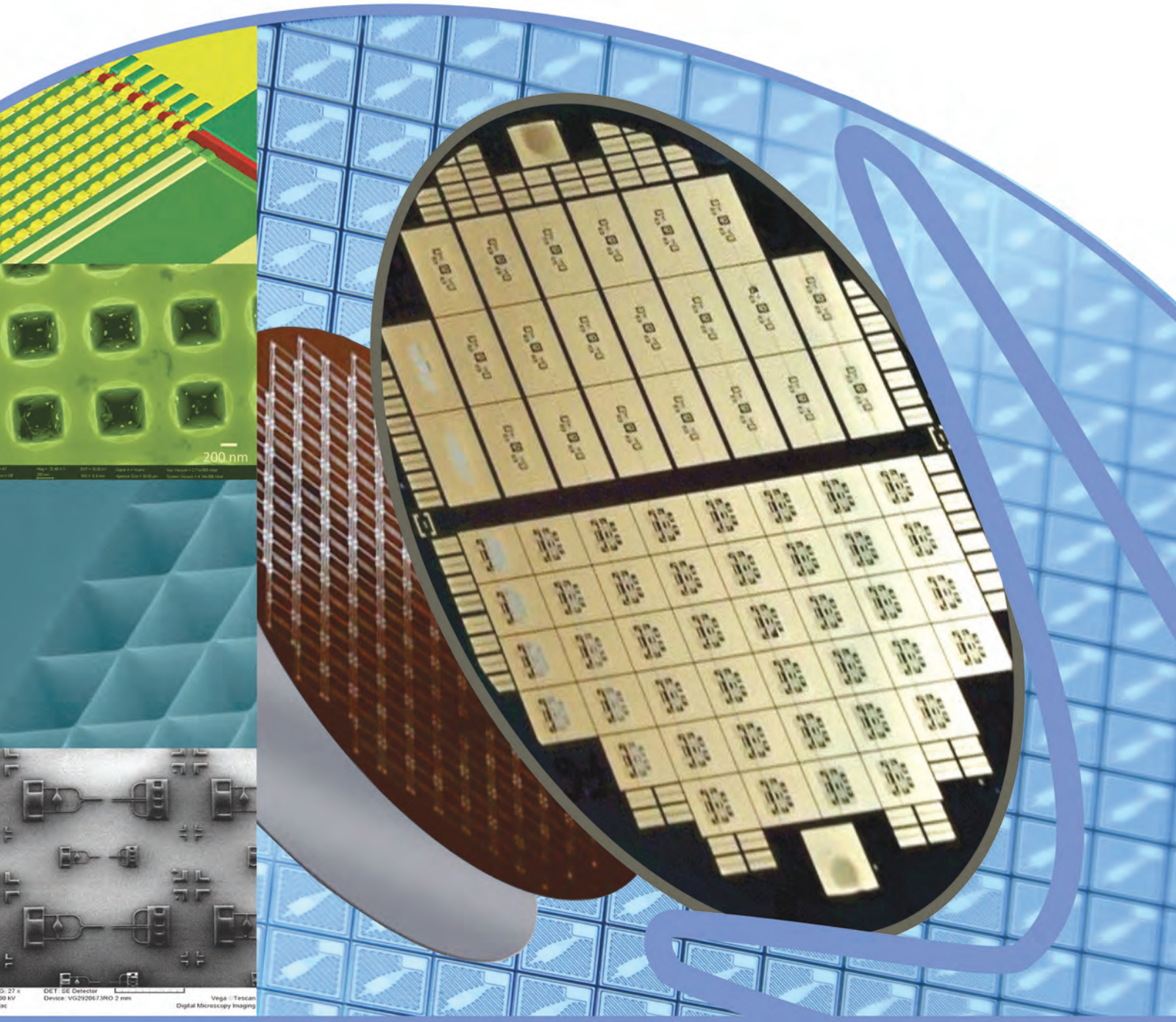
National Institute for Research and Development in Microtechnologies - IMT Bucharest

Scientific Report 2013



From micro to nanotechnologies, nano-biotechnologies and nanoelectronics

Ministry of National Education

MINISTERUL EDUCAȚIEI NAȚIONALE

National Institute for Research and Development in Microtechnologies

IMT Bucharest

SCIENTIFIC REPORT 2013

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. The Institute is the successor of the Institute for Microtechnologies - IMT (founded in 1993) which merge with the Research Institute for Electronic Components - ICCE (founded in 1969).

IMT Bucharest is coordinated by the **Ministry of National Education**, acting basically as an autonomous, non-profit research company. The institute employs around 185 researchers, engineers and support staff.

IMT has 22 Romanian partners from academia and industry and 132 partners from EU countries and also partners from Argentina, Korea, South Africa, Rep. of Moldova.
The funding is 70% competitive won, and covers many fields as: ICT, Health, Nanotechnologies, Enviromental, Space and Security.
IMT- Bucharest is one of the leading national institutes in Romania, its mission being devoted to development of micro- nano-bio-technologies and nanoelectronics. The main research fields are in closed connections to KETs (Key Enabling Technologies): RF-MEMS, photonics, nano-bio-technologies, sensors for different market oriented applications, graphene based nanodevices, wide bandgap semiconductors, microfluidics, rapid prototyping.

IMT-Bucharest offers a collaborative environment, being visible in 2013 at national level, in different types of projects, financed from the Second National Plan PN II or STAR program funded by ROSA (Romanian Space Agency). The institute is involve in 12 FP7 projects (IPs, STREPs, CA) and related FP7 projects as ENIAC, ERA-NET, COST.

The 2011 ***Report of EC on Innovation*** **placed IMT on the 5 position** among the first 5 organizations (and the only national institute) as far as funding from EU programmes was concerned.
Digital Agenda 2013, published a result regarding **most active organizations in terms of ICT R&D EC** contribution granted to the FP7 research projects, and **IMT is on the 4th position** of the first "*Top 50 RO organisations by funding, 2007-2012 (cumulated figures)*".

IMT was involved in 2013 in 4 structural funds different types of projects in new scientific fields: carbon-based integrated systems & nanomaterials, microfluidics for nanosystem self-assembling, micro-nanotechnologies, focused on research, investments, postdoctoral studies, support for services in Microsystems and nanotechnology in the transfrontalier region Romania- Bulgaria.

In **July 2013 - IMT Bucharest celebrated its 20 years annivesary**. The following photo shows Prof. Dan Dascalu, Member of the Romanian Academy, the founder of the institute and the director of IMT till July 2011, presenting the most important results of the last 20 years and participants from the Ministry of National Education, other national Romanian institutes working in complementary fields of science and collaborators from multinational companies, which were present at the event.

The research activity of the institute is going on through **4 centers, grouping 10 R&D laboratories:**
1. ***MIMOMEMS: European Research Centre of Excellence "Micro- and nano systems for radiofrequency and photonics***
2. ***CNT- IMT: Centre of Nanotechnologies"*** (under the aegis of the Romanian Academy)
3. ***CINTECH: Research Centre for integration of technologies" (micro-nano-biotechnologies)***
4. ***CENASIC: Research Centre for nanotechnologies and carbon based nanomaterial***

Resources

IMT-Bucharest displays a broad range of experimental and computing resources for micro- and nanotechnologies, from simulation and design techniques, to characterization tools, processing equipments (including a mask shop, EBL nanolitography) and testing equipments and a reliability laboratory. Most of these resources are now grouped in the IMT-Bucharest ***centre for Micro- and NAnoFABrication*** (IMT-MINAFAB, www.imt.ro/MINAFAB).

Technology Transfer and Innovation
Since 2005 in IMT-Bucharest a Centre for Technology Transfer in Microengineering (CTT-Baneasa), and respectively June 2006, a Science and Technology Park for Micro- and Nanotechnologies (MINATECH-RO) are active.

Education and Training: IMT-Bucharest is open for educational activities in cooperation with universities from Romania, EU and many other counties: undergraduate, M.Sc. and Ph.D. studies, and also for "hands-on training". 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.

Conferences and Publications: Since 1978, IMT-Bucharest is organizing the "Annual Conference for Semiconductors (CAS)", 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 12 th edition in 2013).

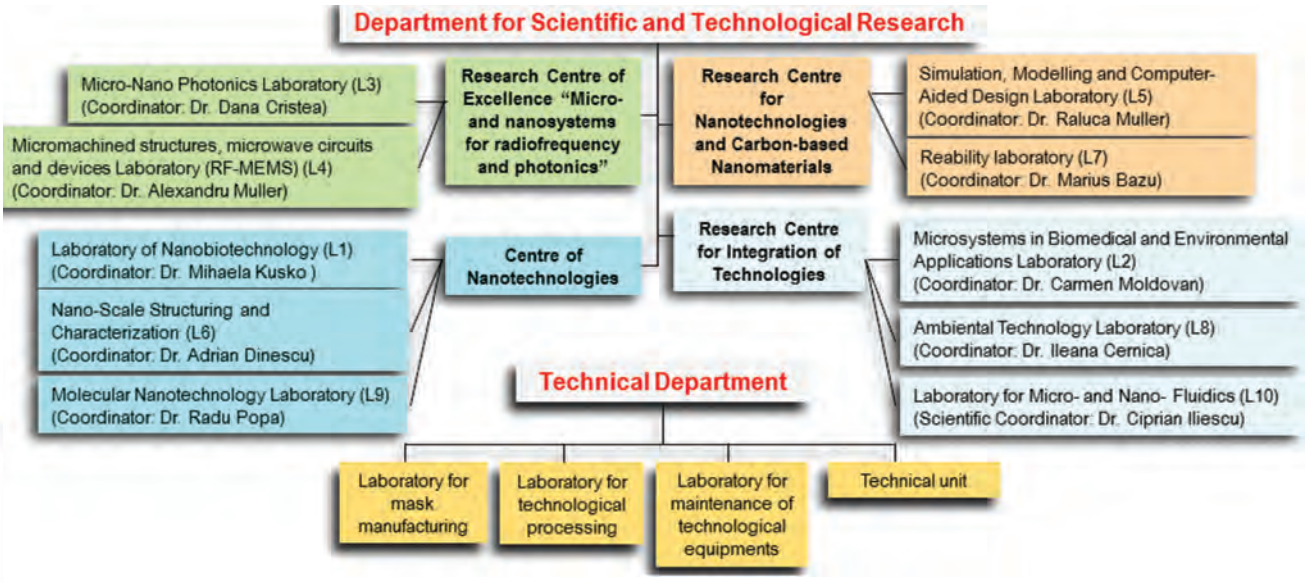
IMT was co-organizer of the ESSDERC Conference 2013, held in Bucharest, together with Infineon Technologies Romania, Politechnica Univesity Bucharest and Technical University Iasi .
The institute is co-editing the series of volumes Micro- and Nanoengineering", in the Publishing House of the Romanian Academy (21 volumes until 2013).

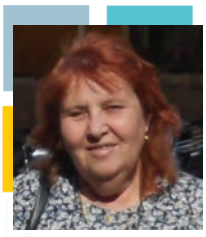
About present report
The Scientific Report 2013 starts with the organizational chart and continues with the basic figures in human and financial resources. The second part is devoted to the R&D labs, presenting the successful stories obtained in the ongoing national and international projects. Brief 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 2013.

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.

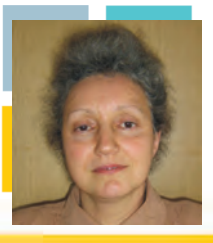
From 1978-1994 she was Research Scientist with ICCE-Research Institute for Electronic Components, Romania; since 1994 she is with IMT. She was Scientific Director starting with 2009 and ***General Manager*** startig with July 2011. Her main scientific interests include design, and technological processes (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 inancial Director in 2009 (delegated as Financial Director since 2001).

Human resources, funding sources, investments

In IMT – Bucharest are active in collaborative 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 national and European projects.
IMT – Bucharest provides an opportunity to students, especially from Politechnica Univesity Bucharest, to develop multidisciplinary research, to be in contact with new technologies, by access to practical labs, supervising experimental work of their diploma and PhD thesis.

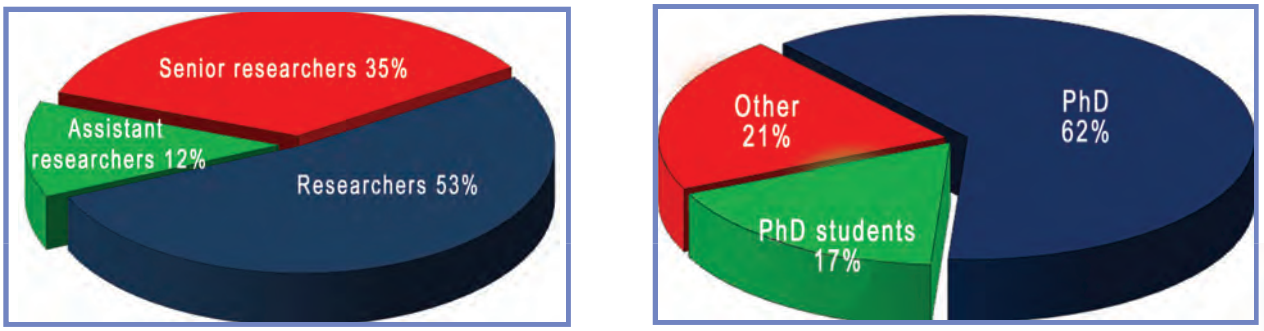


Fig 1 - Researchers active in IMT (82)

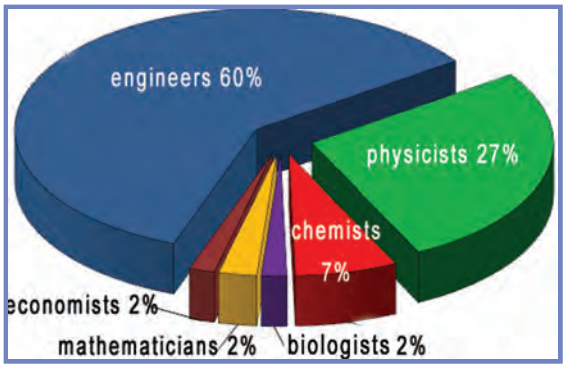


Fig.2 Multidisciplinary background of specialists active in IMT (117)

Figure 1 (a, b) provides information about the number and distribution of researchers active in IMT in 2013 (82 persons). 35% of them are senior researchers and 12% are young assistant researchers. Compared with 2012, the number of people which graduated a PhD or being a PhD students is higher. The average age of our researchers is around 40.

Figure 2 presents information about the multidisciplinary background of the specialists active in IMT in 2013 (117 people): researchers and engineers, covering most of the fields, providing technical services. The male (62) - female (55) number is relatively balanced

Funding sources and investments

Fig. 3 presents the funding sources in 2013, excluding investments. The funding comes from different sources: national R&D programs (competitive funding, through open calls): 33%, Structural Funds 9%, European Projects 7% (FP7, ENIAC) and other sources 2 %.

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 2013. The turnover decrease is also due to the national research funding allocation in 2013.

