non-conducting specimens without coating them with metal.



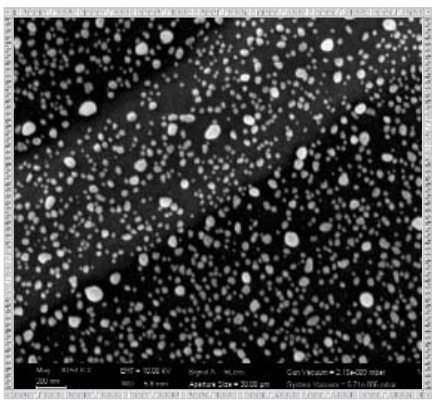
ZnO on glass



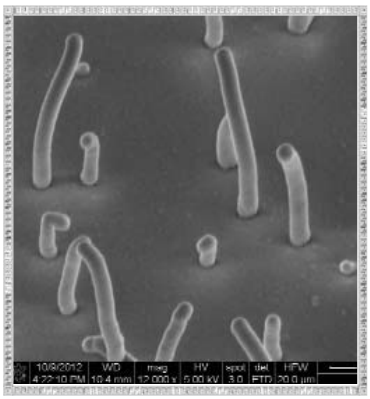
PbS on glass



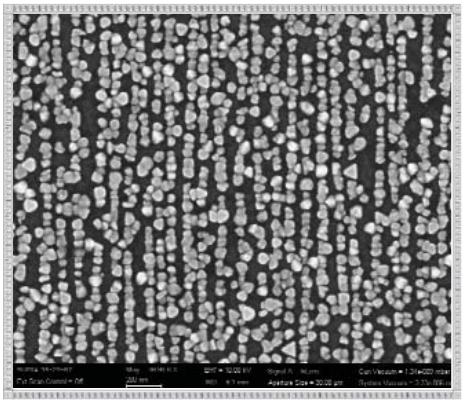
Gold coated graphene



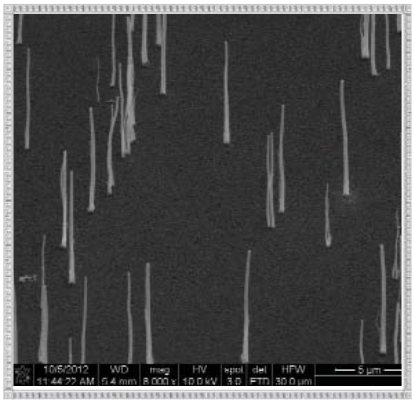
Ag nanoparticles on graphene



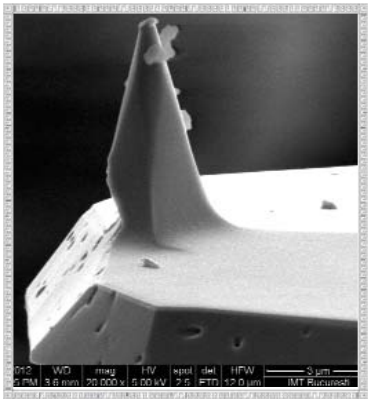
SiO_2 coated CNT's



Gold nanoparticles on Si (111) for SERS applications



Carbon nanofibers on silicon dioxide



Contaminated AFM tip

► Teaching activity:

Master (M. Sc.) Course "Microphysical characterization of micro and nanosystems" for the Advanced Master Studies in Microsystems at the Faculty for Electronics, Communications and Information Technology, University "Politehnica" of Bucharest.

Molecular Nanotechnology Laboratory

• Mission
• Main areas of expertise
• Research Team

Mission: We address the following research 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 nanocomposites 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.

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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.

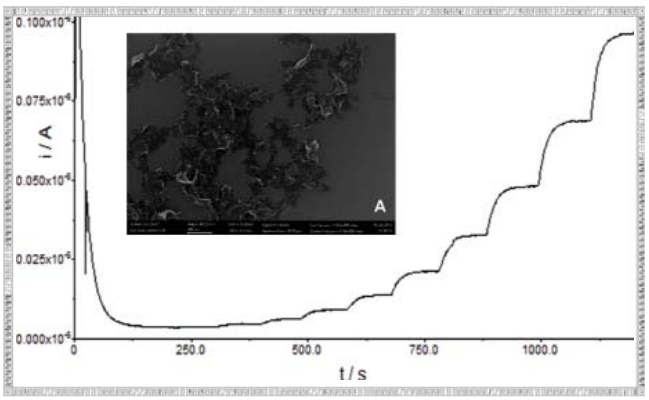
Research team: The lab was established in 2009, but it gained critical mass between 2010 and 2011, when 6 researchers out of its current 8 members joined the team construction. The lab team consists from 3 physicists, 3 chemists and 2 engineers. All members are PhD graduates and the average age is 38.

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.

Graphene and graphene oxide modified electrode for NADH and L-lactic acid investigation



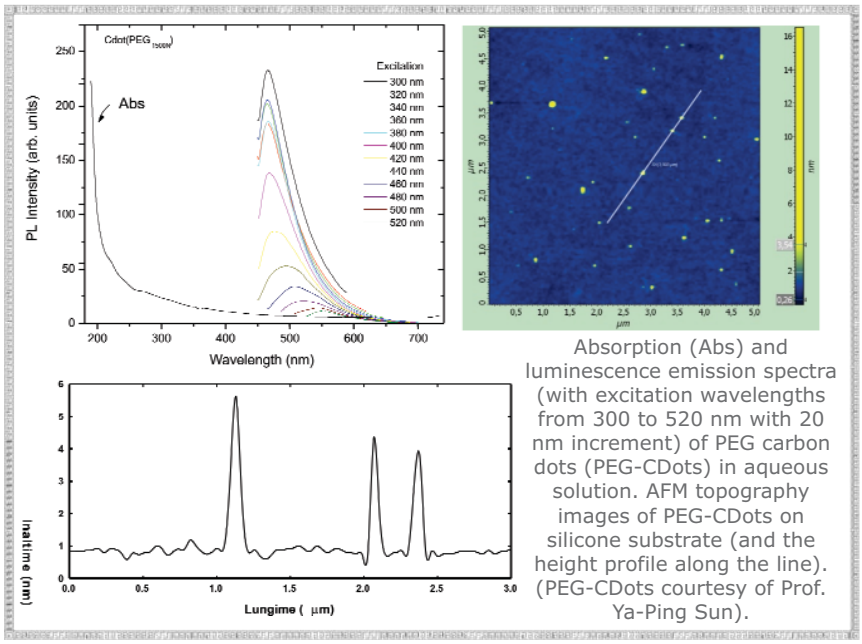
Amperometric recordings of the L-Lactate biosensor in presence of successive additions of L-lactic acid in supporting electrolyte; SEM of graphene flakes (inset).

Pristine graphene platelets and graphene oxide were used as electrode modifiers, aiming at the investigation of their electrochemical efficacy towards β-nicotinamide adenine dinucleotide. Relying on the graphene modified transducer, L-lactic dehydrogenase (L-LDH) was successfully immobilized in a 1% Nafion® membrane. The developed biosensor worked at an applied potential of +250 mV vs. Ag/AgCl reference electrode and was used to assess L-lactic acid in four different types of yogurts, revealing an L-lactic acid concentration ranging between 0.3% and 0.6%.

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

Carbon quantum dots: exploring a new concept for next generation opto-electronic devices

Carbon nanodots (or Carbon quantum dots, CQDs), a newly discovered class of nanocarbon materials, are inspiring gradually expanding research efforts due to the increasing number of identified properties. Deeper fundamental research on the photophysical properties of these nanocarbons promises to reveal their potential to become an important component in various applications. In this context, our studies are aiming to demonstrate the functionality of optoelectronic devices, LEDs and PVs, based on CQDs by thoroughly understanding from experimental and theoretical point of views the electronic, optical and transport properties of the appropriately passivated CQDs.

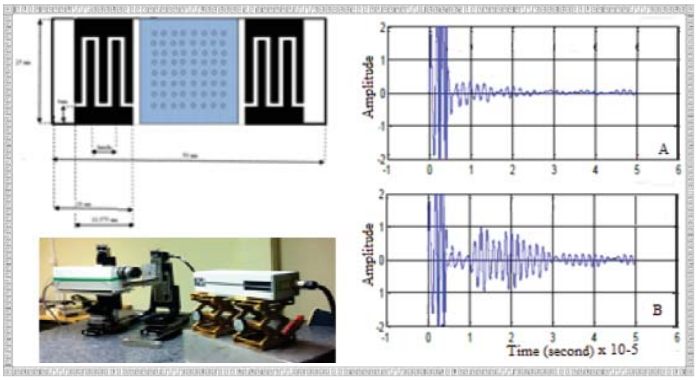


Absorption (Abs) and luminescence emission spectra (with excitation wavelengths from 300 to 520 nm with 20 nm increment) of PEG carbon dots (PEG-CDots) in aqueous solution. AFM topography images of PEG-CDots on silicone substrate (and the height profile along the line). (PEG-CDots courtesy of Prof. Ya-Ping Sun).

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

Phononic SAW device

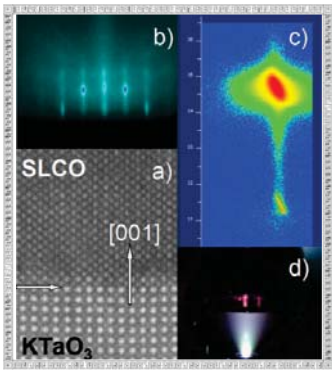
This work is addressing the fabrication and acoustic characterization of surface acoustic wave (SAW) based phononic crystal (PhC) device. The interdigital SAW transducers (Silver) together with PhC structure (2-dimensional) were fabricated on the YZ lithium niobate wafer by by ICP - DRIE. Megahertz surface acoustic waves have been optically generated and detected using the laser-induced grating technique. A strong attenuation of the acoustic signal is obtained when the PhC crystals are present in the SAW area, while the wave packets preserve their position in time.



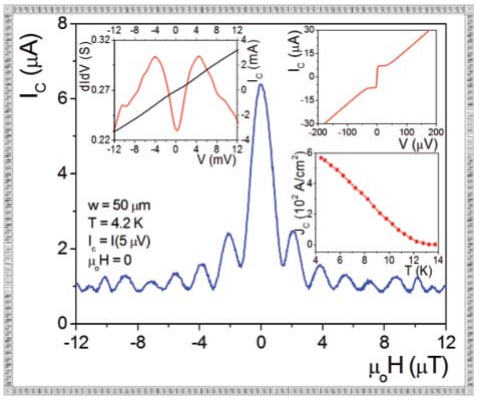
Time evolution of the acoustic signal in the SAW device without PC (B) and PC (A) in the active area for the central frequency 0.7 MHz.

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

Studies on the microscopic mechanism of superconductivity and applications



$Sr0.85La0.15CuO_2$ thin film grown on $KTaO_3$ (001): a) STEM image, b) RHEED pattern, c) XRD reciprocal space map of (101) plane, and d) plasma plume.



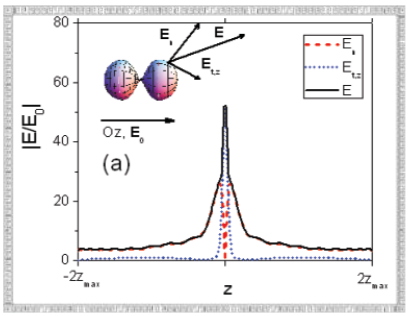
Transport properties of a 50 μm wide 30° symmetric $Sr0.85La0.15CuO_2$ grain boundary junction at 4.2 K.

Apart from their promising application potential, the copper oxide superconductors (HTSc) – low dimensional doped Mott insulators with strongly correlated electrons or holes as charge carriers - remain a challenge in solid state physics due to the still unknown microscopic mechanism of superconductivity in these materials. Our work focuses on understanding the correlation between the structure and transport properties in HTSc thin films and Josephson junctions, as well as device fabrications.

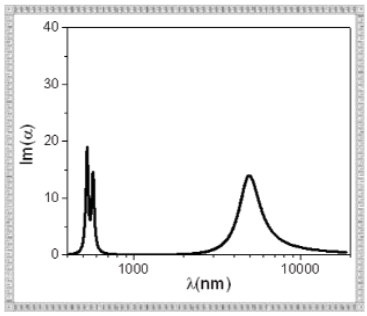
The materials of interest are the electron-doped cuprate from the infinite-layer type class, namely $Sr1\text{-}xLaxCuO_2$ (SLCO), for doping levels x=0.125-0.175, in order to determine the order parameter symmetry in this system. For structural characterization the films were prepared by pulsed laser ablation on a series of substrates, e.g., $KTaO_3$ (001), $BaTiO_3$-buffered $SrTiO_3$ (001) or $DyScO_3$ (110). Grain boundary junctions have been structured by optical lithography on [001] symmetrically tilt 24°, 30°, 36.8° $SrTiO_3$ [001] bicrystal substrates and their structural and transport properties analyzed. 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. The work on these materials is done in collaboration with groups from National Institute for Laser Processing, Magurele (Romania), Institute of Physics, University of Tübingen (Germany), University of Loughborough (UK), and Karlsruhe Inst of Technology (Germany).

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

Calculation of the near-field enhancement in metallic nanoparticles



The near-field enhancement in the x-z plane at the plasmon resonance wavelength of λ=4867 nm (in the near-IR)



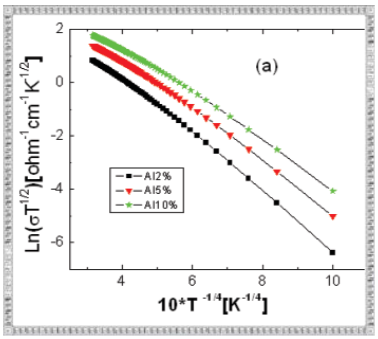
Extinction spectra of a spherical dimmer

Localized plasmon resonances in noble metal nanoparticles are studied for sensing applications. There are two key factors in plasmon resonances: large optical absorption (extinction) at plasmon resonance wavelength and a huge electric field enhancement near nanoparticles. We proposed a calculation method of field enhancement around metallic nanoparticles performed in a boundary integral equation formulation. The method relates directly the spatial behavior of near-field enhancement to the eigenfunctions associated with the boundary integral equation. It allows a fast identification of hot-spots on nanoparticles and it has the ability to help in the process of optimizing the near-field enhancement, a figure-of-merit in plasmonic based sensors.

Ab-initio related studies of wide-bandgap semiconductors

The wide-bangap semiconductors and their doping play a major role in transparent electronics. We carried out ab-initio calculations of electronic structure in doped wide-bandgap semiconductors by Coherent Potential Approximation implemented in the Density Functional Theory. We also performed theoretical study of Variable Range Hopping (Mott) conduction in the same doped wide-bandgap semiconductors.

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



Mott's conductivity versus temperature for Al doped ZnO, which is manifested as a T-1/4 dependence.

Simulation, Modelling and Computer Aided Design Laboratory

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, micro-channels, 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 research areas:

■ **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 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;

From left to right: Rodica Voicu, Rodica Plugaru, Catalin Tibeica, Victor Moagar-Poladian, Raluca Muller, Gabriel Moagar-Poladian, Oana-Tatiana Nedelcu, George Boldeiu

Research team:

Research 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.

Simulation, Modelling and Computer Aided Design Laboratory

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, piezo-electric, pneumatic, electroosmotic), micro-reservoires, 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).

Teaching activities

■ Labs for students hands on training) "**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 MSc in Microsystems, 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

• **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.

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.

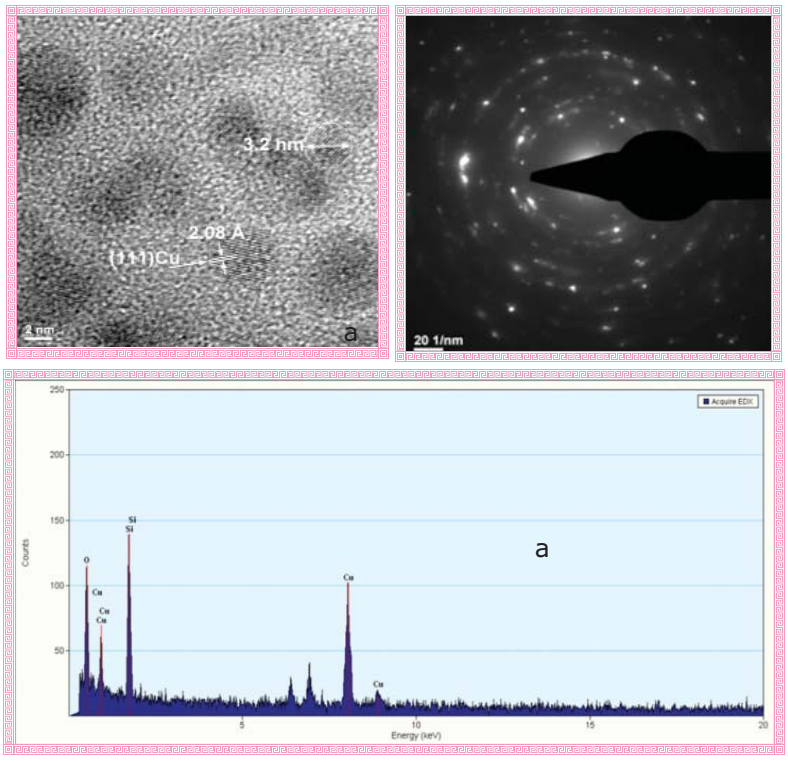
Her main scientific interests include design and technological processes for sensors and actuators based on MEMS/MOEMS techniques, integrated optics, nanolithography. She was involved in teaching activities as associated professor at Univ. "Valahia Targoviste" and Master of Science courses at Univ. Politehnica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

BILATERAL PROJECTS

Experiment and Modeling of Physical Processes in Porous Silicon/Metal Systems.

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 on the subject: Experiment and Modeling of Physical Processes in Porous Silicon/Metal Systems.



Nanoporous silicon filled with copper obtained by electrochemical deposition using 0.1 M $CuSO_4$ + 0.05 M H_2SO_4 solution: (a) HRTEM image of silicon nanopores and Cu nanoparticles; (b) SAED pattern of the area presented in (a); EDX spectrum showing O-K, Cu-K and Si-K characteristic peaks.

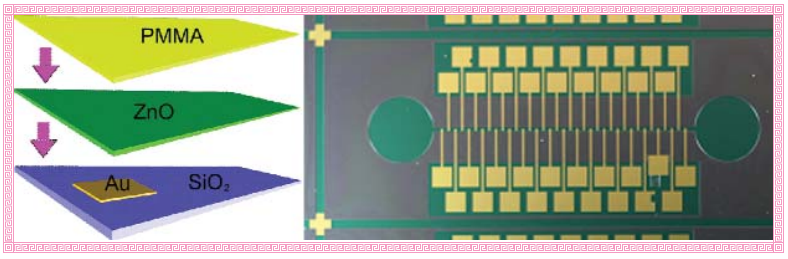
Contact person: Dr. Rodica Plugaru (rodica.plugaru@imt.ro@imt.ro)

Biochemical sensors based on nanoporous InP and metal nanpoparticles, obtained by MEMS/MOEMS techniques for electrical and optical measurements

Bilateral Cooperation with Institute of Applied Physics, Academy of Science of Moldova (2010-2012)

We developed am electrowetting on dielectric chip (EWOD) transparent for THz radiation that allows easily scanning of any bio-fluid moving through the microchannel. The structure was obtained by thermal oxidation of a (100) Si wafer. A positive photoresist (PMMA) was used to configure Cr-Au pads, obtained by lift-off method. ZnO was deposited by RF magnetron sputtering.

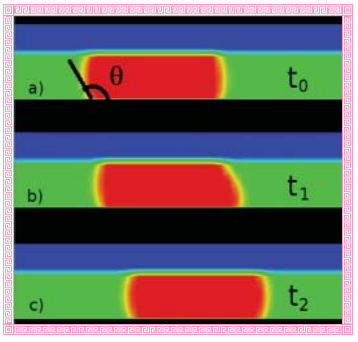
In order to have a structure with hydrophobic surface we left the ZnO material on the surface of EWOD chip. As the undoped ZnO is considered dielectric we remove it from external pads for contacting with microcontroller circuit.



Technological processes steps (left), and EWOD device optical microscope image (right)

The EWOD device can be used to manipulate droplets for dispensing, transporting, splitting, merging, and mixing. We used a method in order to manipulate liquid droplets in digital microfluidics (discrete droplet-based). The next figure (a, b and c) presents the results of simulation, using COVENTOR, for the moving process inside of microchannel at different moments of time t0, t1 and t2 respectively.