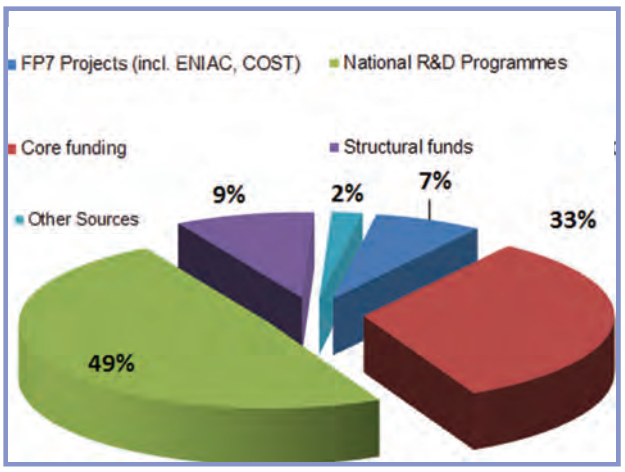


Fig.3 Funding sources in 2013

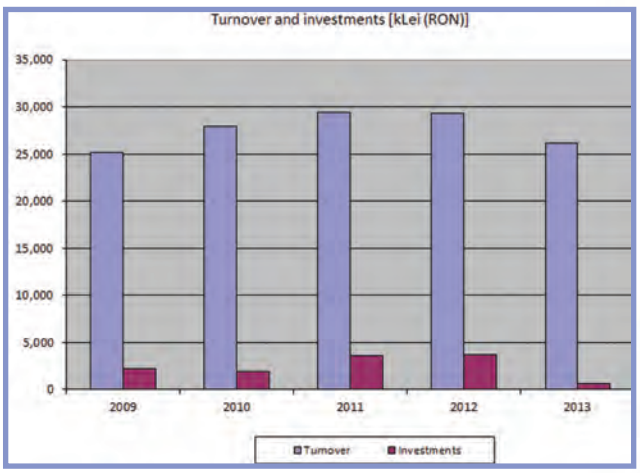


Fig.4 Turnover and investments (kLei)

Experimental Facility: IMT-MINAFAB

Constant and coordinated investments in the experimental infrastructure represented a priority of IMT Bucharest. These investments allowed the institute to 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 **MI**cro- **NANOFAB**rication (IMT-MINAFAB).

IMT-MINAFAB operates several clean-room areas and specialized laboratories - totaling a surface of almost 700 m^2 and modern equipments worth more than 8 Meuro; 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 provides a unique concentration of state-of-the art research equipments for micro-nanotechnology at national level.

This research infrastructure enabled IMT to 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 other leading international partners. The main results achieved by IMT are in the field of the micro-nanoelectronics (more specifically micro-nanosystems) and photonics, two of the Key Enabling Technologies (KETs). A new investment of 6 Meuro in the CENASIC centre (to be finalized in April 2015) is presented separately in this report, and it will allow IMT to extend its existing capabilities in nanotechnologies and advanced materials, another two KETs. The strategic goal of IMT is to become a technological platform for integration of KETs, which is an important direction of development within EU programme for RDI, "Horizon 2020".

A short presentation of the most important components of the research infrastructure follows.

- A class 1000 clean room (220 m^2) for the mask shop and the most demanding technological processes (in use since September 2008);
- A class 100,000 clean room, the so called "Grey Area" (200 m^2), mostly for the characterization equipments (in use since September 2008);
- A class 10,000 clean room (105 m^2) for thin layer deposition by CVD techniques: LPCVD, PECVD; DRIE; RTP etc. (fully in use since early 2012);

• Photolithography (chrome, maskless, wafer double-side alignment and exposure)

Pattern generator - DWL 66fs Laser Lithography System (Heidelberg Instruments Mikrotechnik, Germany)

Double Side Mask Aligner - MA6/BA6 (Suss MicroTec, Germany)

• Nanolithography (EBL, EBID, EBIE, Dip-pen) and SEM

Electron Beam Lithography and nanoengineering workstation - e_Line (Raith, Germany)

Dip Pen Nanolithography - NSCRIPTOR (NanoInk, Inc., USA)

Field Emission Gun Scanning Electron Microscope (FEG-SEM) - Nova NanoSEM 630 (FEI Company, USA).

• Physical depositions of materials in high-vacuum

Electron Beam Evaporation - TEMESCAL FC-2000 (Temescal, USA)

Electron Beam Evaporation and DC sputtering system-AUTO 500 (BOC Edwards, UK)

• Chemical depositions, thermal processing

PECVD - LPX-CVD, with LDS module (SPTS, UK)

LPCVD - LC100 (AnnealSys, France)

Rapid thermal processing/annealing - AS-One (AnnealSys, France)

• Precision etching of materials (plasma reactive ion, humid, shallow and deep)

DRIE- Plasmalab System 100- ICP Deep Reactive Ion Etching System (Oxford Instruments, UK)

RIE Plasma Etcher - Etchlab 200 (SENTECH Instruments, Germany)

Experimental Facility: IMT-MINAFAB

IMT centre for MIcro- and NAnoFABrication (IMT-MINAFAB) was the first “open” research infrastructure in this field from Eastern Europe (2009), providing access for research, education and industry, as clearly explained on the web page www.imt.ro/MINAFAB. IMT is maintaining this advantage, because in 2013 it was the only organization from this region selected to participate to EUMINAfab 2, a proposal for a network of “advanced nanofabrication”, to be financed in “Horizon 2020”. In the EUMINAfab consortium IMT is offering Laser Lithography (2D and 3D patterning), Electron Beam Lithography (down to 20 nm), thin film technology (PECVD/LPCVD), plasma etching (RIE/DRIE), micro-nanoprinting, on wafer RF characterization up to 110 GHz, spectroscopy (FT-IR, Raman, fluorescence), X-ray metrology, reliability testing. What is essential behind the participation of IMT in a proposal aiming at “integration and opening of essential European infrastructures”, it is the scientific expertise of researchers operating most of the more complex equipments (see also the presentation of R&D laboratories).

• X-Ray diffractometry

X-ray Diffraction System (triple axis rotating anode) - SmartLab - 9kW rotating anode, in-plane arm (Rigaku Corporation, Japan)

• Scanning probe microscopy: AFM, STM, SNOM, confocal, Raman mapping

Scanning Probe Microscope - NTEGRA Aura (NT-MDT Co., Russia)

Scanning Near-field Optical Microscope, Witec alpha 300S (Witec, Germany)

• Nanomechanical characterization

Nanomechanical Characterization equipment - Nano Indenter G200 - (Agilent Technologies, USA)

• Microarray spotting/scanning

Micro-Nano Plotter - OmniGrid (Genomic Solutions Ltd., UK)

Microarray Scanner - GeneTAC UC4 (Genomic Solutions Ltd., UK)

• Analytical characterization tools

Scanning Electrochemical Microscope

ElProScan (HEKA, Germany)

Zeta Potential and Submicron Particle Size Analyzer - DelsaNano (Beckman Coulter, USA)

Fluorescence Spectrometer - FLS920P (Edinburgh Instruments, UK)

• Interferometry/profilometry; Spectroscopy

High Resolution Raman Spectrometer - LabRAM HR 800 (HORIBA Jobin Yvon, Japan)

White Light Interferometer - Photomap 3D (FOGALE nanotech, France)

Electrochemical Impedance Spectrometer - PARSTAT 2273 (Princeton Applied Research, USA)

Fourier–Transform Infrared Spectrometer - Tensor 27 (Bruker Optics, Germany)

UV-Vis-NIR Thermo-Electric Cooled Fiber Optic Spectrometer - AvaSpec-2048 TEC (Avantes, The Netherlands)

Refractometer for layer thickness measurements - NanoCalc-XR (Oceanoptics, USA)

• Probers, on-wafer; electrical characterization

Semiconductor Characterization System (DC) with Wafer Probing Station - 4200-SCS/C/Keithley

Easyprobe EP6/ Suss MicroTec (Keithley Instruments, USA; Suss MicroTec, Germany

Semiconductor Characterization System - 4200-SCS, C-V 3532-50, DMM 2700-7700, 2002, 6211-2182 (Keithley Instruments, USA

Microwave network analyzer (0.1-110GHz) with Manual Probing Station (Anritsu, Japan; Suss MicroTec, Germany)

Frequency Synthesizer up to 110 GHz (Agilent, USA)

Spectrum Analyzer up to 110 GHz (Anritsu, Japan)

TECHNOLOGICAL TRANSFER INFRASTRUCTURES

CTT - Baneasa

CENTRE FOR TECHNOLOGY TRANSFER IN MICROENGINEERING

CTT-Baneasa is a distinct, autonomous entity of the National Institute for R&D in Microtechnologies- IMT Bucharest, established in 2003. The major mission of the Center is to become an active professional link between research and industry, within the field of micro- and nanotechnology. Concrete activities in 2013 have been dissemination of information, including participation to exhibitions, such as Bruxelles Innova/ Eureka 2013 (International Exhibition of Inventions), Brussels, November 2013. CTT-Baneasa is a member of ReNITT, National Network for Innovation and Technological Transfer. CTT-Baneasa is also a founding member of ARoTT, Romanian Association of Technology Transfer (AROTT)

Contact data: CTT-Baneasa (www.imt.ro/ctt); Tel/Fax: +40-21-269 07 71; E-mail: info-ctt@imt.ro.

Address: 126A Erou Iancu Street, Bucharest, 077190.

MINATECH-RO

THE SCIENCE AND TECHNOLOGY PARK FOR MICRO AND NANOTECHNOLOGIES

MINATECH-RO (www.minatech.ro) technology park is focused on R&D for micro and nanotechnologies. The initiative of the establishment belonged to a national consortium coordinated by IMT Bucharest and including the "Politehnica" University of Bucharest (PUB). This park is located almost entirely on the IMT premises. MINATECH-RO was created and received institutional funding during 2004-2005 through the national INFRATECH Programme, administered by the Ministry of Education and Research.

The companies presently located in the park in 2013 have been:

- ROMQUARTZ SA
- SITEX 45 SRL
- DDS DIAGNOSTIC SRL
- TELEMEDICA SA.

These companies have priority in accessing scientific and technological services provided by IMT-MINAFAB. They are also privileged partners of IMT in national and international projects, e.g. ROMELGEN SA is cooperating with IMT Bucharest in the European project "The Integrated Platform for Pesticides Detection", PESTIPLAT(2011-2014). A special case is the cooperation with the local subsidiary of the multinational company Honeywell: apart from access to services, they have their own equipments hosted in the technological space of IMT.

Contact data: MINATECH-RO (www.minatech.ro); Tel: +40-21-269.07.67; E-mail: team@minatech.ro

Address: 126A Erou Iancu Street, Bucharest, 077190.

RO-BG MicroNanoTech

Romanian-Bulgarian Services Centre for Microsystems and Nanotechnology MIS-ETC 587

Joint Project Steering Committee Meeting, 28th June 2013, University "Angel Kanchev" Ruse

The project 'Romanian-Bulgarian Centre for Services in Microsystems and Nanotechnologies' (RO-BG Micro Nanotech), financed by the Romanian-Bulgarian Cross-Border Cooperation Programme 2007-2013 of the European Union, will run for 18 months, since May 1, 2013 until October 30, 2014. It is financed with 577,725.85 euro, granted by the European Commission through the Cross-Border Cooperation Programme for Romania and Bulgaria 2007-2013, from the European Regional Development Fund (ERDF), in the Priority Axis: 3 - Economic and Social Development; Key Area of Intervention: 3.1 - Support for cross-border business cooperation and promotion of a regional image and identity, and Indicative Operation: 3.1.4. - Promotion of co-operation between universities, research institutes and businesses in the field of R&D and innovation. The participants are: the National Institute for Research and Development in Microtechnologies – IMT-Bucharest, as Coordinator (Project Manager: Dr. Corneliu Trişcă-Rusu), the Chambers of Commerce, Industry and Agriculture Călăraşi and Giurgiu (from Romania), as well as the University 'Angel Kanchev' Ruse and the Chamber of Commerce and Industry Ruse, representing Bulgaria.

The aim of the both workshops were to obtain an overview of the opportunities that SMEs on the cross-border area may have in relation to MNT, with regard to availability of specific services delivered by R&D institutions.

The main objective of the project is to create and develop a Romanian-Bulgarian Centre for Services in Microsystems and Nano-technologies, based on cooperation of universities, research institutes and SMEs from the border area of Romania and Bulgaria. Target groups covered by this project are entities situated in the Romania-Bulgaria cross-border area: SMEs, research groups, local associations active/interested in the field of micro/nano technologies (MNT). The access to HighTech services (offered by the partners) in the Micro- and Nanotechnologies is crucial to develop new competitive products and services with one important added value. The Centre will have two offices, at IMT-Bucharest and University of Ruse, as well as two information points, at the Chambers of Commerce, Industry and Agriculture Călăraşi and Giurgiu. One other activity is the cooperation of universities, research institutes and SMEs (represented by the Chambers of Commerce) in the field of R&D and innovation on themes of cross-border interest (microsystems and nanotechnologies), including development of a proposal for Master degree Engineering programs in MNT in the Romanian and Bulgarian universities from the cross-borde area.

During the year2013 the project organized 2 workshops, in Romania with various focus to promote the high tech services offered by the scientific partners and the complementary services offered by the Chambers of commerce, partners in the project. Visit of the research teams and SMEs representatives of the technological area and of laboratories of IMT-Bucharest was organized by the project partners.

MICRONANOFAB - Microfluidic Factory for "Assisted Self-Assembly" of Nanosystems

Project thematic area: Innovative materials, products and processes

Operational programme: POS CCE; *Priority Axis 2* – Research, Technological Development and Innovation for Competitiveness

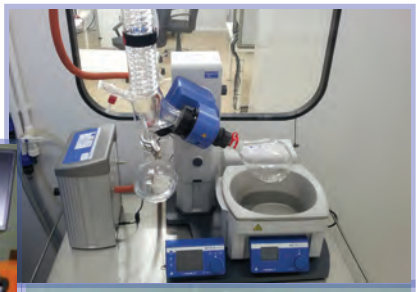
Operation: O.2.1.2 "Complex research projects fostering the participation of high-level international experts"

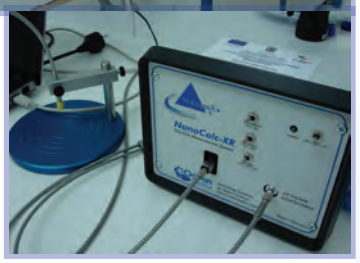
ID/COD SMIS/No.: 665/12609/209/20.07.2010

Initial duration of contract: 36 months (July 2010- July 2013). Extended to January 2014

Total value: 7,071,000 RON, with 5,900.,000 RON financed from POS CCE

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





The main target 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 new equipments acquired in the frame of the project are shown in the photos: Wafer-Substrate Bonding System, Suss MicroTec SB6L (left, top); Micro - Particle Image Velocimetry Measuring System, Micro - PIV System, Dantec Dynamics (left, bottom); Rotary evaporator with integrated heating bath and vertical glassware, IKA® - RV 10 control V (right, top); ICP Deep Reactive Ion Etching System, Plasmalab System 100 (right, middle); Refractometer for layer thickness measurements, NanoCalc-XR (right, bottom); Microfluidic Pumpimg System, Mitos P-Pump system, Dolomite Center Ltd.

"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). The initial value of the grant has been 10,072,499 RON, but only 7,228,380.81 RON have been spent (including 146,192.23 lei cofinancing). Coordinator: Acad. Dan Dascalu (dan.dascalu@imt.ro), Deputy coordinator: Dr. Corneliu Trisca-Rusu (corneliu.trisca@imt.ro).