Moving of microdroplet inside of microchannel. a, b, c) position of the microdroplet for moments of time t0, t1 and t2, respectively (COVENTOR)- Hydrophobic ZnO used in EWOD technology and SAW devices for better bio-fluid slip at microchannel walls controlled by DC pulses - L. Sirbu, et al- Proc of CAS 2012, vol. I, p. 231



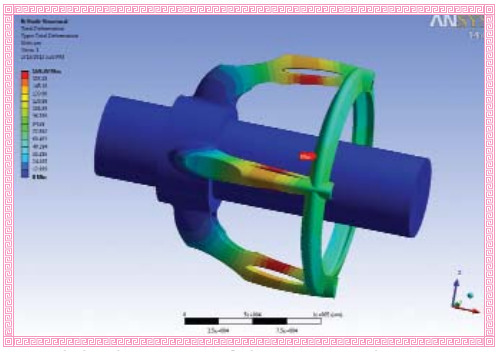
Contact person: Dr. Raluca Muller (raluca.muller@imt.ro@imt.ro)

INTERNATIONAL PROJECTS: ENIAC Project (related FP7- Public – Private Partnership)

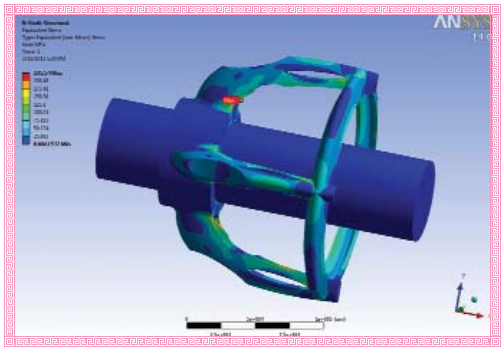
Nanoelectronics for Electric Vehicle Intelligent Failsafe PowerTrain-MotorBrain

Project type: ENIAC JU 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.



Total displacement of the optimized structure (simulation results ANSYS Multiphysics v.12.1)



von Mises stress of the optimized structure (simulation results ANSYS Multiphysics v. 12.1)

- 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 all technologies to be developed in the above mentioned topics.
- Power and high voltage electronics and smart miniaturized systems for electrical cars.

Bottom-Up view

Lateral view

Inclined view

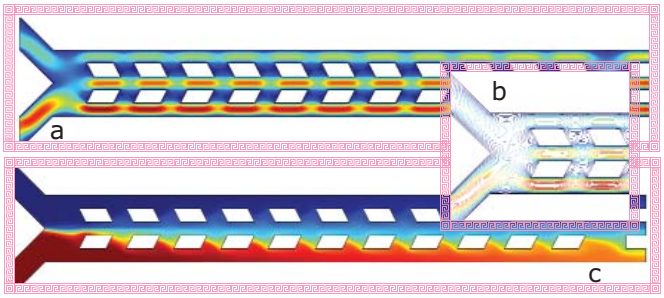
Project objectives of IMT:
- Conceive of the torque measurement principle for the torque sensor with accent put on using magnetic sensors developed by Infineon Romania
- Modelling and mechanical and magnetic simulation of the sensor
- Transmission of requierements for the magnetic sensor to Infineon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

Results: - A version of the magnetic sensor was conceived and simulated, allowing a better signal processing. It ensures compensation of the magnetization variation with temperature, mechanical stress and the compensation of the signal variation due to angular acceleration.
- An optical torque sensor was devised and simulated that shows satisfactory measurement accuracy (1 % at full scale)

POSDRU Project: Theoretical models for coupled phenomena in microfluidics", domain: Micro-nanosystems for bio-medical applications BIOMEMS

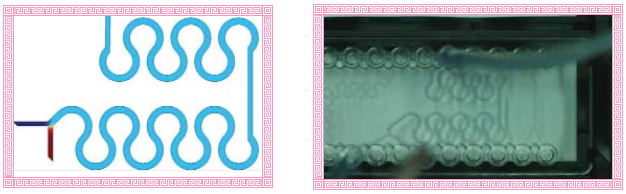
Dr. Oana Nedelcu, Postdctoral positions in the frame of POSDRU project "Human Resource Development by Postdoctoral Research on Micro and Nanotechnologies", POSDRU/89/1.5/S/63700, 2010-2013.

Models for flow and difussion properties depending on liquid components properties and concentration are proposed and numerically solved for mixing phenomena in passive micromixers, using weakly Navier-Stokes and nonlinear diffusion equation. The results show that variation of mixture vascosity in flow domain have significat impact on velocity and difusivity. By comparison to classic approach, the models offer more accurate predictions in velocity and concentration distribution, and it can be used to optimize the design specification of micromixers.



Flow and diffusion of liquids with different viscosities in a passive micromixer: a) velocity distribution; b) velocity isolines, detail on inlets; c) concentration distribution of liquid enterning from left bottom inlet (Simulations in Comsol Multiphysics)

Flow and diffusion in an experimental micromixer made of COC- cyclo-olefin copolymer ("ThinXX Technology" design and fabrication) Mixing water with high viscosity glucose solution: distribution of glucose concentration.

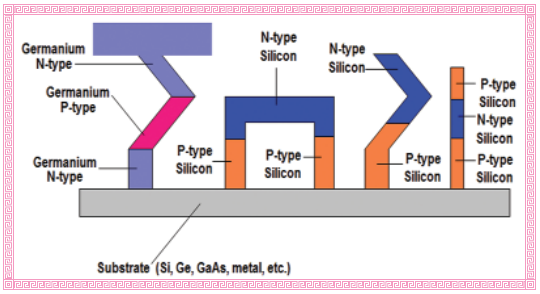


a) simulation results (Comsol Multiphysics); b) experimental results (Optical microscope metalographic EUROMEX objective 5x, 10x, 40x, Image Digital aquisition Olympus EP-L3)

NATIONAL PROJECTS:

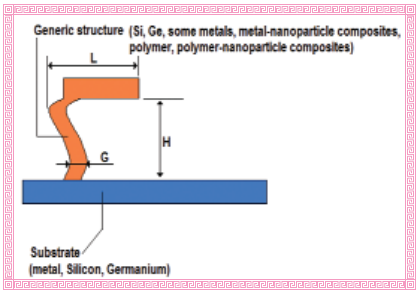
Prospective research regarding rapid prototyping processes for applications in the field of micro- and nanosystems realization

Project type: IDEI 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).



Example of some Si and Ge structures that can be made in 3D with the devised techniques

From another perspective, there are several questions that will be addressed: 1) which are the physical processes that may be used for achieving fully 3D nanoscale fabrication? 2) what class(es) of materials is / are suitable for such a use? 3) which are the technological steps for achieving that goal ? 4) which are the tools (hardware, software) necessary for implementing such a process? 5) which are the main hurdles for passing to a well established technological process? 6) which is the complexity degree of the 3D geometries that can be obtained by using such a process? 7) is there any possibility to obtain a high yield technological process? Answering to at least some of these questions will bring the novelty of our contribution.



A generic structure made in 3D showing the main dimensions

Results: 1) We devised a method for 3D realization of Silicon and Germanium structures (electronic devices as well as MEMS), subjected to patenting, with a 3D resolution of 40 nm. A sketch showing an example of strctures that can be made by this technique is depicted in the following figures.
2) We applied for an international patent for the 3D printing method at the nanoscale.
3) We have devised a method to control the thermal conductivity of a material by using electric or magnetic fields.

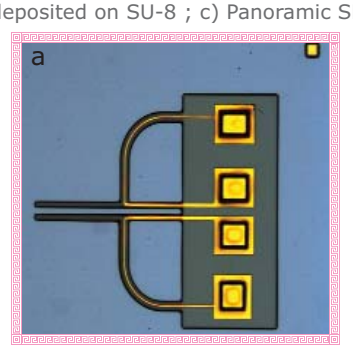
The H parameter in the figure above may have a value between few tens of nanometers up to 1 millimetre, usually smaller than 250 microns. The L parameter may have a value between several tens of nanometers up to 1 milimeter, usually being smaller than 100 microns. The G parameter may have values ranging form 30 nanometers to several tens of microns.

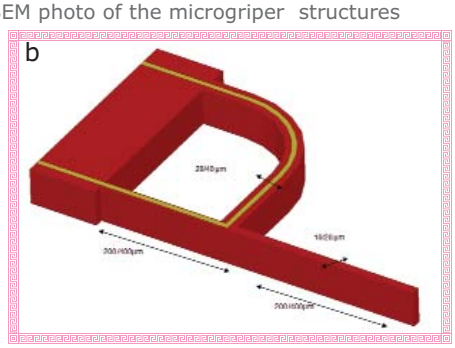
MEMS microstystems for micro-robotic manipulations

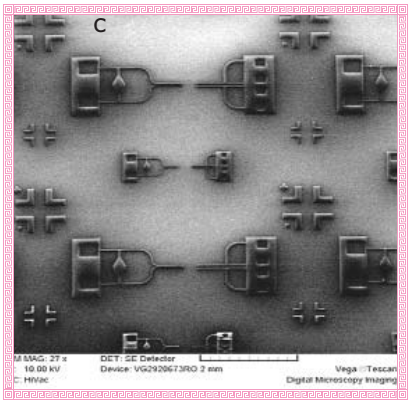
National Programme CONVERT (Basic funding)
Dr. Raluca Muller (raluca.muller@imt.ro); Dr Rodica Voicu (rodica.voicu@imt.ro)

Results: **Design, simulation and fabrication of an electro-thermally actuated micromanipulator** capable to operate in different environments. Coupled electro-thermo-mechanical simulations have been performed using CoventorWare software tool in order to describe the structures behaviour in air, as function of the applied voltage.