The final Conference of the project took place on 27th of March, 2013. Despite the fact that only 72% of the financial resources have been spent, all project objectives have been completed. The final report, posted on the site www.mnt-postdoc.ro, shows that this project provided financial support for 30 months to 35 postdoctoral researchers from National Institute for R&D in Microtechnologies (IMT Bucharest), National Institute for R&D in 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 (UPB); Tehnical University from Cluj-Napoca; Transilvania University Brasov; University of Pitesti; S.C. DDS Diagnostic SRL; S.C. METAV-Research Development S.A. IMT, INFLPR, UPB offered open access to their experimental facilities.

The above mentioned report is mentioning 65 papers published (or accepted for publication) in ISI periodicals, other 63 papers in various periodicals and 149 papers presented in scientific conferences (64 in oral and 85 in poster sessions). Dedicated scientific sessions have been also organized each semester, two of them open to the public. Training courses and working stages abroad completed the actions within this project.

EUROPEAN UNION
ROMANIAN GOVERNMENT
STRUCTURAL INSTRUMENTS 2007-2013

Sectorial Operational Program - Increase of Economic Competitiveness
„Investments for your future"
Project co-financed by European Regional Development Fund

Research Centre for Integrated Systems Nanotechnologies and Carbon Based Nanomaterials - CENASIC

CENASIC project (new infrastructure) is devoted to the creation of modern research center focused on applied research, involving highly specialized techniques and experienced researchers. This strategic investment allows access to new equipment, laboratories and state-of-the art technology fully integrated into the existing IMT infrastructure.

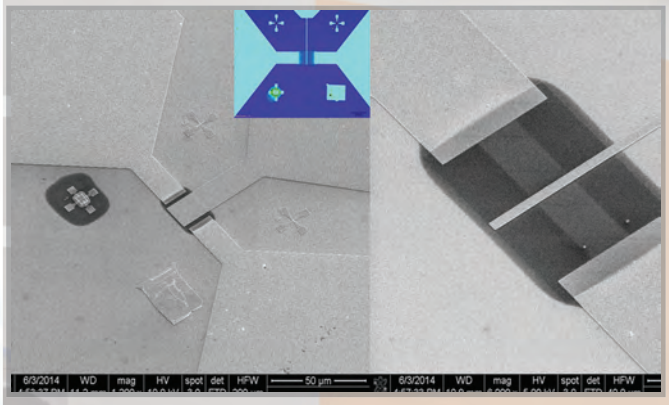
CENASIC aims to develop a clear-cut thematic for research, partnerships and collaborations in the sphere of micro/nanotechnologies targeting the implementation of new technologies based on dedicated carbon materials: SiC, graphene and nanocrystaline diamond. The thematic priority is Innovative Materials, Processes and Products (according to the National RDI Programme 2007-2013, the contract for financing was signed in 2010).

The "philosophy" of CENASIC project is the continuous investment in growing of human potential, by offering access to the new and existing R&D equipment and facilities, developing new partnerships with foreign scientists within the EU and creating new employment opportunities in an international environment.

Part of the existing clean room equipment for chemical deposition from the vapor phase in plasma and micromachining volume facility that will be built in the center CENASIC.

With the investment of 6.23 Meuro in building, facilities and equipment (to be implemented until April 2015), the output of the project in the following 5 years should include the training and formation of at least 20 young professionals (part of them from IMT), maintaining at least 33 existing jobs in IMT, creating at least 10 new positions (5 of them to be occupied by foreign scientists), as well as providing a number of technological services etc.

The new building has approximately 1000 m2, including 4 levels: the clean room (ground floor), technical level, 2 levels for labs and offices. The 8 new experimental laboratories (new or reinforced) will complete technological process in order to develop products and services offered in the project. The list of these laboratories is: Lab for Processing of Carbon based Nanomaterials and Nanostructures, Lab for Thermal Processes, Lab for Graphene technology, Lab for Chemistry of Hybrid Interfaces, Lab for Thin Layer Spectrometry, Lab for Electro-mechanical Processes and Sample Preparation, Lab for Electromechanical Testing & Reliability and Laboratory for Simulation and design for carbon-based MEMS/NEMS. The key equipments within the CENASIC labs will be: Multiprocess Furnace System, Molecular Beam Epitaxy (MBE), Plasma Enhanced Chemical Vapor Deposition, Atomic Layer Deposition tool and RF Magnetron Sputtering. A 200 m2 new clean room will extend one of the existing ones (see photo above).



SEM image of top gated field effect transistor on CVD graphene ribbon (left) and optical image (inset); 50 nm thick hydroxi-silsesquioxane (HSQ) used as a gate dielectric (right). M. Dragoman, A. Dinescu et al. (in press)

IMT has a proven experience on carbon based materials certified by results already published in literature (see an example in the figure below). The research will be focused on carbon based nanoelectronics, heterostructures based on graphene/semiconductors such as GaN and Si, nanophotonics based 2D materials, MEMS/NEMS based graphene and physical sensors based on carbon nanomaterials. Several processing techniques for graphene and carbon nanotubes CNT) have been already implemented and the team is focused on areas of current research aiming 2D material processing (WS2, MoS2) devices NEMS / MEMS sensors on graphene and carbon materials.

Since the CENASIC project is not limited to graphene and CNT: Silicon Carbide (SiC) and diamond should be also used in industrial applications, partnership with other research organizations and industrial companies is highly required.

Project Contact: ***Dr. Lucian Galateanu*** (lucian.galateanu@imt.ro), Director of the CENASIC Project

MIMOMEMS European Centre of Excellence

MIMOMEMS - "European Centre of Excellence in Microwave, Millimetre Wave and Optical Devices, based on Micro-Electro-Mechanical Systems for Advanced Communication Systems and Sensors", REGPOT call 2007-1, Contract no. 202897, 2008-2011, Coordinator: IMT-Bucharest, http://www.imt.ro/mimomems

MIMOMEMS is the first centre of excellence created in Romania through the FP7 REGPOT project call of EU. The MIMOMEMS project (2008-2011) joints the effort of two laboratories from IMT Bucharest, the RFMEMS Laboratory and the Microphotonics Laboratory to bring their activity and results at the highest European level. MIMOMEMS has represented a support action for the developing of microwave, millimetre wave devices and circuits, optical devices and sensors based on MEMS technologies, with applications in modern communication systems. This support action helped the development of the two labs in terms of equipment upgrading, high qualified personnel hiring, common scientific research actions together with twining partners and dissemination actions of the results

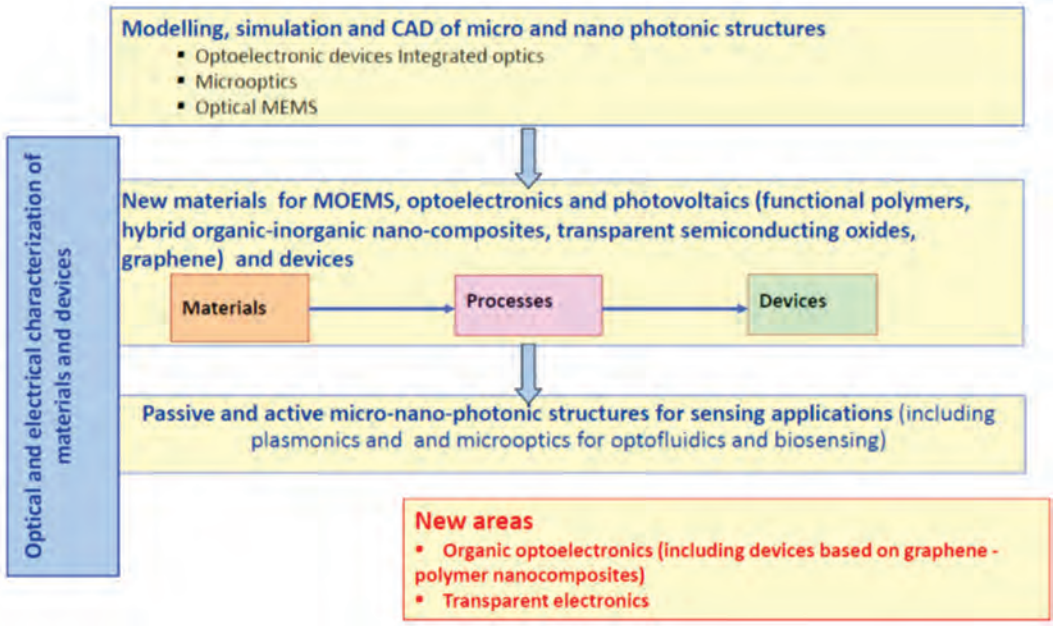
The MIMOMEMS Centre of excellence remains as a distinct entity in IMT after the end of the EU founded project. The very good results of the MIMOMEMS centre were materialized by a deep involvement in other EU founded research projects (the centre is now partner in 2 FP7 IPs, one STREP, 2 ENIAC projects and one ERA-NET project). The team is prepared for the participation at the Horizon 2020 calls. Also various collaborative research activities with many European teams have been developed by the MIMOMEMS team, in the last years, with results in high quality publications in high ranked journals.

Laboratory of Micro/Nano Photonics

Member of "*European Centre of Excellence in Microwave, Millimetre Wave and Optical Devices, based on Micro-Electro-Mechanical Systems for Advanced Communication Systems and Sensors" (MIMOMEMS)*, funded (2008-2011) through the "Regional potential" – FP7 REGPOT.

Mission- *Research, development and education* in **micro and nanophotonics**

Main area of expertise



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

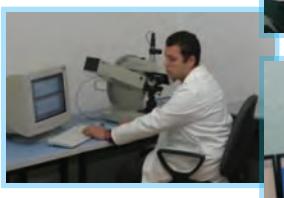
Dr. Dana Cristea obtained the MSc in Electronics and PhD in Optoelectronics and Materials for Electronics from "Politehnica" University, Bucharest, Romania. She was a research scientist in the Optelectronics Lab from the Research Institute for Electronic Components, Bucharest (1982-1994).

Since 1994 she has been a senior researcher in the IMT- Bucharest, Romania, head of Micro- and Nano-photonics Lab since 1997 and head of Department for Multidisciplinary Research between 2002 and 2008. Since 1990 she is 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, micro-optics (design, processing and characterization), new nanostructured materials for photonics, chemo and bio-sensors, micro-optics. She has been authored more than 90 papers published in journals and Conference Proceedings. She is also a reviewer in Romanian and international scientific journals and evaluator for FP6 and FP7 projects. Dr. Dana Cristea coordinated more than project 20 national projects. She participated in several FP6 projects (WAPITI, 4M, ASSEMIC) and has been coordinated and participated in two FP7 projects (FlexPAET, MIMOMEMS).

Laboratory of Micro/Nano Photonics

Specific facilities



Modeling and simulation:

- **Opti FDTD 12.0** - design and simulation of advanced passive and nonlinear photonic devices
- **OptiBPM 11.0**- design of complex photonic integrated circuits for guiding, coupling, switching, splitting, multiplexing and demultiplexing of optical signals.
- **OptiGrating**- design software for modelling integrated and fiber optical devices that incorporate optical gratings.
- **LaserMod** - analysis of optoelectronic devices.
- **3Lit** – design of 3D micro-optical elements.
- **Zemax** – optical design.

Characterization:

- spectrophotometers for UV-VIS-NIR and IR spectral range;
- spectroscopic ellipsometer
- High Resolution Raman Spectrometers LabRAM HR with module TERS/AFM
- Alpha300 S System –Scanning Near-field Optical Microscope, Confocal Microscopy and Atomic Force Microscopy
- Optical Theta Tensiometer (KSW Instruments)
- experimental set-up for optoelectric characterization in UV-VIS-IR spectral range

Technology: • glove box for preparation and deposition of nanocomposites and organic layers

Cooperation

European Projects: • **FP7**

- Flexible Patterning of Complex Micro Structures using Adaptive Embossing Technology *FLEXPAET* – IP priority NMP; European
- Centre of Excellence in Microwave, Millimetre Wave and Optical Devices *MIMIOMEMS*– CSA- programme capacities

MNT EraNet Project

- Multifunctional Zinc-Oxide based nanostructures: from materials to a new generation of devices *MULTINANOWIRES*

National Projects:

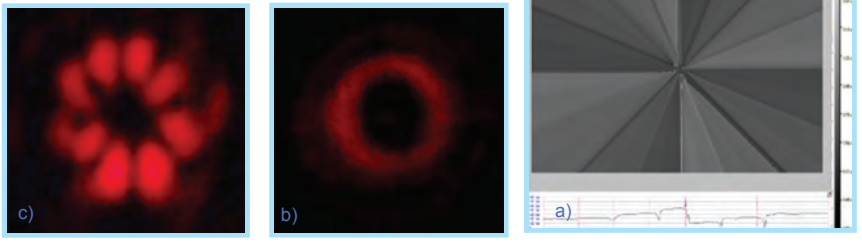
- Thin film photodetectors-new concepts and studies for aerospace applications (*STAR project*)
- Bolometers for space applications in middle and long infrared (STAR Project)
- Secured high volume free space optical communications based on computer generated holograms (*PNII- Partnership*)
- Carbon quantum dots: exploring a new concept for next generation optoelectronic devices (*PNII- IDEAS*)

Results

High volume free space optical communications based on computer generated holograms

Project PN-II-PT-PCCA *Dr. Cristian Kusko*
(cristian.kusko@imt.ro)

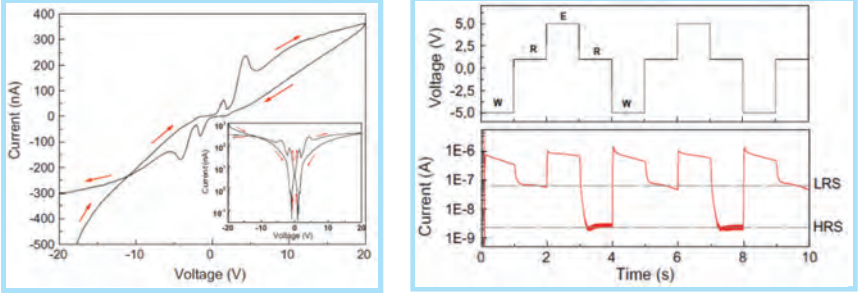
We fabricated diffractive optic elements generating optical vortices for optical communications in free space and we realized experimental setups for characterization and determination of their optical angular momentum number.



a) White light interferometry image of a diffractive optic element generating an optical vortex with m=4. Optical vortex with m=4. c) Interference of two vortices with m=4 si m=-4.

Carbon quantum dots for optoelectronic devices *(project PNII-ID-PCCE)*

We investigated electrical and optical properties of graphene quantum dots – polymer nanocomposite . We have shown that the devices based on this nanocomposite present negative differential resistance, memory efects and photoelectric properties. *(Organic Electronics 15 (2014) 216–225).*



a) I–V characteristic of GQD – PEG600 nanocomposite film deposited on interdigitated electrodes where the applied voltage was scanned in a loop from −20 V to 20 V and back to −20 V, the arrows indicating the scan course. Inset: I–V curve in logarithmic scale of current.. b) Operation of a write – read – erase – read sequence (−5/1/5/1 V).

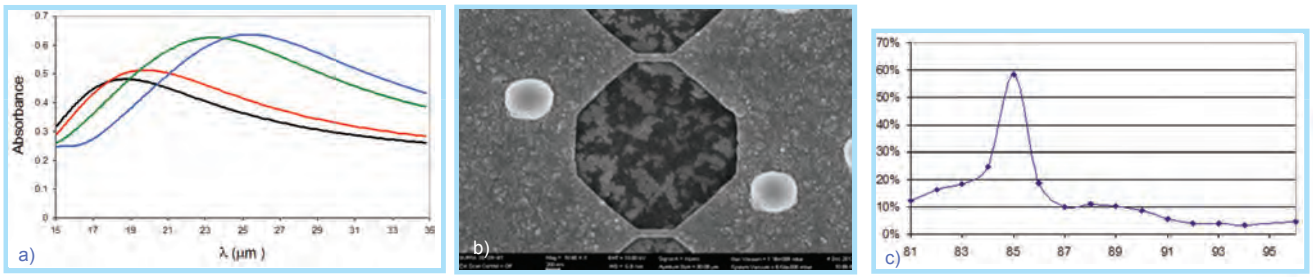
Results

Nonlinear plasmonic waveguides

We investigated theoretically and numerically the properties of nonlinear plasmonic waveguides for applications such as generation of terahertz radiation and generation of femtosecond pulses. (C.Kusko - IEEE J. of Quantum Electronics 49, 1080 (2013).

Bolometers for space applications in middle and long infrared (STAR project)

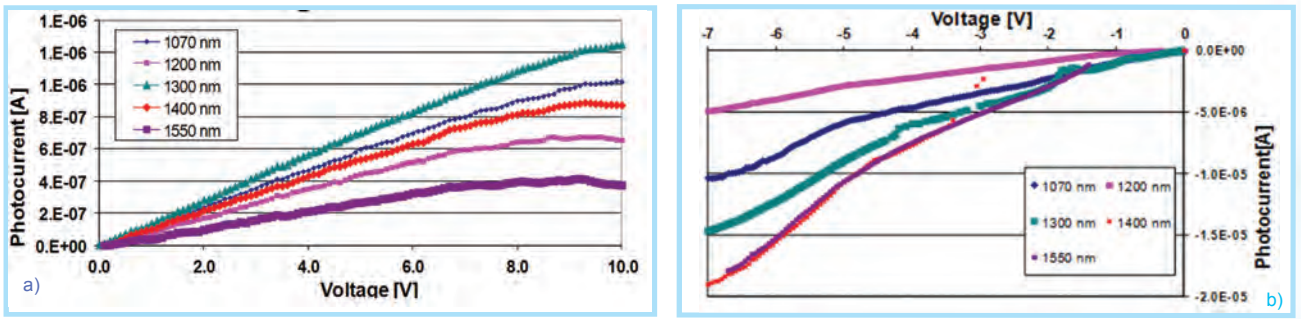
We have performed FDTD simulations of metamaterials which present increased absorption in middle and long infrared domain; technological experiments for fabrication of SQUID structures; electrical characterization of superconducting YBCO layers and demonstration of resistivity variation at infrared irradiation. (Mihai Kusko - mihai.kusko@imt.ro).



a) Absorption variation with wavelength of various metamaterials configurations. b) Metallic mask written with EBL and obtained via lift-off for SQUID configuration. c) Relative variation of the resistivity at infrared irradiation.

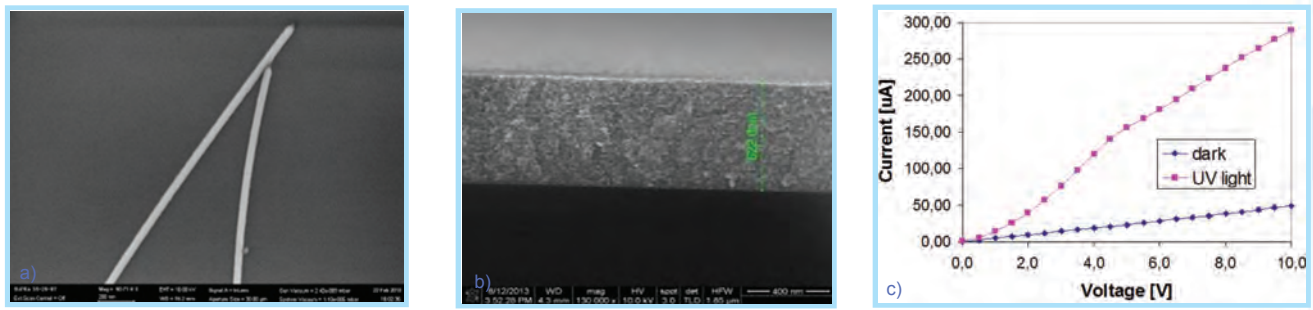
Photodetectors with improved sensitivity in IR (STAR project)

We have performed FDTD simulations of metamaterials which present increased absorption.



Fotocurentul la diverse lungimi de unda in IR:a) detectoarelor fotoconductive pe baza de PbS-QDs; detectoare schottky PbS/Si
Photocurrent under IR illumination for : a) PbS QDs based photoconductor; b) PbS QDs/Si Schottky photodetector; (D.Cristea –ana.cristea @imt.ro)

Nanowires and nanocomposites for optoelectronics



a) An nanowires for transparent electrodes (SEM inage); b) n-ZnO thin film for UV sensors; c) I-V characteristics in dark and under UV illumination for n-ZnO/Si detectors.(P. Obreja- paula.obreja@imt.ro)

Training activities:

- **Master courses** – Optoelectronics/Integrated optics and Microsystems in cooperation with “Politehinca” Univ. Bucharest.
- Supervising undergraduate, master and PhD students.

Scientific sevices:

- Raman Spectroscopy
- Ellipsometry
- Scanning Near-field Optical Microscopy- SNOM

Laboratory of micromachined structures, microwave circuits and devices

Activity

• Development of microwave and millimeter wave circuits based on semiconductor (Si, GaAs, GaN) micromachining and nano-processing
• Acoustic devices (FBARs and SAWs) based on micromachining and nanoprocessing of wide band gap semiconductors (AlN, GaN)
• Temperature and humidity sensors based on GHz operating SAWs and FBARs
• RF MEMS
• Microwave devices based on carbon nanotubes; and graphene

Team:

The L4 laboratory team has multidisciplinary expertise in physics,electronics, microsystems and is composed of 12 senior researchers (PhD in physics, electronics, microwave and chemistry) and 2 PhD students in Electronics.

Dr. Alexandru Muller, senior researcher I, head of lab;
Dr. Mircea Dragoman, senior researcher I;
Dr. Dan Neculoiu, senior researcher II;
Dr. Gheorghe Sajin, senior researcher I;
Dr. Valentin Buiculescu, senior researcher II;
Dr. Dan Vasilache, senior researcher III;
Dr. Alina Cismaru, senior researcher III;
Dr. Alexandra Stefanescu, senior researcher III;
Dr. Emil Pavelescu, senior researcher I;
Dr. Anton Cornel, senior researcher II;
Eng. Alina Bunea, PhD. St, researcher;
Eng. Ioana Giangu, PhD. St, junior researcher;
Eng. Cristina Buiculescu, senior researcher III;
Phys. Ioana Petrini, senior researcher III

Equipment:

"On wafer" measurement system 0.1-110 GHz range, Frequency Syntesizer up to 110 GHz; Spectrum Analyzer Anritsu up to 110 GHz; Tektronix digital serial analyzer with TDR module; Semiconductor characterization system, Optical profiler WLI – Photomap 3D; Computers and software for microwave electromagnetic simulations (IE3D); cryostat (5 - 500K tmp range).

International projects:

FP7: - ***SMARTPOWER, IP***- FP7-ICT-2011-7, No 288801, "Smart integration of high power electronics for industrial and RF applications", Coord Thales Research&Technology, France, 2011-2015

- ***NANOTEC, IP***-FP7-ICT-2011-7, No 288531, "Nanotechnology for Adaptive Communication and Imaging Systems based on RF-MEMS", Coord Thales Research & Technology, France, 2011-2015
- ***NANO RF, STREP***-FP7-ICT-2011-8, No 318352, "Carbon based smart systems for wireless applications", Coord Thales Research & Technology, France, 2012-2015
- ***MOLD-NANONET, CA***-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 " Coord ELIRI, Moldova, 2011 - 2014

ENIAC JU projects: - ***MERCURE*** (ENIAC-2009-1) *"Micro and Nano Technologies Based on WBG Materials for Future Transmitting Receiving and Sensing Systems"* (2010 –2014)
- ***NANOCOM***, ENIAC-2010-1, *"Reconfigurable Microsystem Based on WBG Materials, Miniaturized and Nanostructured RF-MEMS"* (2011–2015)

National projects:

3 projects in the IDEAS programme (2011-2015): *"Nanoelectronic devices based on grapheme for high frequency applications" (Dr M. Dragoman), "Novel technologies based on micromachining and nano-processing of GaN/Si, for advanced microwave and photonic devices" (Dr. A. Muller) and „Millimeter-wave Front-End for Imaging in Security and Medical Applications" (Dr. D. Neculoiu),*

2 projects as partner in PN II programme (2012- 2015) and 1 project coordinated by Romanian Space Agency STAR project *"Millimetre and submillimetre wave GaAs Schottky diodes detectors and mixers"* (2013 – 2016, Dr. A. Muller).

Referents and members in committees:

Laboratory members A. Muller, M Dragoman, D Neculoiu, Gh Sajin, A Stefanescu, A Cismaru, A Bunea, are reviewers at: Appl Phys Lett, IEEE Trans on El Dev, IEEE El Dev Lett, J of Appl Phys, Electron Lett, IEEE MWCL, Sensor Lett, J M M.

A. Muller, M. Dragoman and D. Neculoiu are members of the Technical Programme Committee and Paper Review Board, at the International Semiconductor Conference (CAS, an IEEE event). M. Dragoman and A. Muller were members of the ESSDERC 2013 Technical Program Committee. M Dragoman, Gh Sajin and D Neculoiu are associate editors at ROMJIST and A. Muller is co-editor of the Micro and Nanoengineering Series (Romanian Academy Press).

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

Dr. Alexandru Muller obtained the PhD degree in Semiconductor Physics in 1990, Bucharest University.
Career path and current position: 1972-present Senior Research Scientist at IMT Bucharest; 1996-present head of the Micromachined Structures, Microwave Circuits and Devices (L4).

Competences: Silicon, GaAs and GaN micromachining and nanoprocessing: membrane supported circuits (1997-European priority), acoustic devices (FBARs and SAWs) based on micromachining and nanoprocessing of WBG semiconductors (AlN, GaN).

Dr. Müller was the coordinator of the European project FP7 REGPOT (2008-2011) No 202897 "European Centre of Excellence in Microwave, Millimetre Wave and Optical Devices, based on Micro-Electro-Mechanical Systems for Advanced Communication Systems and Sensors". Also has coordinated the *European Project FP 4 MEMSWAVE (1998-2001), the first ITC EU project coordinated by an Eastern country.*
Dr A. Muller coordinated, for IMT Bucharest as the Romanian partner, 3 EU projects (FP6, FP7), 2 ENIAC projects, 1 COST project, as well as an important number of national projects.

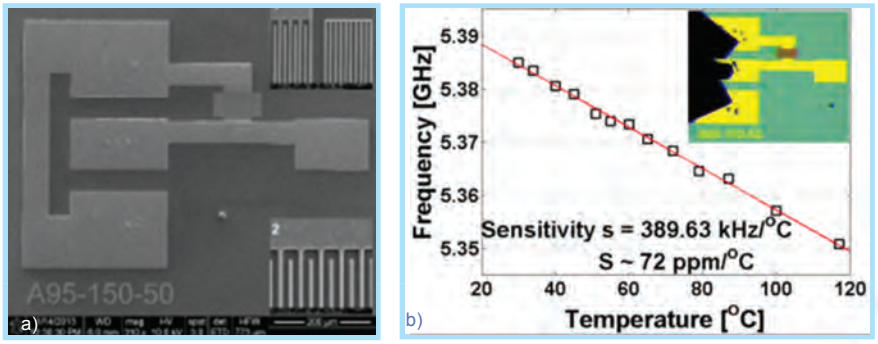
Laboratory of micromachined structures, microwave circuits and devices

Most important scientific results

GaN based single resonator SAW structure operating in the GHz range, for temperature sensing – in the frame of the European Project SMARTPOWER – FP7-ICT-2011-7, No 288801 - "Smart integration of high power electronics for industrial and RF applications"

An optimized single resonator for improved T sensitivity and Q has been developed (GaN/Si; GaN layer 1 μm thin; IDT and reflectors metallization 100 nm thin Ti/Au). The IDTs length was 50 μm, and 100 μm, the digit/interdigit spacing 200 nm.

The IDT has 150 fingers/interdigits and reflectors with 50 digits / interdigits. The frequency shift of the resonance frequency vs. temperature was used for measurements. Sensitivities beyond the state of the art have been obtained for the on wafer measurements.

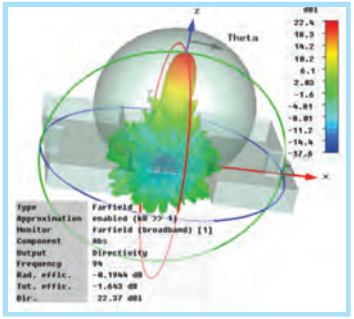


SEM photo of the single resonator SAW structure with the insert presenting details of the nanolithography (a);"on wafer" measurements (b)

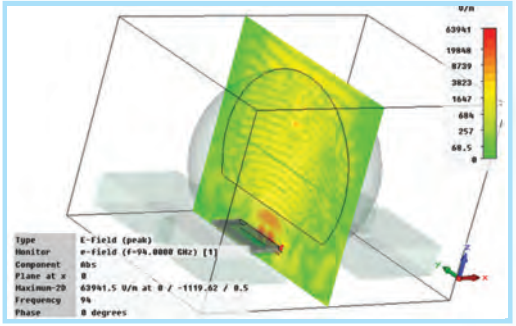
Near-field gain enhancement for mm-wave planar antennas using 3D printed polyamide structures – research performed in the frame of the European project NANOTEC - FP7-ICT-2011-7, No 288531 – "Nanostructured materials and RF-MEMS RFIC/MMIC technologies for highly adaptive and reliable RF systems

Spherical lenses placed in the near-field of the planar antenna were investigated due to facile modelling and fabrication using 3D printing of polyamide. A spherical lens concentrates the electromagnetic radiation in a quasi-focal region. This was demonstrated by electromagnetic simulations using CST Microwave Studio by exciting the lens with a plane wave and viewing the electric field distribution. 3D electromagnetic simulation results for hyper-hemispherical lenses excited by a W-band planar antenna element showed an increase of gain of 10 – 15 dBi. Test structures with radiuses of 10 – 15 mm and heights of 15 – 22.5 mm were fabricated through 3D printing through laser sintering of polyamide. Measurement results validated the electromagnetic simulations.