Fig. 1 a) 3D model used in FEM simulations with CoventorWare tool (half of the structure); b) Optical microscope image of the configuration of the metallic layer deposited on SU-8 ; c) Panoramic SEM photo of the microgriper structures

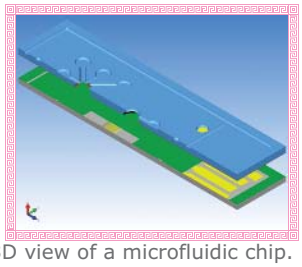




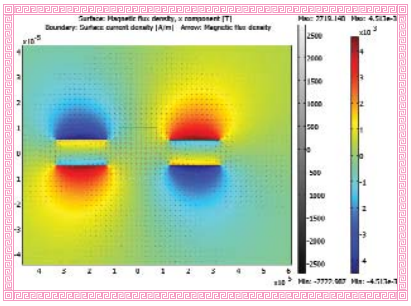


Research activities of L5 laboratory in coopereation with Micro and Nano fluidics Laboratory

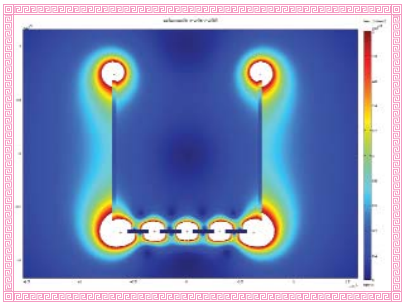
Simulation performed for the project "Immunoassay Lab-on-a-chip for cellular activity study" (in cooperation with L10 Laboratory)
Contact person: Phys. Catalin Tibeica (catalin.tibeica@imt.ro)



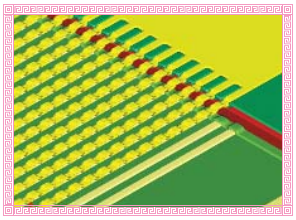
3D view of a microfluidic chip.



Magnetic force field in a microfluidic device.



Magnetic flux density field in a microfluidic device



Detailed view of the microfluidic chip (reaction chamber)

Scientific Results 2012 presented in conference papers and journals

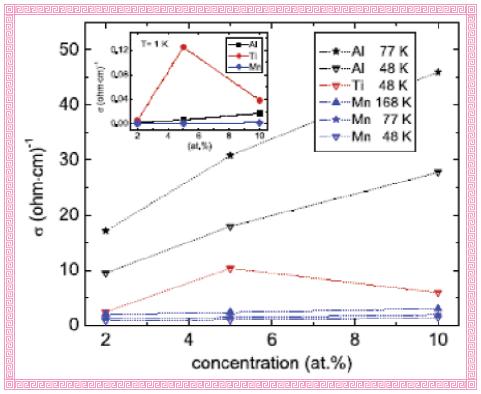
♦ First principles study and variable range hopping conductivity in disordered Al/Ti/Mn-doped ZnO, **Rodica Plugaru, Titus Sandu**, Neculai Plugaru, Results in Physics, Vol.2, 2012, p. 190–197

♦ **Computational study of transport phenomena in semiconductor oxides**

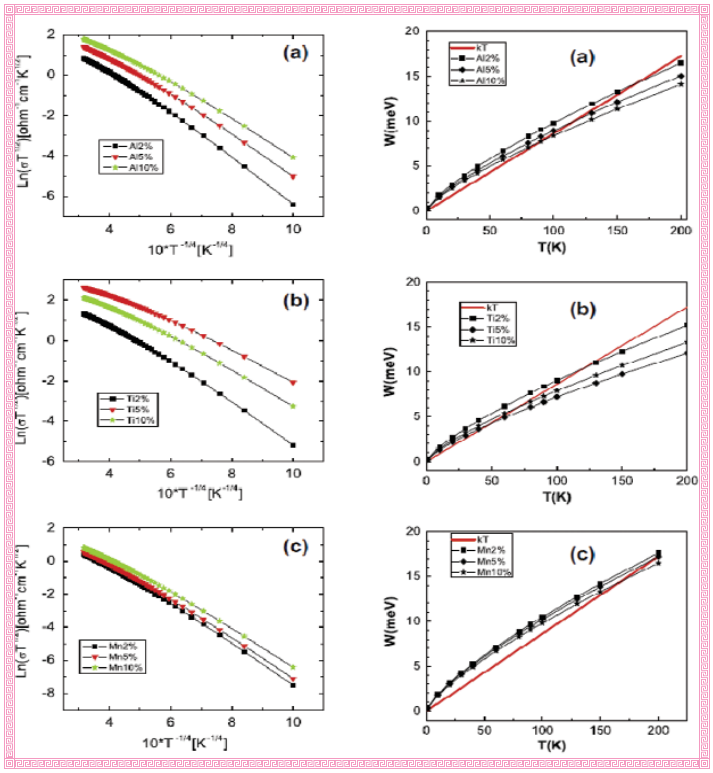
➤ Evaluation of low temperature dc conductivity and its temperature dependence for n-doped wurtzite-type M:ZnO, with M = Al, Ti, Mn, at concentrations of 2, 5 and 10 at.% respectively, based on first principles electronic structure calculations using the Coherent Potential Approximation (CPA) in the Blackman–Esterling–Berk (BEB) multiscattering formalism and the variable range hopping (VRH) model proposed by Mott.

➤ Calculation of phenomenologic quantities in the expression of the hopping conductivity, e.g. the hopping distance R, the hopping energy W, the dimensionless parameter $\xi^{-1}R$, and the critical temperature, Tc, below which the Mott mechanism of conductivity is valid, as well as the temperature range in which the VRH model is applicable to the investigated compounds.

➤ The results in this study point to 2–5 at.% Ti and approximately 2 at.% Al codoping in wurtzite-type ZnO as an interesting option to obtain a material with an increased low temperature dc conductivity and ferromagnetic background.



Calculated dc conductivity versus dopant concentration x for bulk $Zn_{1-x}M_xO$, M=Al, Ti and Mn.



Calculated $\ln(\sigma x T^{1/2})$ versus $T^{-1/4}$ dependence for Al (a), Ti (b) and Mn (c) doped ZnO, between 1 and 100 K.

Calculated temperature dependence of hopping activation energy for Al (a), Ti (b) and Mn (c) in $Zn_{1-x}M_xO$.

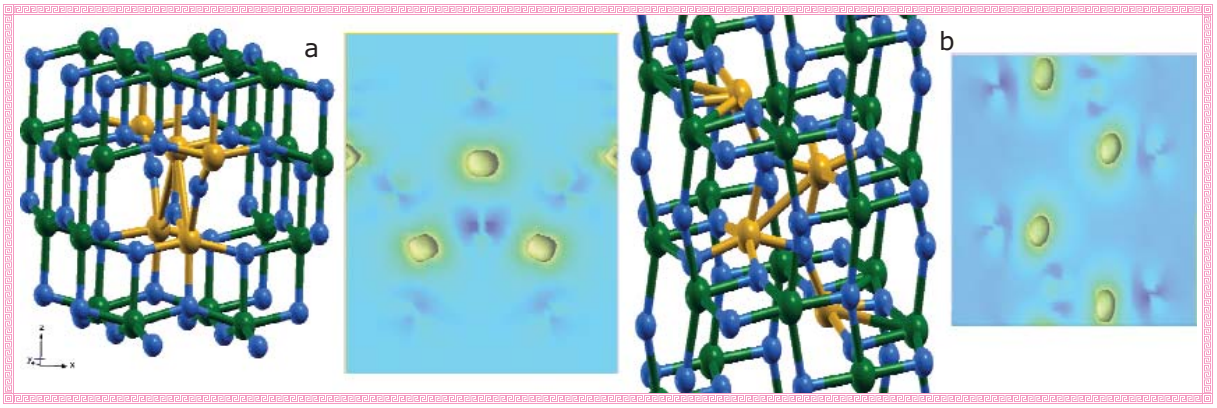
Scientific Results 2012 presented in conference papers and journals

♦ **R. Plugaru**, N. Plugaru, E-MRS Fall Meeting, September 17-20, Warsaw, Poland (2012) http://www.emrs-strasbourg.com/

♦ **Materials design: modelling of electronic structure of non-stoichiometric, doped and co-doped semiconductor oxides**

➤ LSDA+U Study of Anatase Mn:TiO_2-δ

DFT+U study performed to evaluate the nearest neighbor exchange coupling strength, J, in anatase Mn:TiO_2-ð and the effect of oxygen vacancies (VOs) induced disorder and local lattice distortion which results due to internal coordinates relaxation, on the material magnetic properties.



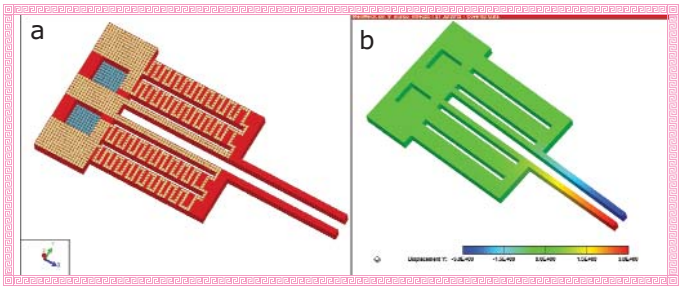
Supercells of anatase TiO_2 designed with the same configuration of the 25% Mn ions (yellow) and two concentrations of neutral VOs (3.125% and 6.25%) in different distributions: a) 2×2×1, Mn chain along [010] and one VO, with $VOTi_3$ within the (100) plane;. 25% Mn si 3.125% VOs; b) 2×2×1, Mn chain along [010] and two VOs, with $VOTi_3$ within the (100) plane, d(VO-VO)= 2.46 Å; 25% Mn si 6.25% VOs. Spin density maps calculated for the for the two configurations.

♦ **Rodica Voicu, Raluca Muller**, New design for an electrothermally actuated microgripper and finite element simulation results, Acta Technica Napocensis, Series: Applied Mathematics and Mechanics, Vol. 55, Issue III, pp. 635-639, 2012

♦ **Rodica Voicu, Raluca Muller**, Finite-element analyses for a new designed electro-thermal Micromanipulator, Book of Abstracts Micro&Nano2012, The 5-th International Conference on Micro-Nanotechnologies and MEMS, Crete, Greece, 7-10 October 2012

♦ **Micromanipulators with two 'hot' arms**

The microgripper's devices consist of two thermal actuators positioned face-to-face which are composed by hot and cold underarms/parts of 200/400 μm in length and a pair of extended free arms of 200/400 μm in length.



a) 3D model used in FEM simulation; b) Displacement obtained for the microgripper when 0.2 V are applied (Coventoware software)

RELIABILITY LABORATORY

Mission: Providing tools and expertise to improve the design & technology of sensors, actuators, micro-systems, 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 (Technical University of Kosice) "Time and stress degradation phenomena in lead-free solder joints", project (2011-2012).

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).

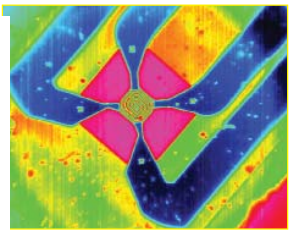
Research team The research team is formed by four persons: three senior researchers and a research assistant, all with background in microelectronics.

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;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.

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…2012 (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 (2010) and Springer Verlag (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.

Alena Pietrikova (Technical University Kosice), working together with Virgil Emil Ilian (IMT-Bucharest) to performing reliability tests.

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 prototypes. Two variants of tests were used: (i) Thermal Cycling (between -55°C and 150°C, 1000 cycles) and (ii) HAST - Highly Accelerated Stress Test (130°C and 85% relative humidity, 96 hours), followed by Thermal Cycling (between -55°C and 150°C, 1000 cycles).

Failure analysis of a protoype furnished by FAMOBS, after 200 cycles of Thermal Cycling (-55°C to 150°C, 10 minute dwells: a crack in the package was noticed.

The Reliability Laboratory was solicited by the **company FEI, from The Netherlands** (well-known fabricant of complex equipment, such as SEM, TEM, etc.) to perform thermal analyses on devices manufactured by FEI.

Specialists from IMT-Bucharest and FEI, preparing the thermal analyses of FEI products. From left to right: Marius Bazu (IMT-Bucharest), Pleun Dona (FEI), Virgil Emil Ilian (IMT-Bucharest), Stan Konings (FEI) and Lucian Galateanu (IMT-Bucharest.)

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.

Microsystems for Biomedical and Environmental Applications Laboratory

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:

Micro nanosensors: Development of microsensors (chemoresistive, resonant gas sensors, accelerometers, microarrays, ISFET sensors, Nano Wire based 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)

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

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 O_2 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 and IMT 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. Dr. Moldovan is also coordinating the Romanian activities within the FP7-HEALTH **PARCIVAL** project.

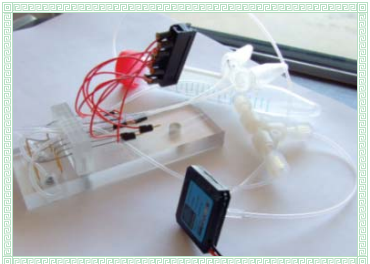
She is a **member of IEEE**, and is a **NEXUS Association *Steering Committee Member.*** The scientific activity is published in more than 70 papers in journals, books and communications in Proceedings.

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

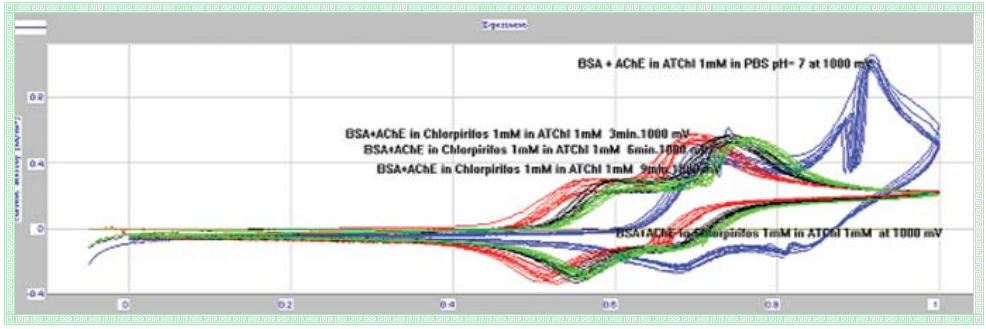
The platform developed within PESTIPLAT will be used in food security monitoring (fruits, vegetables, drinking water, milk etc.) and agriculture research laboratories will be a user friendly tool able to perform fast measurements (10 minutes), to diagnose the pesticide presence, to alert and to record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

Consortium members:
- Coordinator: Carmen Moldovan (IMT-Bucharest), Romania
- Partners: Romelgen SRL, Romania; HSG-IMIT c/o IMTEK, Germany; Scienion AG Research and Development, Germany.

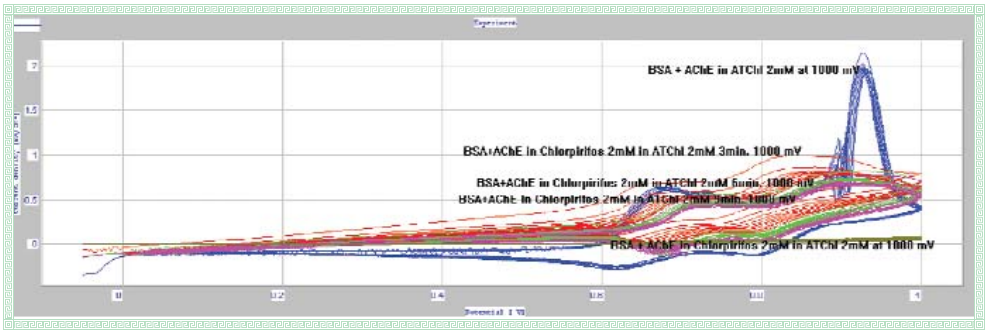
Main results 2012: - Silicon chips with integrated transducers fabrication,
- Biosensors preparation: protocols establishment, surface functionalisation, enzymatic layer deposition and activation,
- Fluidic module development,
- Electronics modules development,
- Interface software development, GUI development.



Microfluidic module
(PDMS chip, gold wires for connection, pump and fluidic connections)



Voltammetric characterisation of AChE over the activation in ATChI 1mM and inhibition in Chlorpirifos 1mM



Voltammetric characterisation of AChE over the activation in ATChI 2mM and inhibition in Chlorpirifos 2mM

PARCIVAL - Partner network for a clinically validated multi-analyte lab-on-a-chip platform – FP7-HEALTH

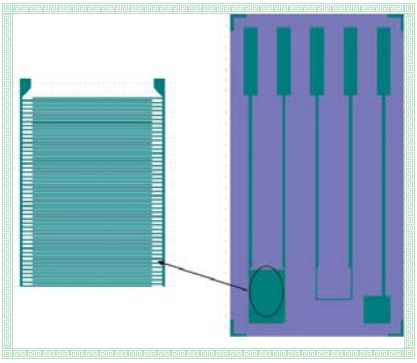
The objective of PARCIVAL is to develop an integrated and automated multi-analyte lab-on-a-disk platform for the fast and reliable sample in, answer out diagnosis of highly infectious respiratory pathogens, resistance patterns and biomarkers for individual severity of the infection. The platform format will be based on completely integrated microfluidic foil-disposables with no external connections except one rotational axis of the centrifugal processing device and the sample inlet ports. We are aiming at a multiplexing platform of up to 24 parameters simultaneously in a quantitative way.

Consortium members: - Coordinator: PathoFinder B.V., the Netherlands,
- Partners: HSG-IMIT, Germany;IMT-Bucharest, Romania; Labor Stein, Germany; Erasmus MC, the Netherlands; Rohrer AG, Switzerland; ASKION GmbH. Germany; Agrobiogen GmbH, Germany; EADS, Germany.

Main results 2012:
- Software module concept development,
- Software components definition: data acquisition, central results analysis module, interpretation and visualisation module.

IMUNOPLAT – Micro Immunosensors Platform for Metabolic Syndrome Investigation

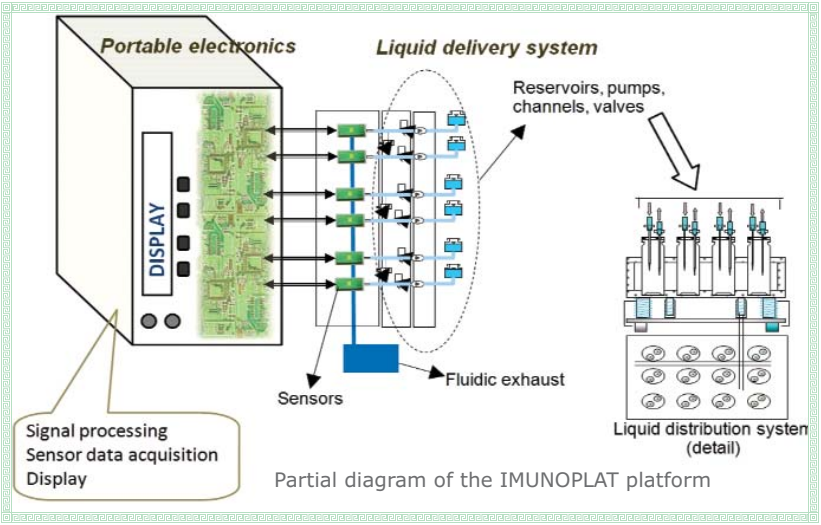
The concept of the IMUNOPLAT project consists in the development and fabrication of a multiparametric, miniaturized micro immunosensors platform for early investigation of the metabolic syndrome. A novel technology using immunosensors array, label free, integrated with temperature and pH sensors into micro fluidic channels, with a high degree of automation is going to be developed for replacing the standard "ELISA", chemiluminescence, particle-enhanced immunonephelometry and lateral flow immunoassay techniques in order to speed up the metabolic syndrome investigation, to record and follow the patients with risk, to early diagnosis and to decrease the operational costs.



Sensors chip for impedimetric measurements (right) and detail (left)

Consortium members:
- Coordinator: Carmen Moldovan (IMT-Bucharest)
- Partners: DDS Diagnostic SRL, Bucharest; University of Medicine and Pharmacy "Carol Davila" Bucharest; Telemedica SRL, Bucharest; University of Bucharest.

Main results 2012:
- Sensors cell design (the cell contains 4 sensors, including impedimetric, amperometric and test structures),
- Design of the technological steps for manufacturing,
- Development and validation for the patients screening and diagnosis methodology,
- Inclusion and exclusion criteria refinement, for the enrolled patiens,
- Invasive and non-invasive tests definition,
- Patients informed consent definition.