Photo of polyamide lenses fabricated through 3D printing (cooperation with L5- Dr. G. Moagar)



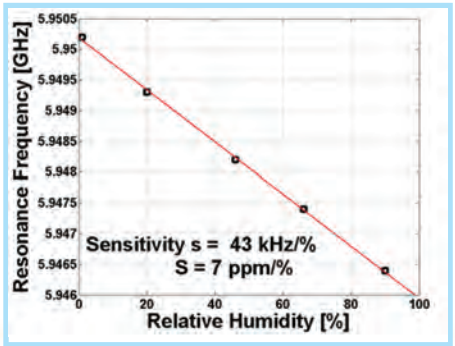
3D radiation pattern at 94 GHz for a 3D printed 10 mm radius hyper-hemispherical lens fed by a planar antenna

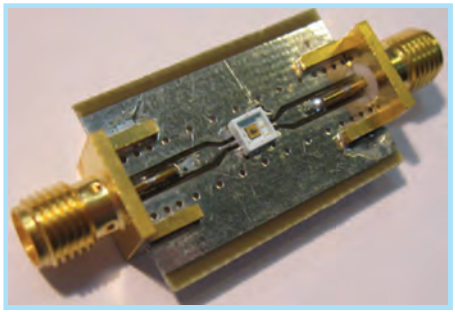


Electric field distribution at 94 GHz

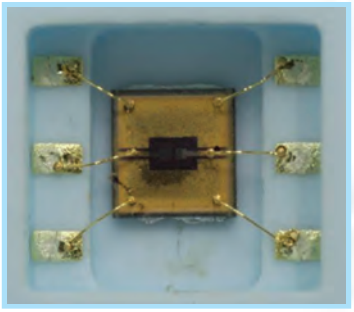
Humidity sensor structures based on GaN/Si FBAR structures have been obtained in the frame of the ENIAC_JU project, **MERCURE**, *"Micro and Nano Technologies Based on WBG Materials for Future Transmitting Receiving and Sensing Systems"*. The FBAR structures were manufactured on GaN/Si thin membranes by micromachining of the silicon substrate. The humidity sensor demonstrator has been manufactured and characterized in cooperation with FORTH Heraklion, Univ Krakow, Thales TRT and Via Electronic Gmbh.

Resonance frequency of the FBAR sensor vs relative humidity(RH)





PCB holder FBAR humidity sensor and resonance frequency shift measurement



FBAR structure for the humidity sensor mounted on the LTCC based package

Based on the experimental linear variation of the resonance frequency vs. humidity, the sensitivity of the sensor was determined.

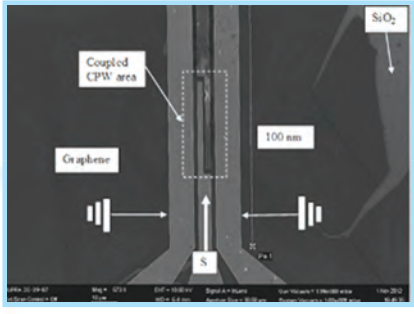
Laboratory of micromachined structures, microwave circuits and devices

Most important scientific results

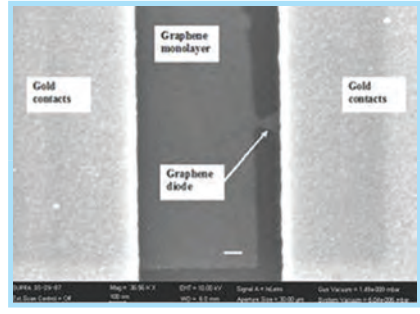
Devices on graphene for microwave, millimeter wave and submillimeter wave domain obtained in the frame of the European project NANO RF – STREP - FP7-ICT-2011-8, No 318352 "Carbon based smart systems for wireless applications",

Antennas, FET transistors and a diodes based on graphene have been designed. The graphene ballistic diode was electric characterized and a ballistic detector for electromagnetic waves on graphene was obtained. The ballistic diode on graphene has 100nm length, the diode "neck" has 30nm.

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



SEM image of the frequency multiplier on graphene

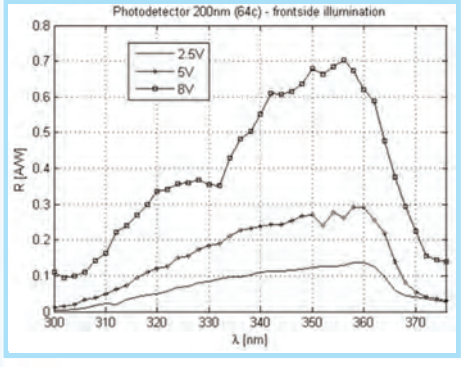


SEM image of the ballistic diode with resonance frequency 8 THz

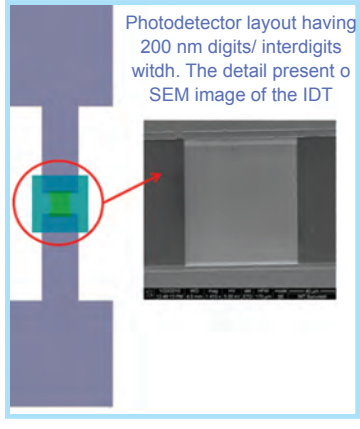
A new frequency multiplier on graphene : an one atomic layer frequency multiplier on graphene for the 11-33 GHz frequency band was designed and fabricated during 2013 (Mircea Dragoman, Alina Cismaru, Adrian Dinescu, Daniela Dragoman, G. Stavrinidis, and G. Konstantinidis, Enhancement of higher harmonics in graphene-based coupled coplanar line microwave multipliers, Journal of Applied Physics 114, 154304 (2013).

Manufacturing and characterization of UV MSM photodetector processed on very thin membrane – research performed in the frame of IDEAS Project PN-II-ID-PCE-2011-3-0513 "Novel technologies based on micromachining and nano-processing of GaN/Si, for advanced microwave and photonic devices"

The MSM (metal –semiconductor-metal) interdigitated photodetectors structures were manufactured on GaN/Si thin membranes (wafers purchased from NTT AT Japan) having the thickness of the GaN layer 0.3 μm and the total thickness of the buffer layer AlN and AlGaN 0.2 μm. The diport type pads were deposited by a lift-off process of Ni/Au (20nm /500 nm). The interdigitated MSM structure was process by direct writing on the wafer using Electron Beam Lithography (EBL "e_Line", e-beam lithography equipment from RAITH GmbH). 200 nm digits/interdigits width and 100 μm were processed.



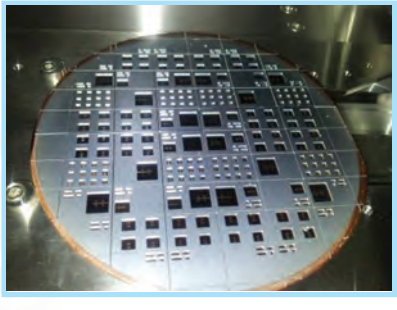
Responsivity vs. wavelength for front side at front side-illuminated UV photodetector structures with digits and interdigits 200 nm witdh, at bias of 2.5 V, 5 V, 8V



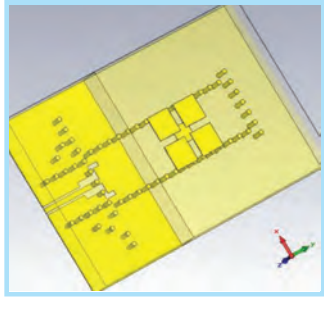
The semitransparent Ni/Au metallization Au (5nm /10 nm) was processed by lift-off. The silicon substrate was then thinned down to 150 μm. For the formation of the membranes, an Al mask was patterned and deposited on the back side, to serve as an etch mask for the reactive ion etching (RIE) process (300 μm x 300 μm).

Technological processes and design for mm-wave front-end – research performed in the frame of the IDEAS project PN-II-ID-PCE-2011-3-0830 "mm-wave front-end for imaging in security and medical applications"

High resistivity silicon micromachining technologies for the fabrication of thin dielectric membranes were developed. For the dielectric layers, two materials which are easily obtained in the silicon technology processes were chosen: thermal silicon dioxide and silicon nitride. The thickness of each layer is selected so as to ensure the stress compensation and a good mechanical stability and planarity for the metallic layers.



Back side view for the test structures fabricated in 2013 through silicon micromachining



3D electromagnetic model of a 94 GHz SIW LTCC antenna structure

Membrane supported double folded slot antenna arrays with 2 and 3 radiating elements were modeled and designed, for the 94 GHz and 140 GHz operating frequencies. Test structures were fabricated through silicon micromachining. Substrate integrated waveguide (SIW) antenna structures were investigated. The multilayer Low-Temperature Cofired Ceramic (LTCC) technology was considered for fabrication.

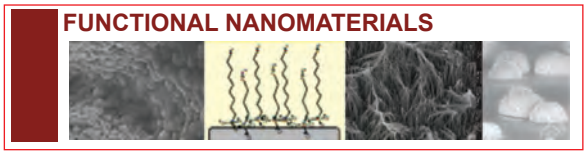
Centre of Nanotechnologies

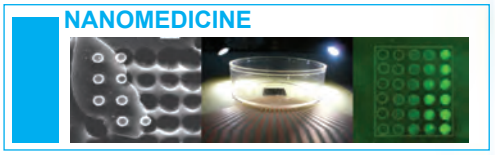
Centre of Nanotechnologies (CNT-IMT) is one of the scientific entities from the Department of Scientific and Technological Research of IMT. CNT comprises three research labs: L1 (nanobiotechnology), L6 (nanoscale structuring and characterization), L9 (molecular nanotechnology) and **it is concentrating most of the research in nanoscience and nanotechnology done in the institute**. The directions of research and the results obtained are described in detail below (follow the Lab presentations). This "center", **coordinated by Academician Dan Dascalu** has a special status: *it operates under the aegis of the* **Romanian Academy** (of Sciences). This supervision is related to the content of the scientific research, with no administrative or financial implications. This kind of "affiliation" provides more visibility to the centre and to IMT in general, as CNT-IMT is also considered part of the system of research institutions of the Romania Academy (mostly basic research, notably in chemistry and biology). This center is the organizer of the National Seminar for NanoScience and Nanotechnology (in 2013 at its 12th edition), developed as an event of the Romanian Academy, with logistic support from IMT. IMT is also involved in publication of a series of books and a periodicals edited by the Romanian Academy.

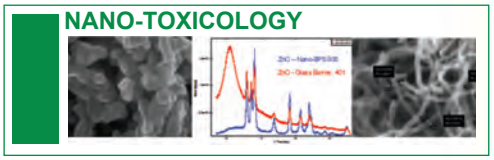
Prof. Dan Dascalu was the founder and the director (CEO) of the Centre for Microtechnology (1991), then of the Institute of Microtechnology (July 1993), and finally (since November 1996) of the National Institute for Research and Development in Microtechnologies (IMT Bucharest). His mandate came to and 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).

Laboratory of Nanobiotechnologies

The research in our group combines nanoparticles synthesis and polimer chemistry to prepare functional materials which have potential applications in the bio- and chemo-sensors, opto-electronic and energy storage devices. We are also interested in design and fabrication of reliable silicon carbide based sensors for harsh environment applications. Researchers from a variety of fields, such as physics, chemistry, biology, and electronics collaborate and encompass both materials science, development and characterization of new nanomaterials, and their device integration. ***The L1 mission*** can be summarized as research, development and education in nano-bio-technologies..







Team

Adina Bragaru, Chemist, PhD., senior researcher;
Florea Craciunoiu, Physicist, PhD., senior researcher;
Iuliana Mihalache, Physicist, PhD. St., junior researcher;
Melania Banu, Biolog, Ms., research assistant;
Mihaela Kusko, Physicist, PhD., senior researcher, head of laboratory;
Mihai Danila, Physicist, senior researcher;
Monica Simion, Physicist, PhD., senior researcher;
Razvan Pascu, Dipl. Engineer, PhD. St, junior researcher;
Teodora Ignat, Chemist, PhD., senior researcher.

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

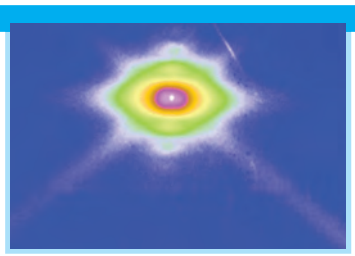
Dr. Mihaela Kusko obtained the B.Sc. degree (1998) in Solid State Physics and the PhD degree (2006) in physics, both from University of Bucharest. Since 1998 she joined IMT-Bucharest, where her main research activities are in the field of nanobiotechnologies, from study of nanomaterials and nanostructures to their integration in complex 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 4 national research projects and currently is the Romanian partner responsible of the FP-7 IP project ***NanoValid*** and LIFE+ project ***i-NanoTool***, both in the nanosafety area.

Laboratory of Nanobiotechnologies

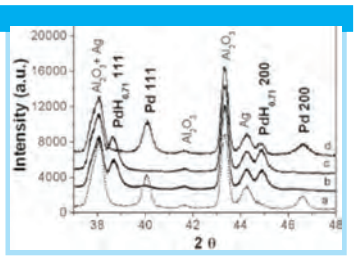
Characterization facilities – recent results

High Resolution SmartLab X-ray Diffraction System (Rigaku Corporation, Japan) - triple axis multiple reflection modular XRD system

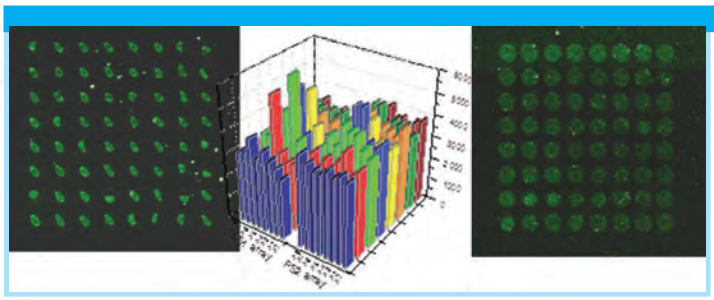
Contact person: Phys. Mihai Danila, mihai.danila@imt.ro



Quantitative defect evaluationin GaP/Si nanolayers
Thin Solid Films 541 (2013) 36



Phase transition monitorization by in situ XRD measurements Sensors and
Actuators A 203 (2013) 434



Fluorescence mapping of a streptavidin – biotin recognition on different substrates of porous silicon. **Mater. Sci. Eng. B 178 (2013) 1268**

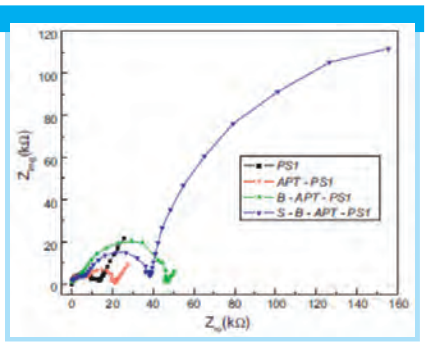
Micro-Nano Plotter (OmniGrid, UK) and **Flourescence Scanning System** (GeneTAC UC4) for microarray technology

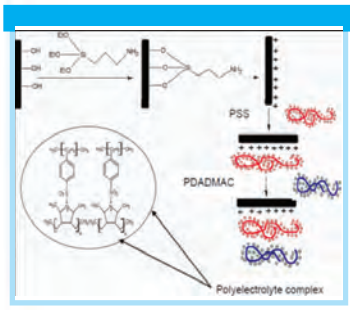
Contact person: PhD. Monica Simion, monica.simion@imt.ro

Impedance Spectrometer (PARSTAT 2273 - Princeton Applied Research, USA).
Electrochemical Scanning Microscope (ElProScan HEKA, Germany)