Partial diagram of the IMUNOPLAT platform

Sensors **2012**, *12*, 11372-11390; doi:10.3390/s120811372

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Article

Miniaturized Integrated Platform for Electrical and Optical Monitoring of Cell Cultures

Carmen Moldovan [1,*], Rodica Iosub [1], Cecilia Codreanu [1], Bogdan Firtat [1], Daniel Necula [1], Costin Brasoveanu [1] and Ion Stan [2]

ACADEMIA ROMÂNĂ
Revue Roumaine de Chimie
http://web.icf.ro/rrch/

Rev. Roum. Chim., **2012**, *57*(6), 559-567

POLYANILINE NANOFIBER BASED DEVICE ON FLEXIBLE SUBSTRATE

Carmen MOLDOVAN,[a*] Rodica IOSUB,[a] Anton MANOLESCU,[b] Anca MANOLESCU[b] and Cornel RADU[a]

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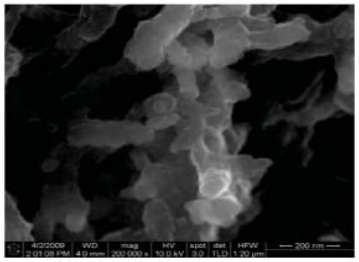
[b] Politehnica University of Bucharest, Faculty of Electronics, Telecommunication and Information Technology, 3-5 Iuliu Maniu Street, 061102 Bucharest, Roumania



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 nano-structured 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 (2007) 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.
HIGH TEMPERATURE FURNACE CARBOLITE (2007)
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 temp tests and firing&sintering of ceramic samples.
CHARACTERISATION EQUIPMENTS - *SPECTROMETRIC CHARACTERISATION: FTIR SPECTROMETER TENSOR 27, BRUKER OPTICKS (2007)*
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.
UV-VIS SPECTROMETER AVASPEC-2048 TEC (thermo-electric cooled fiber optic spectrometer) AVANTES (2007)
Applications: Spectroscopic measurements are being used in many different applications, ideal for absorbance, transmittance, reflection, fluorescence and irradiance.

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 RD activities 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 to 2010) 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

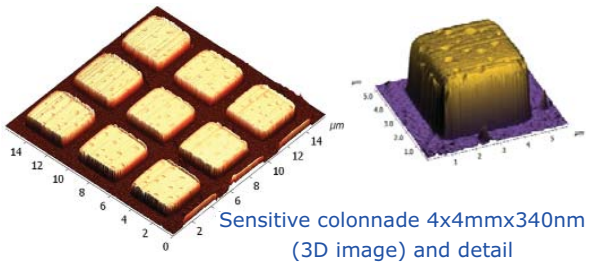
„Manufacturing method for yttrium aluminium garnet cerium doped used as phosphorous in emissive optoelectronics applications", BI Nr. 123429/30.04.2011, V. Schiopu, I. Cernica

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, $LiTaO_3$, $LiNbO_3$) 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.

Project manager: Dr. Ileana Cernica, ileana.cernica@imt.ro, PNCDI II project.
Partners: ROM-QUARTZ S.A; SITEX 45 SRL; INCD for Electrochemistry and Condensed Matter Timisoara; "GH. ASACHI" University Iasi; Politehnica University Bucharest (UPB-CCO, DCAE)

SAW microsensor with sensitive substance configured

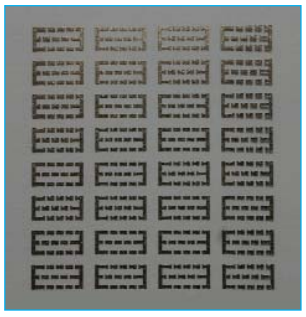


Sensitive colonnade 4x4mmx340nm (3D image) and detail

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 light emitting matrix on flexible organic substrates.
The substrates used were: polydimethylsiloxane (PDMS), polyimide and transparent Rubylith. These substrates were processed in RIE plasma in order to improve the adherence of the metallic films.
The metallic films used were: Ti/Au and Ti/Al sputter deposed and photolithographic configured and Ag conductive ink for ink-jet technique.
The below figure presents: Ag conductive ink on different organic substrates (PDMS, transparent Rubylith) and wire bonding (Au wire) on test structures.

Core National Programme; Coordinator: IMT Bucharest;
Project manager: Dr. Ileana Cernica (ileana.cernica@imt.ro)



Matrix metallic mask

Au wire on test structures

Organic substrates:
a) PDMS,
b) transparent Rubylith

Active micro-shields for protection of space infrastructures

The aim is the development of innovative concept for Active Micro-Shields Method and System, with the purpose to improve protection against the high velocity micro-space debris, particle and solar flares dust, including the capability to decrease radiation exposure using the synergy with advanced nano-technologies and micro-materials fabrication.
Objectives: - Specific niche identification for research, technology and industry at national/international levels;
– To define and identify future protect proposal for participation to ESA operational programs;
– Development and promotion at the national capacity for research, education and industrial in the area of space, aeronautics, security and connected domains;
– Improving partnership (cooperation and interaction model) between the research entities and industry;
– Interdisciplinary developments of research experts at the highest level – continuing formation/practice;
– Setting the base for top scientific production and increasing the up/down stream research quality level;
– Development and improved diversity for the research applications from space domain to industry areas, education, security and social applications.

STAR Program 2012. **Project manager: Dr. Ileana Cernica,** ileana.cernica@imt.ro
Partners: European Business Innovation And Research Center S.A. (EBIC), IMT-BUCHAREST

Micro and Nanofluidics Laboratory

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, microsensors and lab-on-a-chip devices.

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 experimental&numerical viewpoints.

Molecular transport in microfluidic devices: Magneto-phoretic 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.

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. Adrian Serban-PhD in Physics (Plasma, Pulse Power Technology) and Master's degree in business administration (MBA) from Nanyang Technological University, Singapore. Currently he contributes to the development of lab mini-equipments and takes care of technology transfer.

Dr. Marioara Avram – project manager, Senior Scientific Researcher, PhD in Magnetoelectronic microsensors. Her scientific interest: magnetic micro and nanofluidics, electromagnetic lab-on-a-chip 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 Micro-PIV techniques and anodic bonding process.

Andrei Marius Avram – With MSc Degree in physics from the University of Bucharest – Faculty of Physics, he is currently pursuing his PhD. He has 6 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.

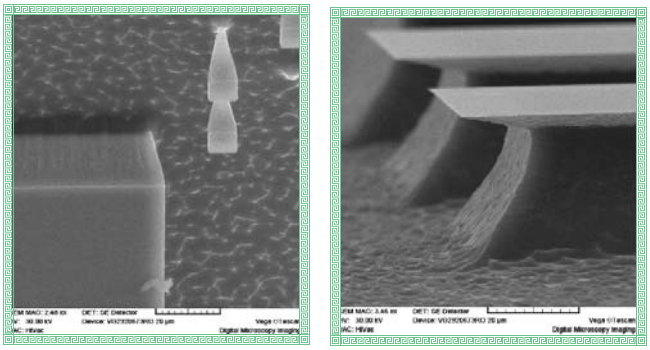
Adrian Serban, Catalin Marculescu, Marioara Avram, Catalin Balan, Andrei Avram

Projects:

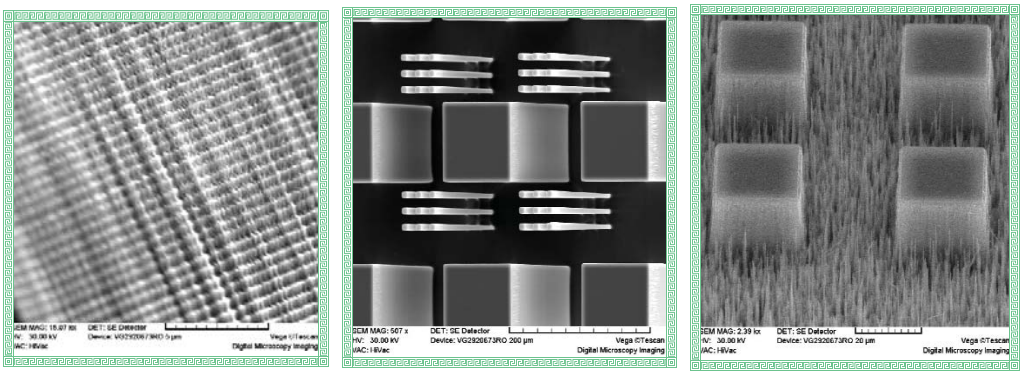
Project co-founded by the European Fund for Regional Development POS-CCE 2009 - "Microfluidic factory for assisted self-assembly of nanosystems" (**MICRONANOFAB**) until July 2013

PN-II-PT-PCCA-2012: Immunoassay Lab-on-a-chip for cellular apoptosis study" **CELLIMMUNOCHIP** until July 2015.

Silicon processing: **ICP-RIE deep etching of silicon for microfluidic applications using Bosch and Cryogenic processes.**



Etch angle control in Cryogenic process



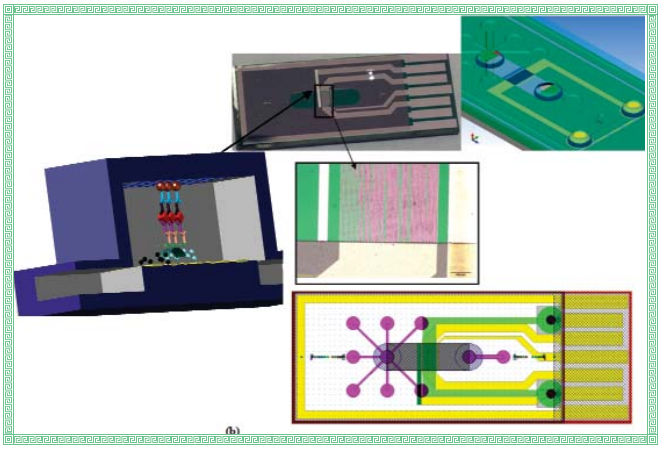
Pillars of various sizes etched in Si using the Bosch process. On the left one can observe the scalloping of the side-walls

Si grass obtained during the Cryogenic process

Immunoassay Lab-on-a-chip for cellular activity study

The lab-on-a-chip integrated system (2 cm of length and 1 cm of width – the dimensions were chosen to be compatible to SATA hard-disk bus connector) that we are proposing is composed of a microfluidic platform, an interdigitated microelectrodes electrochemical biosensor and a magnetophoretic platform (spin valve array as separator and biosensor) for specific antigen detection, in order to detect the formation of antigen-antibody complex, of cellular growing on the electrode surface or cellular apoptosis. This magnetoelectrochemical immunosensor device can have direct clinical diagnostics applications.