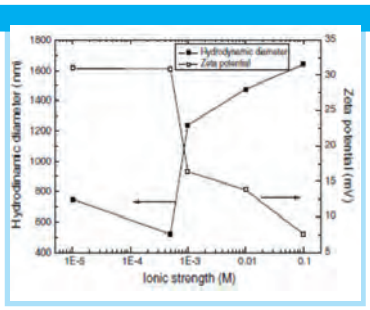
Contact person: PhD. Mihaela Kusko, mihaela.kusko@imt.ro

Nyquist plots (ZImg vs ZRe) of recorded for porous silicon sensing substrate subjected to successive biomolecule interactions.
Mater. Sci. Eng. B 178 (2013) 1268





Variation of the zeta potential with deposited polyelectrolytes layers.
Cent. Eur. J. Chem. 11 (2013) 205



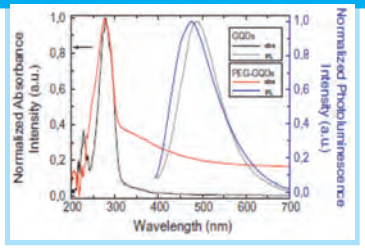
Influence of ionic strength on the average hydrodynamic diameter and zeta potential of ZnO-NPs
J. Nanopart. Res. 15 (2013) 1352

DelsaNanoC-Size and Zeta Potential Measurement System (Beckman Coulter (DelsaNano, Beckman Coulter, USA)

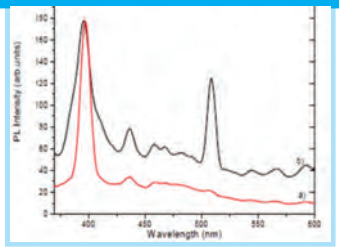
Contact person: PhD. Adina Bragaru, adina.bragaru@imt.ro

Combined Time Resolved and Steady State Fluorescence Spectrometer -FLS920P (Edinburgh Instruments, UK)

Contact person: PhD. St. Iuliana Mihalache, iuliana.mihalache@imt.ro



Optical characterizations of graphene quantum dots: UV–vis absorption; PL emission and lifetime; absolute quantum yield
Organic Electronics 15 (2014) 216



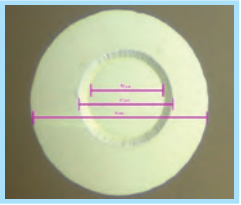
PL spectra of ZnO powders using various solvents (a) ethanol, (b) water
J. Optoel. Adv. Mater. 15 (2013) 703

Highlights in micro- nanoelectronics:

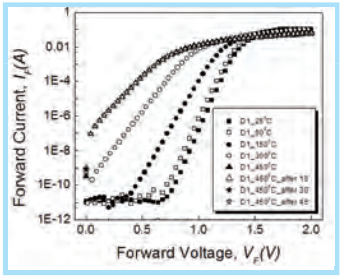
Devices based on silicon carbide (SiC) with applications in harsh environments

1. High temperature sensors
> Schottky diodes on SiC

An oxide ramp termination has been designed in order to obtain an uniform distribution of the current density and a high breakdown voltage.



The I-V-T characteristics demonstrate that the Schottky diodes based on SiC successfully operate in the whole range of temperature 25 - 450°C. Moreover, a good stability at high temperature was shown.

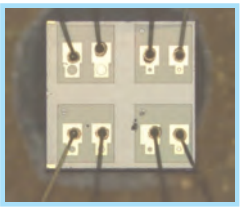


SiC-SET project (PNII - PCCA, 2012-2015)

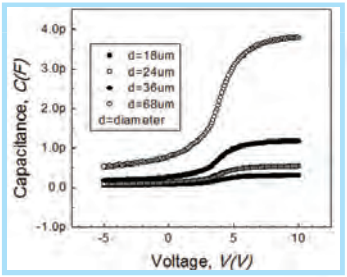
Contact persons: Florea Craciunoiu (florea.craciunoiu@imt.ro);

2. Gas sensors for toxic environments
> MOS capacitors on SiC

4 MOS capacitor geometries have been fabricated on the same chip, having a circular configuration with diameter: 18, 24, 36, and 68 μm, respectively. Moreover, in order to easily measure and eliminate the parasitic capacitance of the pad area, on each chip is provided an additional area of metal with the same configuration.



MOS capacitors have been designed and realised on SiC using thin films (50 nm) of Ni or Pd as electrode gates. The response at hydrogen of the packaged test structures has been analysed.



SiC-GAS project (PNII- PCCA, 2012-2015)

Razvan Pascu (Razvan.pascu@imt.ro).

Ongoing projects

International Projects:

♦ *Large-scale Integrating Collaborative FP7 Project* - **"Development of reference methods for hazard identification, risk assessment and LCA of engineered nanomaterials – NanoValid"** (2011 – 2015) – IMT resp. M. Kusko > THEME NMP.2010.1.3-1 Reference methods for managing the risk of engineered nanoparticles http://www.imt.ro/nanovalid/

♦ *LIFE+ (Environment Policy and Governance) Project* – **"Development of an interactive tool for the implementation of environmental legislation in Nanoparticle manufacturers – i-NanoTool"** (2013 – 2015) - IMT resp. M. Kusko http://www.inanotool.com/

♦ *Collaborative Small or Medium-scale Focused FP7 Research Project* – **„Development of sustainable solutions for nanotechnology based products based on hazard characterization and LCA - NanoSustain"** (2010-2013) – IMT resp. D. Dascalu > THEME 4 NMP and THEME 6 Environment, including Climate Change http://www.imt.ro/nanosustain/.

♦ *Bilateral Cooperation Project Romania – Argentina* (Instituto de Investigaciones en Fisicoquímica de Córdoba (INFIQC)– **„Development of analytical methods based on supramolecular systems to detect and quantify nanomaterials – DAMS"** (2013 – 2015) – IMT resp. M. Kusko.

National Projects - PN II Partnership Projects:

♦ **HRCarrays - 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).

♦ **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);

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.

Nano-Scale Structuring and Characterization Laboratory

Mission

- Support projects and research activities in IMT-Bucharest by providing state of the art facilities and advanced expertise for characterization of materials, processes and structures at micro and nano scale.

- Support research and nano-fabrication capabilities of IMT-Bucharest by infrastructure and technical expertise for direct nanoscale patterning of complex features on a variety of substrates through electron beam lithography-based (EBL-based) techniques

Fields of activity

Characterization: • Scanning Electron Microscopy (SEM) (both conventional and field emission) and Energy Dispersive X-ray Spectrometry (EDX)

• Nanoscale characterization of surfaces and interfaces by Scanning Probe Microscopy (SPM)

• Small-scale mechanical characterization by depth-sensing nano-indentation techniques

Structuring: • Nanoscale patterning by Gaussian beam Electron Beam Lithography (EBL) for obtaining micro-nanostructures with applications in photonics, MSM-UV photodetectors, SAW structures for microwave applications etc.

• Fabrication of graphene devices using EBL-based techniques

Team: L6 team consisted in 2013 by three senior researchers with background in Physics, one young researcher with background in Electronics (Ph. D. student), two early stage researchers (one MSc. Student in Physics and one Ph. D student in Electronic engineering) and one economist.

Dr. Adrian Dinescu, Senior Researcher, head of laboratory
Phys. Raluca Gavrila, Senior Researcher
Eng. Marian Popescu, Research Assistant
Eng. Stefan Iulian Enache, Research Assistant
Phys. Bogdan Bita, Research Assistant

Main equipment

• Electron beam lithography and nanoengineering workstation Raith e_Line (RAITH GmbH). This is a versatile nanolithography system for direct patterning of electron resists and electron beam-assisted deposition and etching, with modules for nanomanipulation, EBID and EBIE. Minimum achievable linewidth: 20 nm. 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.

• Dip Pen Nanolithography System NScriptor (NanoInk, Inc.). This is an additive-type lithography system that enables the deposition of a wide range of biological and inorganic materials directly on the substrate by an “ink delivery” approach. The size of the resulted geometrical features varies from few tens of nm up to several μm.

• Ultra High resolution Field Emission Gun Scanning Electron Microscope FEI Nova NanoSEM 630 (FEI Company). It features SE and BSE detectors both E-T and in lens, LV BSE detector and high resolution SE detector for low vacuum working mode, true eucentric sample stage with encoder, charge compensation technique (water vapors). Equipped with EBL - Raith Elphy Plus - pattern generator for Electron Beam Lithography.

• Scanning Electron Microscope TESCAN VEGA II LMU (TESCAN s.r.o)- General Purpose SEM with thermionic electron gun. Low vacuum operation up to 150 Pa for charge compensation. Equipped with Energy Dispersive X Ray Spectrometer with Si(Li) detector – (EDAX Genesys).

• Multifunctional Scanning Probe Microscope Ntegra Aura (NT-MDT Co). It performs high resolution 3D measurements of topography and complex surface characterization by advanced complementary techniques (AFM, STM, EFM, MFM, SKPM, C-AFM 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).

• Nano Indenter G200 (Agilent Technologies). This is a high resolution nanomechanical characterization equipment providing access to various mechanical properties of small-volume samples by instrumented indentation and scratch testing,

L6 encompasses four experimental laboratories, included in the IMT-MINAFAB support centre for micro- and nanofabrication and certified to ISO 9001:2008 quality management standards: “Raith e_Line electron beam lithography Laboratory”; “Laboratory for SEM characterization”; “Laboratory for field emission SEM characterization”; “Laboratory for SPM and nanomechanical testing”.

Co-operation projects

International projects: - Bilateral Inter-academic Cooperation Romania - Bulgaria) (2013-2015) "Nanostructured and amorphous semiconductor films for sensors application"

- In 2013 L6 has been implied as a partner in 3 international project proposals in 2013 (2 FP7, 1 ERA-NET)

National projects: - Fabrication and characterization of micro and nano metallic structures with Dip-Pen Nanolithography, PN-II-RU-PD-2011, 2011-2013 (Coordinator)

- STAR Technology 2012 (Partner)

In 2013 L6 has been implied as a partner in 7 international project proposals.

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.

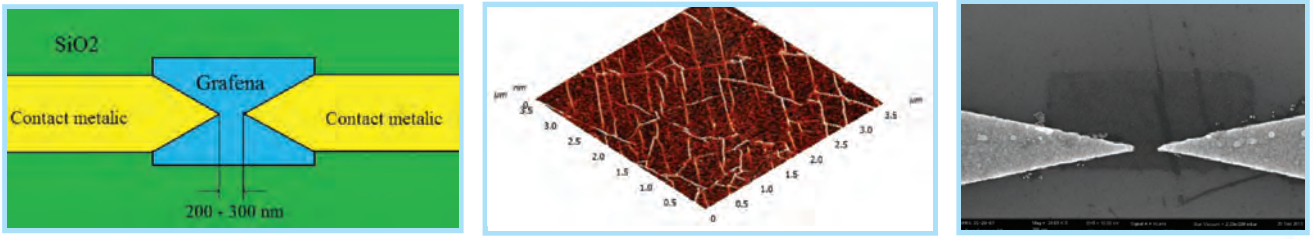
Scientific results

Application of electron beam lithography (EBL) for fabrication of monolayer graphene structures devoted to the study of electromagnetic properties of graphene in the microwave and millimetre-wave spectrum

Coplanar waveguides fabricated on exfoliated graphene flakes using e-beam lithography (M. Dragoman, A Cismaru, A. Stefanescu, A. Dinescu, D. Dragoman, **The electromagnetic properties of graphene in the microwave and millimeterwave spectrum**, 43rd European Microwave Conference (EuMC), Nuremberg, GERMANY, 7-10 Oct 2013, EUROPEAN MICROWAVE CONFERENCE (EUMC) Book Series, p: 530-532, 2013)

Patterning CVD graphene by electron beam lithography for fabrication of integrable micro and nanostructures.

Combined EBL and highly directional metal deposition enables wafer-scale fabrication of graphene-based devices. The high electrical conductivity of graphene allows high-resolution patterning of graphene with minimum stitching errors of PMMA writing fields.



a) Schematics of the device devoted to the study of ballistic transport of electrons in graphene b) AFM scan of the CVD graphene c) SEM micrograph of Pd/Au metallic nano-contacts on graphene

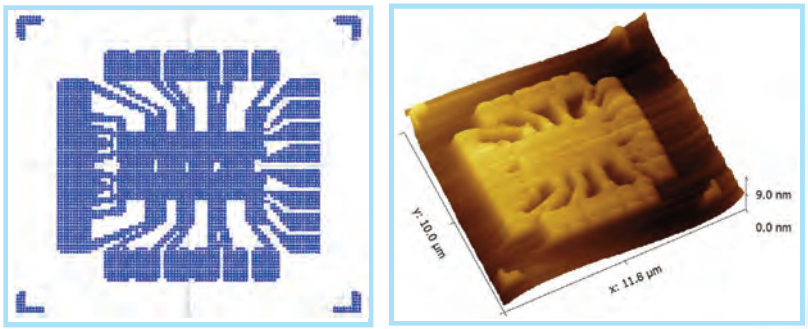
Fabrication of trapezoidal graphene nanostructures by electron beam lithography (EBL) for applications in high frequency rectification"

Using PMMA electron resist for processing CVD graphene allowed us to obtain ribbons with 50 nm minimum width. The fabrication process is implemented at wafer level, as opposed to the vast majority of graphene devices, which are fabricated on small individual flakes. Early estimates predict a cut-off frequency of this device of 6.5 THz.

a) Outline layout of a graphene nanostructure used for rectifying high frequency signals b) The physical structure produced using PMMA electron resist c) SEM micrograph of the on-wafer graphene diode used in high frequency rectification (M. Dragoman, A. Dinescu, D. Dragoman – On-wafer graphene diodes for high-frequency applications, ESSDFERC 2013 Conf., 16-20 September 2013, Bucharest, Romania)

Manufacturing and characterization of micro-nanostructures using Dip-Pen nanolithography.

Micrometer-sized structures with heights in nanometer range have been produced on Si substrate by local oxidation technique using an electrically biased conductive AFM tip.



The mask layout (a) and the structure obtained by local oxidation of Si substrate using an electrically biased AFM tip (b)

Publication

In 2013 L6 team published 16 papers in ISI journals and 6 communications as first IMT author at ISI-indexed international conferences.

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.
- Coordination of licentiate thesis "Fabrication and characterization of oxide-based structures by local anodic oxidation using the Atomic Force Microscope" (in collaboration with University "Politehnica" of Bucharest)

Molecular nanotechnology laboratory

Mission

The lab was established in 2009, based on the necessity to integrate existing practical, analytical and numerical knowledge in areas of chemistry and (supra)molecular structures, functional materials, molecular dynamics, and atomistic modeling / simulation.

The main areas of interest are fundamental research and development of technologies for the fabrication of functional materials and micro / nanosystems based on synthesis, physico-chemical modifications and structural optimization. The studies are directed towards understanding, and making use of, the mechanisms that provide new functions by combining the techniques of preparation and synthesis of 3D ... 0D substrates, controlled molecular attachments, theoretical modeling and numerical analysis by ab- initio and (semi)-empirical methods.

The lab gained critical mass in 2010-2011, bringing together the expertise of returning chemists, physicists and engineers, after doctoral and post- doctoral studies abroad. The L9 lab belongs to the Center for Nanotechnologies of IMT- Bucharest, activating under the aegis of the Romanian Academy.

Activity areas

• Synthesis, development and characterization of physico-chemically modified nanomaterials, exhibiting properties suitable for applications in sensors, nanoelectronics and optoelectronics: carbon-based nanoparticles (carbon quantum dots, graphene quantum dots), metallic quantum dots, carbon nanotubes, nanocomposites.

• Development and characterization of micro/nanosystems and devices that integrate functionally optimized (nano)materials: LEDs, (electro)chemical/molecular sensors, solar cells.

• Analytical-numerical investigation of essential mechanisms responsible for creating new properties and/or for offering solutions for functional optimization of the developed nanomaterials: electronic structure modeling and simulation (DFT, semi-empirical DFT, molecular dynamics, BIE), physical/chemical adsorption mechanisms, optical excitation/emission spectra, plasmonic resonance modes.

Team:

- **Dr. Lucia Monica Veca**, CS I, PhD in Chemistry, Clemson University, USA, 2009.
- **Dr. Antonio Marian Radoi**, CS II, PhD in Chemistry, Tor Vergata University, Italy, 2007.
- **Dr. Titus Sandu**, CS II, PhD in Physics, Texas A&M University, USA, 2002.
- **Dr. Victor Leca**, CS II, PhD in Materials Science, Twente University, The Netherlands, 2003.
- **Dr. Radu Cristian Popa**, IDT I, PhD in Quantum Engineering and Systems Science, University of Tokyo, Japan, 1998; Laboratory head.

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

Dr. 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.

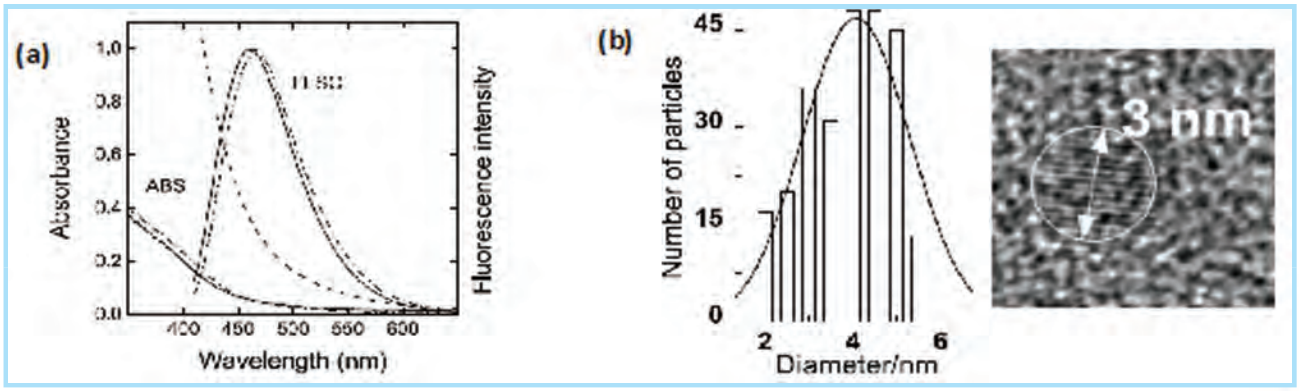
Radu Popa joined IMT Bucharest in 2007 and is presently director of the Center for Integrated Systems Nanotechnologies and Carbon Based Nanomaterials. Main scientific interests include atomistic analysis of electronic transport in molecular junctions in the framework of the rational design paradigm for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

Molecular nanotechnology laboratory

Results

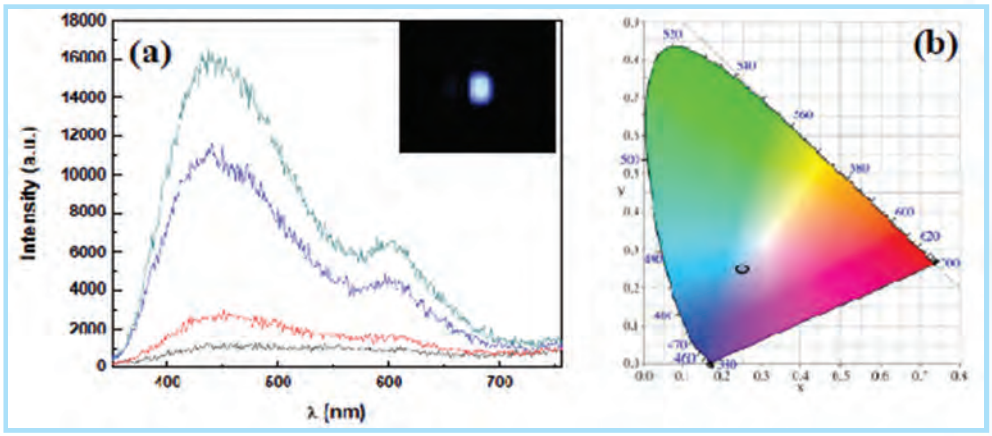
National Complex Ideas Project: PNII- ID-PCCE–2011- 2- 0069 „Carbon quantum dots: exploring a new concept for next generation optoelectronic devices" (2012-2015):

Synthesis of colloidal EDA-CQD (2,2'–(ethylenedioxy)-bis(ethylamine) passivated carbon "quantum" dots), with a diameter below 5 nm and a fluorescence quantum yield up to 30 % at an excitation wavelength of 400 nm - Monica Veca (monica.veca@imt.ro)



(a) Absorption and fluorescence (excitation at 400 nm) spectra of EDA-CQD (curves - and - - represent the ABS of concentrated solution), and of EDA-^{13}CQD (– • – •); (b) Size distribution of EDA-CQD; (c) HR-TEM image illustrating the core diameter of the CQD. [ACS Nano 2014, DOI 10.1021/nn406628s]

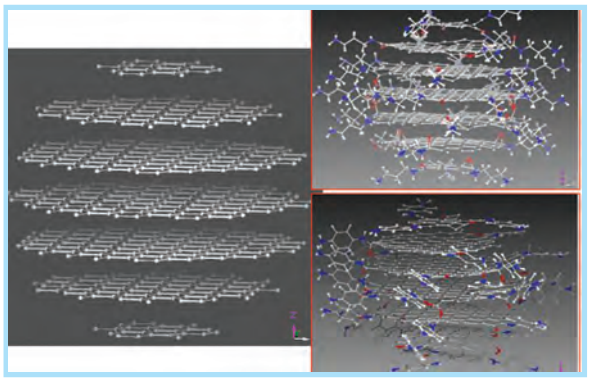
Studies of the electroluminescent properties of PEG1500N-CQD (poly(ethylene glycol) diamine passivated carbon "quantum" dots) - Monica Veca (monica.veca@imt.ro)



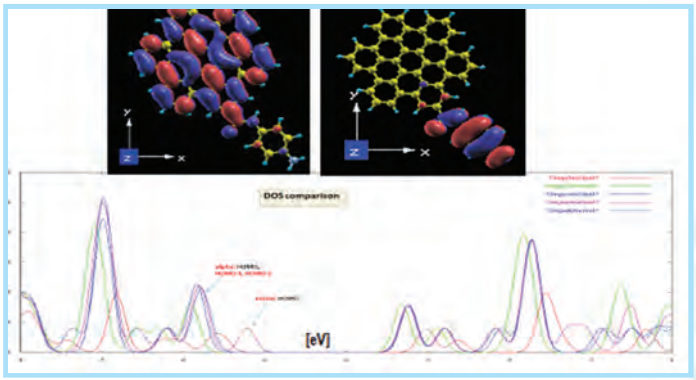
(a) Electroluminescence spectra of PEG_{1500N}-CQD based LED at 10 V, 11 V, 13 V and 15 V; (b) CIE coordinates of the LED at 15 V and 5 mA. The inset shows the picture of the LED.

Theoretical studies on the electronic structure and optical properties of functionalized carbon dots - Radu Popa (radu.popa@imt.ro)

Based on the experimental measurements revealing the crystalline graphitic structure of carbon quantum dots (CQD), we performed atomistic numerical simulations on structures of graphene and graphite nanospheres, aiming at disclosing the effects of functional ligands on the electronic levels and on the allowed and most probable photoexcitation/emission transitions.



Bare (unmodified) graphitic carbon dot, ~2 nm diameter. Inset shows models of amine-based functionalization (top: 1,3-propanediamine; bottom: p-phenylenediamine); 800-1200 atoms.

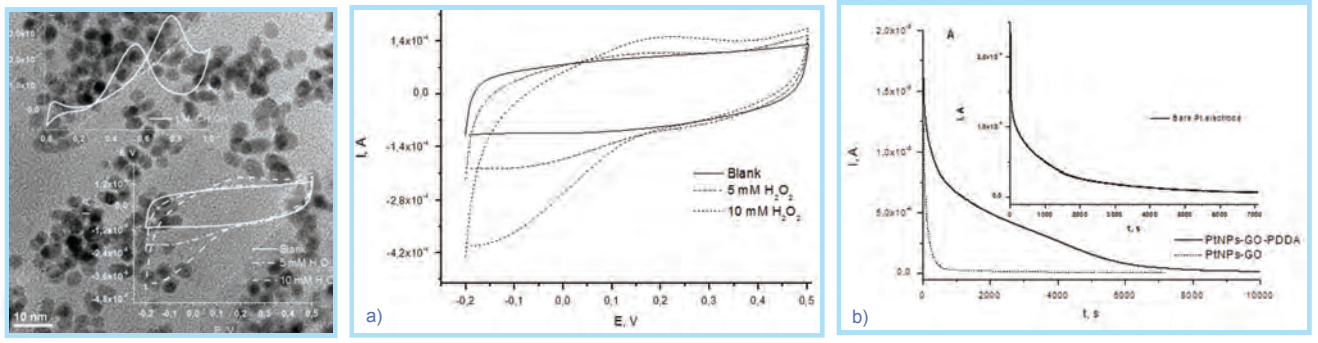


Top: Density of states (DOS) calculated for various ligands edge-attached on a regular structure graphene dot. Bottom: HOMO and LUMO orbitals, in case of p-phenylenediamine ligation.

Results

Electrochemical sensor - Antonio Radoi (antonio.radoi@imt.ro)

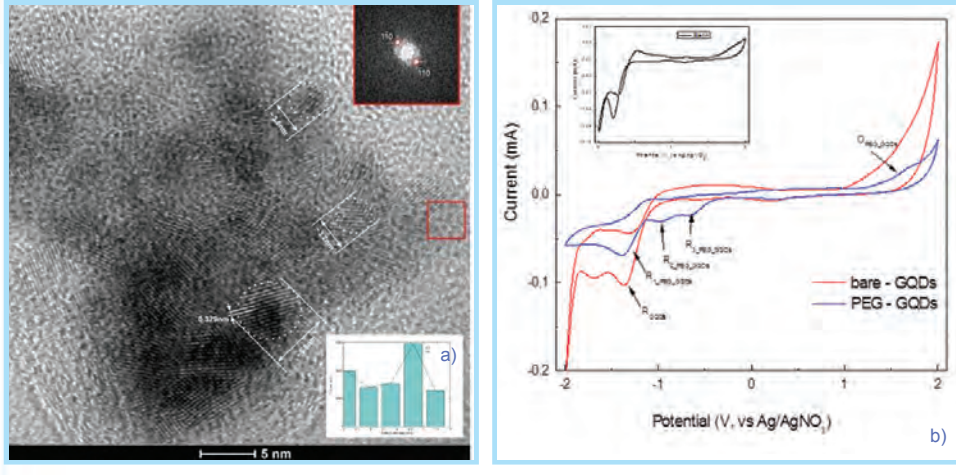
An electrochemical sensor for methanol and hydrogen peroxide based on Pt nanoparticles (NPs) was developed. The response of such a modified glassy carbon electrode (Pt NPs embedded in graphene oxide/PDDA) was investigated. [Mater.Chem. Phys. 146, 538-544, 2014]



(a) Cyclic voltammetry (50 mV/s) showing the electrode response in presence of 5 and 10 mM H_2O_2 (in 10 mM PBS + 0.1 M KCl inert electrolyte purged with N_2).
(b) Electrochemical response of the modified electrode vs. a Pt bulk electrode in presence of 1 M methanol (+0.75 V vs. Ag/AgCl in 0.5 M H_2SO_4 purged with N_2);

Graphene quantum dots

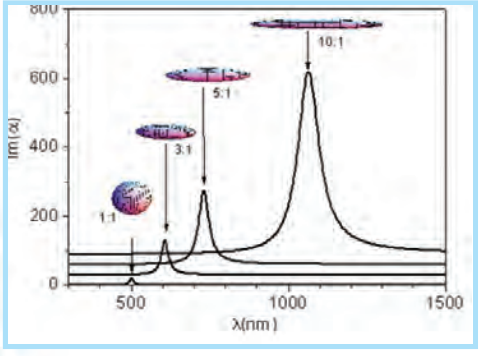
Graphene quantum dots (GQDs) were obtained in a polymeric matrix through microwave assisted hydrothermal synthesis, starting from glucose as carbon source.[Org. Electron 15, 216-225, 2014]



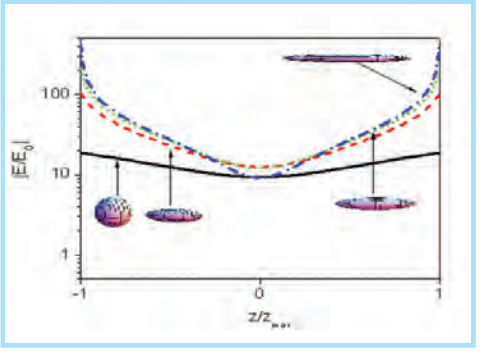
(a) HR-TEM of GQDs embedded in polymeric matrix;
(b) Cyclic voltammetry (50 mV/s) depicting HOMO and LUMO for GQDs in presence and in absence of PEG600; working conditions: Pt electrode, 0.1 M TBAP in acetonitrile.

Modeling plasmonic resonance in metallic nanoparticles - Titus Sandu (titus.sandu@imt.ro)

Based on the Boundary Integral Equation (BIE) method it has been developed a procedure that is able to calculate both the plasmon resonances in metallic nanoparticles and the capacitance/charging of metallic bodies with arbitrary shapes. [Plasmonics, 8, 391-403 (2013)]



Complex-valued polarizability of metallic nanoparticles calculated with BIE. Here it is represented its imaginary part which is proportional to the extinction cross-section of light.



The enhancement factor of electric field at the surface of a metallic nanoparticle due to localized plasmon resonance effect.

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 centimeter size structures), **dip pen nanolithography, MOEMS and MEMS micro-sensors and** investigate new **classes of advanced materials with applications in nanodevices**.