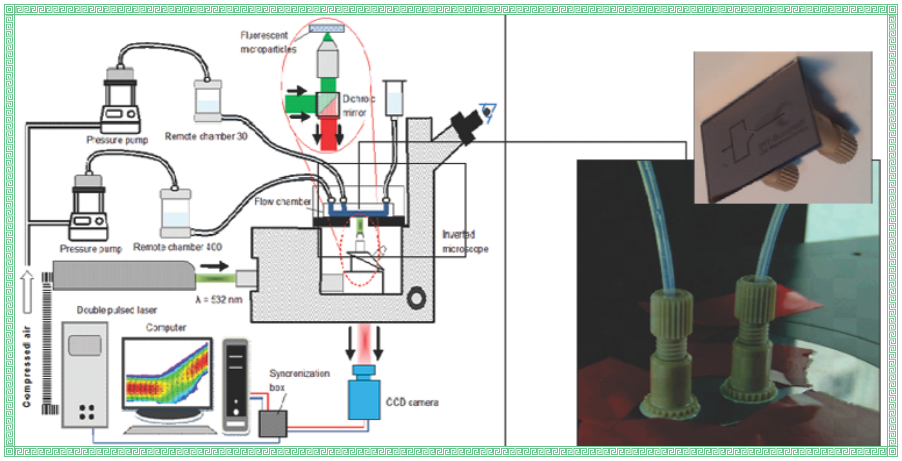
The sequence of the magnetic immunoassay: (a) Injection of superparamagnetic nanoparticles coated with primary antibody; (b) Separation of superparamagnetic nanoparticles; (c) Injection of sample solution; (d) Incubation of target specific antigens; (e) Washing out untargeted antigens with buffer solution; (f) Flowing and incubating enzyme labelled secondary antibody; (g) Washing out unbound enzyme labelled secondary antibody; (h) Injection of enzyme substrate for electrochemical detection.



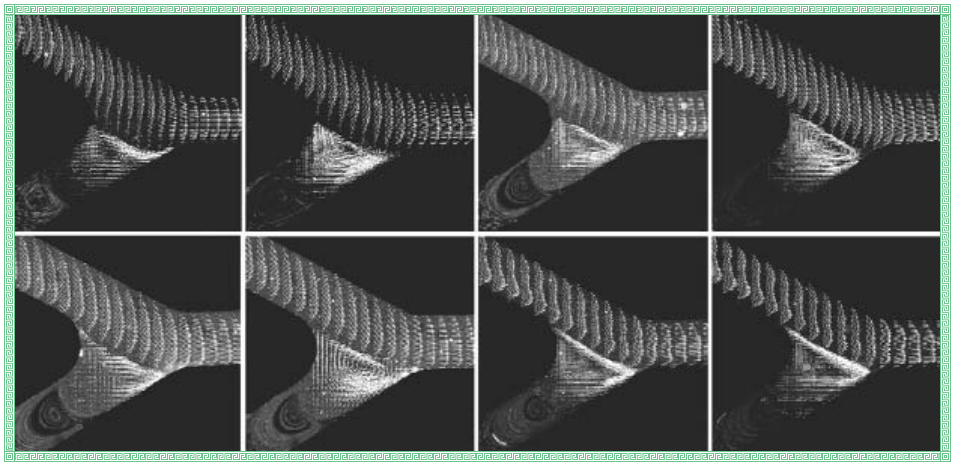
The figure presents: the conceptual illustration of the electrochemical immunoassay based on magnetic nanoparticles, the microfabricated lab-on-a-chip device; the overlap masks layout of the integrated device; details from reaction chamber

Immunochemical reaction of pair antigen - antibody or phosphatidylserine – annexin V marked with superparamagnetic nanoparticles presents changes of the magnetic relaxation (Néel) due to reduction of their mobility and changes of the saturation magnetization, depending on the amount of biomolecules attached. Super Paramagnetic Iron Oxide Nanoparticles (SPION) are used as mobile solid support because of (1) the reduced diffusion distances due to the small diameter, (2) the small volumes of electroactive enzyme, (3) the possibility to monitor reactions occurring on the bead surface, (4) the high area to volume ratio, (5) the short diffusion distance of reagents (half the distance between two beads), (6) the small dilution of the electroactive enzyme product due to reduced volumes.

Experimental and numerical microfluidic flow characterization

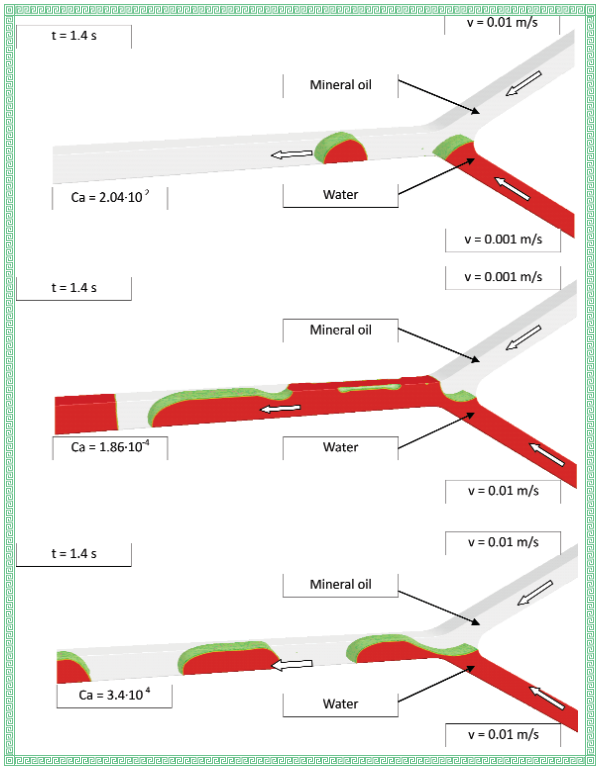


Experimental set-up built on the Micro-PIV platform with a detail on the microfluidic device (the microfluidic chip is made in house from silicon wafer and sealed with a glass wafer).

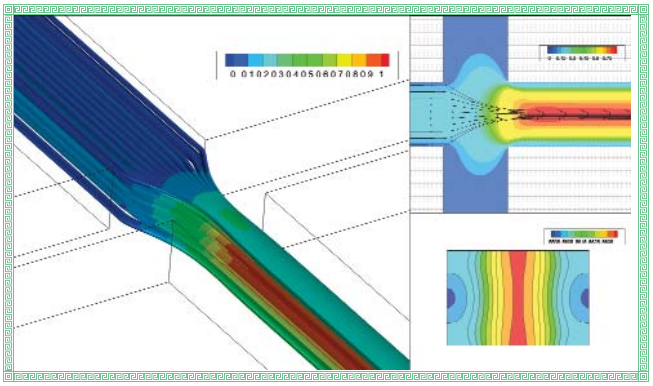


Micro-PIV measurement perfomed in a Y-bifurcation with a closed branch

Numerical investigation on the interface shape dynamics and microfluidic hydrodynamic focusing



Numerical investigation on the interface shape dynamics manifested at different capillary numbers (Ca), by a variation of the flow rate ratios (FRR) over the inlets. The Ca variation has an important impact on the droplet frequency formation. Changing only the FRR of the inlets, the droplets behaviour modifies drastically.



Velocity profiles for a hydrodynamic focusing geometry with three inlets and one outlet: 3D profile, 2D median slice and 2D transversal slice.

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 35th edition in 2012. 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.

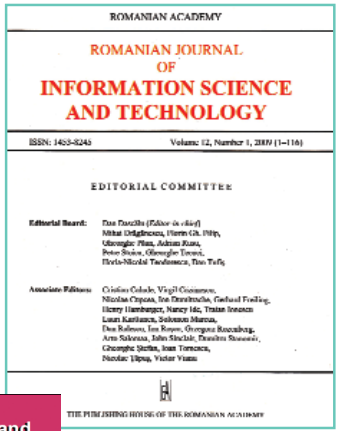
The main topics are: Nanoscience and nanoengineering; Microoptics and microphotonics; Micromachined devices and circuits for microwave and millimeter wave applications; Micro and nanotechnologies for transducers, interfaces and microsystems; Micro and nanotechnologies for biomedical and environmental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

▸ **Exploratory Workshop "Micro-nanoelectronics, micro-nanosystems"**, 26-27 September 2012, organized at IMT- Bucharest

▸ **Workshop**: **"Partenership for innovation- electonic industry"** 18 October 2012, co-organized with INCD-ICPE-CA and ARIES Association at TIB 2012 (ROMEXPO)

National Seminar for Nanoscience and Nanotechnology, the 11th edition in 2012

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 2012, the 11th 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.

Visits and Education activities at IMT-Bucharest

- **Consortium Meeting Project "Smart integration of GaN & SiC high power electronics for industrial and RF applications"** (FP7 INTEGRATED Project SMARTPOWER (2011- 2014)) , 27th-28th February 2012
Local organizer: IMT-Bucharest, Dr. Alexandru Muller
Visitors from: Berliner Nanotest und Design GmbH, Germany; Fraunhofer Institute IZM Berlin, Germany; Infineon Technologies AG, Germany; Schneider Electric Industries SAS, France; Thales Research and Technologies SA, France; Technical University of Chemnitz, Germany; Thales Systèmes Aéroportés SA, France; SHT Smart High Tech AB, Sweden; Budapest University of Technology and Economics, Hungary; Commissariat à l'Energie Atomique et aux Energies Alternatives – LITEN, France; TAIPRO Engineering SA, Belgium
- **Consortium Meeting Project "Enabling MEMS-MMIC Technology for cost-effective multifunctional RF-System Integration"** (FP7 STREP MEMS-4-MMIC (2008-2012)), 1-2 March 2012
Local organizer: IMT-Bucharest, Dr. Dan Neculoiu
Visitors from: OMMIC, France; SAAB AB, Sweden; IMST GmbH, Germany; France; IEMN, France; VTT, Finland; FOI, Sweden.
- **Visit of Dr. Jihad Haidar,** Managing Director Infineon Technologies and **Dr. Traian Visan**, 5 March 2012
- **Student Delegation** of the "Electronic engineering" and "Electromechanical engineering" from Xios university college Limburg in Belgium, 6 March 2012
- **Consortium Meeting - Project "Integrated Platform for Pesticides Detection - PESTIPLAT"** (MNT-ERANET, 2011-2014), 2-3 July 2012, IMT Bucharest. Visitors from ROMELGEN (Romania); HSG-IMIT (Germany). Local organizer: IMT-Bucharest, Dr. Carmen Moldovan
- **Delegation from ClusteriX** (*Ecoplus. The Business Agency of Lower Austria Ltd.*) consortium visited IMT Bucharest (The overall objective of CLUSTERIX is thus to increase the competitiveness of European regions and their innovation potential through the improvement and strategic re-orientation of cluster policies towards smart specialization). 31 October 2012

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:

→ **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:

→ **Course "MEMS Design and prototyping" at IMT Bucharest**, May 7-11, 2012.
This course is organized by STIMESI project "Stimulation Action on MEMS" in cooperation with Europractice, Trainer Dr. Jan Bienstman, IMEC Belgium. Details: http://www.stimesi.rl.ac.uk/locations/IMT_flyer.pdf .

Internship in "Modeling of SAW Devices" Ms Student Catalin Botezatu from Institut polytechnique de Grenoble, June-August 2012;

Papers published in ISI ranked periodicals (with impact factor)

1. **M. Kusko, F. Craciunoiu,** B. Amuzescu, F. Halitzchi, T. Selescu, **A. Radoi**, **M. Popescu, M. Simion, A. Bragaru, T. Ignat,** Design, fabrication and characterization of low-Impedance 3D Electrode Array System for Neuro-Electrophysiology, *Sensors 2012*, 12, 16571-16590; doi:10.3390/s121216571; Impact factor 1.739

2. **A. Bragaru, M. Kusko, A. Radoi, M. Danila, M. Simion, F. Craciunoiu, R. Pascu, I. Mihalache, T. Ignat**, Microstructures and growth characteristics of polyelectrolytes on silicon using layer-by-layer assembly, *Central European Journal of Chemistry* 2013, 11(2), 205-214, doi: 10.2478/s11532-012-0152-9; Impact factor 1.073

3. T. Nguyen Thanh, C. Robert, A. Létoublon, C. Cornet, T. Quinci, E. Giudicelli, S. Almosni, N. Boudet, A. Ponchet, J. Kuyyalil, **M. Danila**, O. Durand, N. Bertru, A. Le Corre, Synchrotron X-ray diffraction analysis for quantitative defect evaluation in GaP/Si nanolayers, *Thin Solid Films* 2012, Available online 16 December 2012, doi: 10.1016/j.tsf.2012.11.116; Impact factor 1,890

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6. **D. Stan**, C-M Mihailescu, **R. Iosub, C. Moldovan**, M. Savin, I. Baciu, Electrochemical studies of homogeneous self-assembled monolayers versus mixed self-assembled monolayers on gold electrode for "label free" detection of heart fatty acid binding protein, *Thin Solid Films* 2012, 526, 143-149, ISSN 0040-6090 Impact factor 1,890

7. S. Antohe, S. Iftimie, V. Ghenescu, R. Constantineanu, M. M. Gugiu, **M. Ion**, I. Stan, A. Radu, L. Ion, Effect of protons irradiation on the performances of CdS/CdTe photovoltaic cells for space applications , *Romanian Reports in Physics*, Vol. 64, Supplement, P. 1153–1162, 2012; Impact factor 0,500

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9. **M. Mihailescu**, **M. Kusko** "Compact System Design Based on Digital in-Line Holographoc Microscopy Configuration", *Journal of the European Optical Society-Rapid Publications* (JEOS:RP), Vol. 7, ISSN: 1990-2573 (on line),Doi: 10.2971/jeos.2012.12010. Impact factor 1.019

10. C. Aurisicchio , R. Marega , V. Corvaglia , J. Mohanraj , R. Delamare , D. A. Vlad , **C. Kusko** , C. Augustin Dutu , A. Minoia , G. Deshayes, O. Coulembier, S. Melinte , P. Dubois , R. Lazzaroni , N. Armaroli , D. Bonifazi, "CNTs in Optoelectronic Devices: New Structural and Photophysical Insights on Porphyrin-DWCNTs Hybrid Materials", *Adv. Funct. Mater.* 2012, 22, 3209–3222 Impact factor 10.179

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12. **A. Müller** , G. Konstantinidis , M. Androulidaki , **A. Dinescu, A. Stefanescu , A. Cismaru , D. Neculoiu, E. Pavelescu** , A. Stavrinidis "Front and backside-illuminated GaN/Si based metal–semiconductor-metal ultraviolet photodetectors manufactured using micromachining and nano-lithographic technologies", *Thin Solid Films 520* (2012) pp 2158-2161; Impact factor 1,890

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14. G. Vicenzi, G.Deligeorgis, F. Cocetti, **M. Dragoman**, L. Pierantoni, D. Mencarelli, R. Plana , "Extending ballistic graphene FET lumped element models to diffusive devices", *Solid –State Electronics 76* , pp.8-12 (2012). Impact factor 1.397

15. **M. Dragoman**, G.Konstantinidis, K. Tsagaraki, T. Kostopoulos, **D.Dragoman, D. Neculoiu**, "Graphene-like metal-on-silicon field-effect transistor", *Nanotechnology* 23, 305201 (2012). Impact factor 3.979

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17. **Gh. Sajin, I. A Mocanu**, „Metamaterial CRLH Antennas on Silicon Substrate for mm-Wave Integrated Circuits", International Journal of Antenna and Propagation, *IJAP*, (2012), Article ID 593498, pp. 1 – 9, doi:10.1155/2012/593498; Impact factor 0.468

18. C. Gilfert, **E.-M. Pavelescu**, J.P. Reithmaier, T. Westphalen, M. Traub, N. Michel, M. Krakowski, "15-W Fiber-Coupled Quantum-Dot pump module", **IEEE Phot**. Technol. Lett., Vol. 24, pp. 1030-32, 2012. Impact factor 2.19

19. **A. A Muller**, A. Moldoveanu, V. Asavei, **D. Dascalu**, „ A 3D Smith chart for active and Passive Microwave circuits and visual complex analysis" *UPB Sci. Bull. Series C*, vol 74, Iss 2, 2012, pp 181-188 Impact factor 0.253

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22. M. Pustan, **R. Muller**, J.C. Golinval, Nanomechanical and Nanotribological Characterization of Microelectromechanical System, *Journal Of Optoelectronics And Advanced Materials* Vol. 14, No. 3-4, March – April 2012, P. 401 – 412, 2012 Impact factor 0.457

23. **E. Franti**, L. Milea, A. Barbilian, V. Butu, S. Cismas, M. Lungu, P. Schiopu, Methods of acquisition and signal processing for myoelectric control of artificial arms, *ROMJIST* , Vol 15, nr.2, pag 91 – 105, 2012 Impact factor 0.154

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32. **Sandu T**, "Eigenmode Decomposition of the Near-Field Enhancement in Localized Surface Plasmon Resonances of Metallic Nanoparticles", *Plasmonics*, (2012); DOI 10.1007/s11468-012-9403-z Impact factor 2.989

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47. Paunovic, N; Dohcevic-Mitrovic, Z; **Scurtu, R**; Askrabic, S; Prekajski, M; Matovic, B ; Popovic, ZV; Suppression of inherent ferromagnetism in Pr-doped CeO_2 nanocrystals, *Nanoscale*, Volume: 4 Issue: 17 Pages: 5469-5476 DOI: 10.1039/c2nr30799e, 2012 Impact factor 5.914

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50. A. Ivan, D. L. Ghindeanu, V. Danciulescu[a], A. Raducu, **A. C. Nechifor***[,a,c,] Composite polyaniline-zeolite membrane material forwastewater ultrafiltration, *Optoelectronics and Advanced Materials – Rapid Communications*, Vol. 6, No. 11-12, p. 1134 – 1138, Nov- Dec. 2012 Impact factor 0.304

51. A. Pop, F. Manea, **C. Orha**, S. Motoc, E. Ilinoiu, N. Vaszilcsin, J. Schoonman, Copper-decorated carbon nanotubes based composite electrodes for non-enzymatic detection of glucose, *Nanoscale Research Letters*, Vol. 7-266, , 22-May-12, 10.1186/1556-276X-7-266 Impact factor 2.726

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Invited Papers

1. **M. Dragoman**, "Graphene RF opto and THz electronics", *European Microwave Conference*, 2012, Amsterdam, 2012, Workshop 16 Graphene Nanoelectronics

2. **A. Müller,** George Konstantinidis "Acoustic and photonic devices based on micromachining and nanoprocessing of GaN/Si", *5th International Conference on Micro-Nanoelectronics, Nanotechnology and MEMS*, Oct 2012, Heraklion, Greece

3. **A. Dinescu**, Electron Beam Lithography applications at IMT Bucharest, *3rd International Scientific Conference - STRANN '12*, 10-12 October 2012, Saint Petersburg, Russia

4. **R. Müller**, Overview of the research activities and the infrastructure in the field of nanotechnologies at IMT- Bucharest, *Nanoscience and Nanotechnology 2012* Conf. 1- 4 Sept Frascati, Italia, 2012

5. N. Plugaru, **R. Plugaru**, Porous Silicon Models in First Principles Calculations, Seminar of Laboratory of Chemical Reaction Complex Processes, *Institute of Advanced Energy, Kyoto University*, Japan, March 2012.

6. **M Zamfirescu**, "Investigation of the mechanism of quasi-periodical surface nanostructures formation by "pump and probe" experiments" *International Student Conference on Photonics (ISCP 2012)*, Mai 2012, Sinaia, Romania

Papers published in nonISI periodicals

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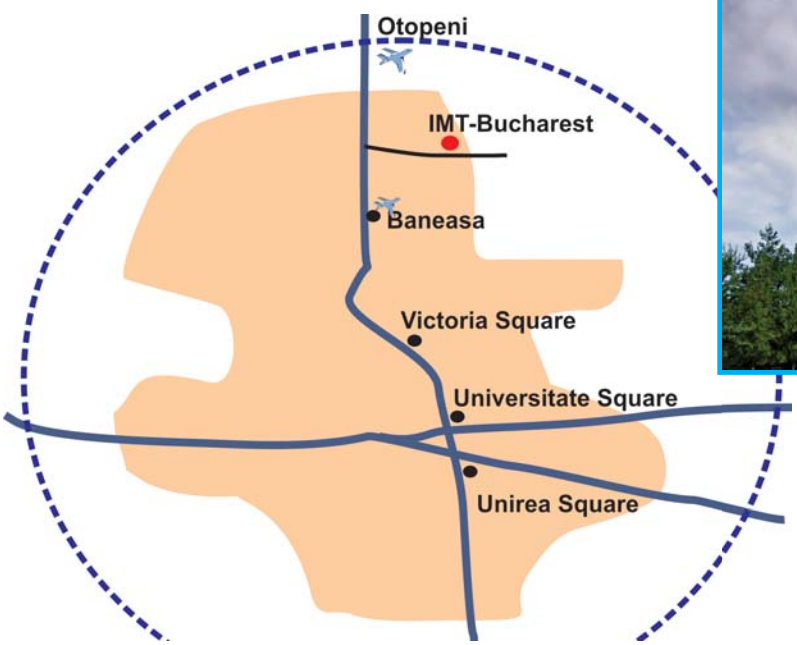

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