Expertise

- **design, simulation, development/optimization of MEMS/ MOEMS** components and devices (switches, cantilevers, bridges, membranes, microgrippers); mechanical, thermal, electrical and electrostatic, piezoelectric, **as well as coupled field** (static and transient) **analysis**;
- **modeling and simulation for multiphysics problems**;
- **design, modelling and simulations of microfluidic components and systems** for biomedical applications and micro-electronic fluidic systems (valves, pumps - with various actuation principle as electrostatic, piezoelectric, pneumatic, electroosmotic-cell reservoirs, microchannels, filters, mixers, heaters, etc.) – the microfluidic analyzes include: fluid dynamics in microstructures (general flow, fluid mixing, thermal analysis); electrokinetic flow (electrophoresis, electroosmosis);
- modelling of electronic structure of materials using **ab initio calculations**;
- **rapid prototyping**: design for and operation of 3D Printer based on selective laser sintering, 3D Printer;
- **design and manufacturing** of MOEMS and MEMS microsensors and microsystems;
- **characterization of physical phenomena** in wide band gap semiconductors (light emission, optical transitions, radiative-nonradiative centers, shallow and deep donors/acceptors, band gap tailoring);

Main research area

- **Modelling, simulation** (mechanical, thermal, electrical and electrostatic, piezoelectric), **coupled field analysis and CAD of MEMS/NEMS**
- **Development of Microfluidic structures and systems** (simulation, design and manufacturing) **for biomedical applications and micro-electronic applications**
- **Development of new technologies for prototyping at micro-nanoscale**
- **Synthesis, characterization and electronic structure simulation of nanostructured materials for functional opto-electronic and spintronic applications**

Research team: The team has a multidisciplinary expertise in: mathematics, physics, electronics; the team **is composed of 9 PhD, 1 PhD students, 2 physicists and 1 engineer.**

Dr. Eng. Raluca Muller, senior researcher I
Dr. Phys. Rodica Plugaru, senior researcher I
Dr. Phys. Gabriel Moagar-Poladian, senior researcher II
Dr. Mat. Oana Tatiana Nedelcu, senior researcher III
Dr. Eng. Franti Eduard, senior researcher III
Dr. Mat. Rodica-Cristina Voicu, senior researcher III
Dr. Mat. Irina Stanciu, senior researcher III
Dr. Eng. Anca Danciu, researcher
Dr. Eng. Lucian Petrica
PhD student Eng. Angela Baracu, junior researcher
Phys. Constantin Tibeica, senior researcher
Phys. Victor Moagar-Poladian, technological development Eng. II
Eng. George Boldeiu

Laboratory Head: Dr. Raluca Müller (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 Solid Films, etc).

Simulation, Modelling and Computer Aided Design Laboratory

Specific software/hardware Tools

• COVENTOR 2012; • MATLAB 2013; • ANSYS Multiphysics 12.1; • COMSOL Multiphysics 4.3.a; • Solidworks Office Premium 2008; • Mathematica 7; • Origin PRO 8; • Visual Studio 2008Pro;

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

• **Computer network for training**

Services

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

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

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

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

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

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

Applications: MEMS (sensors, actuators, accelerometers), Optical MEMS, RF-MEMS, microfluidic microsystems as micropumps, micro-mixers, 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 "**Smart sensors and microsystems**", for MSc **in Microsystems**, Faculty of Electronics, Telecommunications and Information Technology, "Politehnica" University of Bucharest

International co-operation

● **ENIAC Project (related FP7- Public – Private Partnership) "MotorBrain":** "Nanoelectronics for Electric Vehicle Intelligent Failsafe Powertrain" - ENIAC, (2011-2014); Coordinated by Infineon Technologies AG Germany- IMT- partner: coordinator of IMT-L5- Dr. Gabriel Moagar-Poladian

● **M-ERA-NET - "3-Scale modelling for robust-design of vibrating micro sensors-3SMVIB"**, coord by Open Engineering S.A., Liege; IMT- partner: coordinator of IMT-L5- Dr. Raluca Müller (2012-2015)

National cooperation

• PNII IDEAS Project **Prospective Research Regarding Rapid Prototyping Processes for Applications in the Field of Micro- and Nanosystems Realization** (2011- 2014), Project director: Dr. Gabriel Moagăr-Poladian, http://www.imt.ro/3D-rapidpronano/

• **3 projects STAR with Romanian Space Agency (ROSA):**

- Investigation of semiconductor oxide materials performance for space environment applications (2013-2015), Coordinator IMT

- Reliability design of RF-MEMS switches for space applications - REDEMS Project, 2012-2015 , Coordinator UTCN, IMT Partner

- Tribomechanical Characterization of MEMS Materials for Space Applications under harsh environments- MEMSMAT Project, 2013-2016 Coordinator UTCN, IMT Partner

• **National Program CONVERT**, Basic funding **MEMS Microsystems for micro-robotic manipulations** (Dr. Raluca Müller, Dr. Rodica Voicu)

Awards

1) G. Moagăr-Poladian – Gold Medal at 62th World Exhibition of Innovation, Research and New Technology, Bruxelles, Belgium, November 2013. Title of invention: „Optically assisted 2D and 3D fountain pen nanolithography procedure". It is the invention that is the subject of the international patent application.

2) G. Moagăr-Poladian – The Medal of the Bosnia-Herzegovina, Serbia, Montenegro, Kosovo and Macedonia delegation – for the contribution at creativity stimulation, development and promotion at the 62th World Exhibition of Innovation, Research and New Technology, Bruxelles, Belgium, November 2013. Tithe of invention: „Optically assisted 2D and 3D fountain pen nanolithography procedure". It is the invention that is the subject of the international patent application.

Patents

National patent requests (IDEAS project):

1) G. Moagăr-Poladian, Procedure of rapid manufacturing by using a focused beam of ultrasounds, A00736/2013

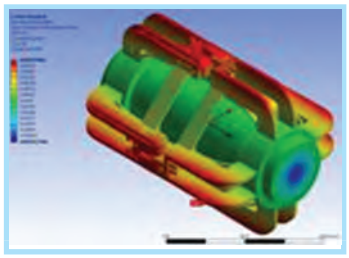
2) G. Moagăr-Poladian, V. Moagăr-Poladian, Element for the protection of cosmic spacecrafts at against micrometeorites impact, A00817/2013

International patent request (IDEAS project): International Search Report al WIPO confirms that the WO 173506 / 2012 patent request is original, represents an inventive activity and it is industrially applicable. The obtained score is ‚A' at all points – that is the maximum score that can be obtained by a patent request, meaning that there is no scientific article or patent that could be opposed to our invention.

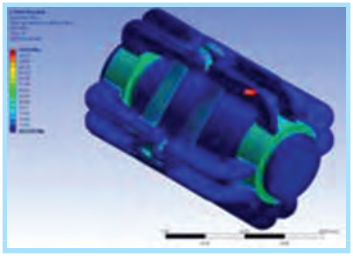
Scientific Results

Demonstrator: Torque sensors on plastic

Successfully tested (*ENIAC project*, project responsible from behalf of IMT Dr. Gabriel Moagar-Poladian, gabriel.moagar@imt.ro), - presented at National Research Conference with the participation of Marie GEOGHEGAN-QUINN, the European Commissioner for Research



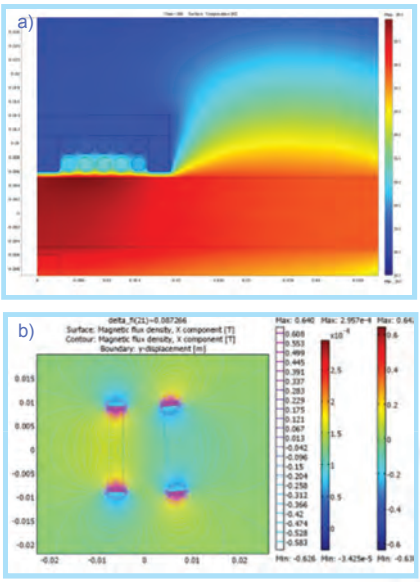
Radial displacement at 10.000 rpm and T= 200^0 C. The maximum displacement in this case is 14 times less than the maximum allowed displacement



vonMises Stress due to centrifugal force and thermal expansion at 10000 rpm and T= 200^{0}C. The maximum stress is 5 times less than the material mechanical strength (metal).

The physical model of the torque sensor, polymr version

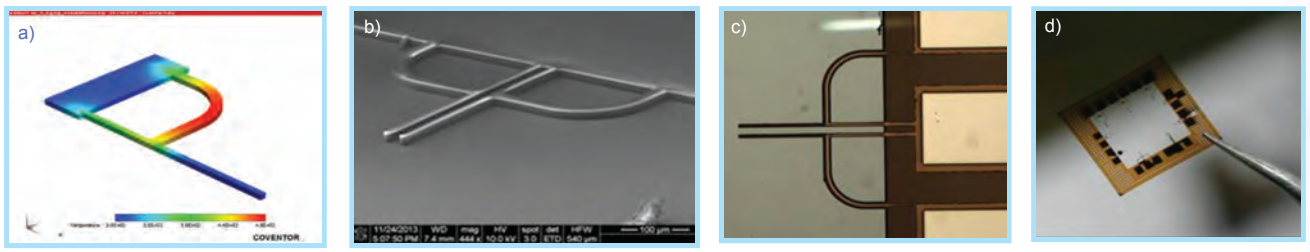
Proiect ENIAC -"Nanoelectronics for Electric Vehicle Intelligent Failsafe PowerTrain" - MotorBrain



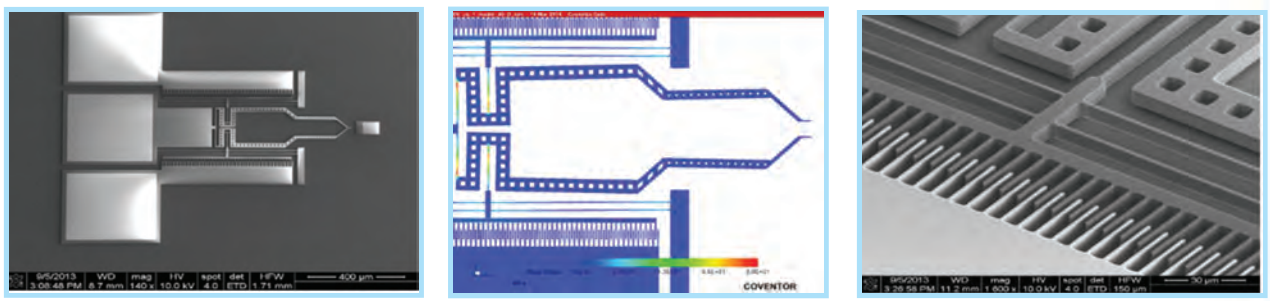
a) Simulation of the thermal effect produced by induced currents in an electrically conductive substrate b) Magnetostatic simulations

Design, simulation and experimental realization of MEMS microgripper for micromanipulation of MEMS and optical microcomponents (lenses, fibers), cells, tissues and biological microparts; coupled FEM simulations electro-thermo-mechanical with CoventorWare; fabrication of micogrippers using biocompatible polymers: SU8.

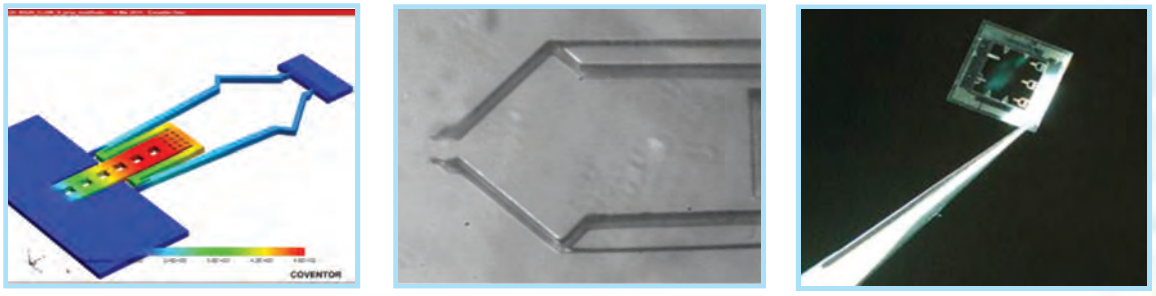
National program CONVERT-PN0929 " MEMS Microsystems for manipulation for micro-robotics", Dr. Rodica Voicu, rodica.voicu@imt.ro



a) Simulated temperatures distribution in the microgripper arms for 0.2 V; b) SEM image of the experimental SU8 microgripper structure; c) Optical picture of the SU8 and gold experimental microgripper structure; d) Released microgripper structures realized using biocompatible polymer SU8 and gold, on a chip; (R. Voicu, R. Muller, New electro-thermally actuated micromanipulator with optimized design and FEM simulations analyses, Proc. DTIP 2013, pp. 261-266, 2013)



Microgripper with electrostatic actuation. Si structures manufactured using SOI wafers (contact: Phys. C. Tibeica).



Microgripper with electro-thermal actuation. Structures fabricated using SU8 polymer. (R. Voicu - rodica.voicu@imt.ro, C. Tibeica)

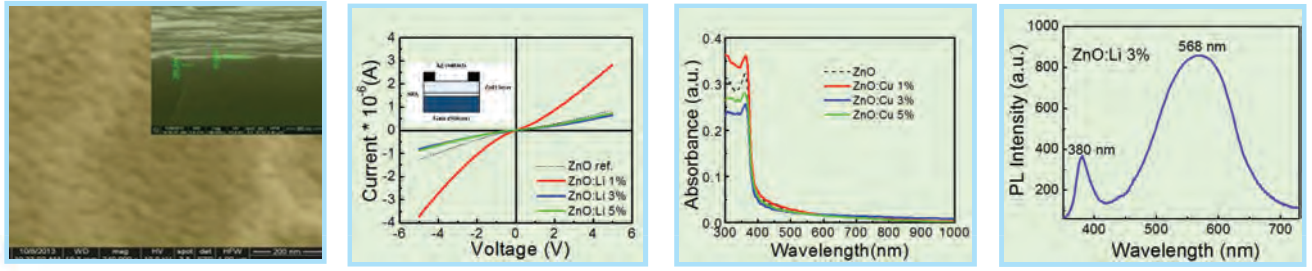
Simulation, Modelling and Computer Aided Design Laboratory

Scientific Results

Contribution to the development of technologies for synthesis of ZnO thin films doped with Li or Cu.

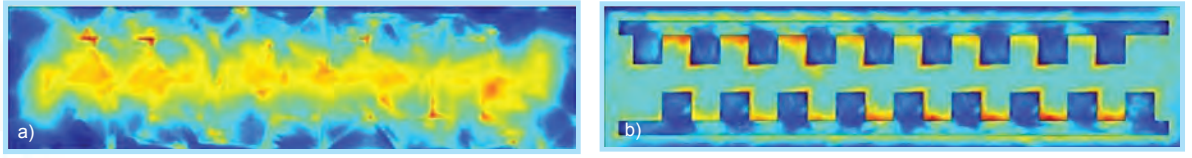
- ZnO multilayer thin films doped with Li or Cu at the concentrations in the range of 1-5 at. % has been obtained by sol-gel, spin coating method.
- Analysis of the structural, morphological, optical (transmission and absorption), photoluminescence and electrical conductivity of the films doped with Li or Cu, Li: ZnO and Cu:ZnO respectively.

Project STAR- Dr. Rodica Plugaru, rodica.plugaru@imt.ro



ZnO semiconductor thin films doped with Li or Cu, prepared by sol-gel, spin coating method

Research Study of ferromagnetic nanoparticles effects in dielectrophoresis applications for separation and detection of bioparticles - National program CONVERT-PN0929 "Study of metallic nanoparticles for improving the sensitivity of detection systems" (contact: Dr. Oana Nedelcu, oana.nedelcu@imt.ro)



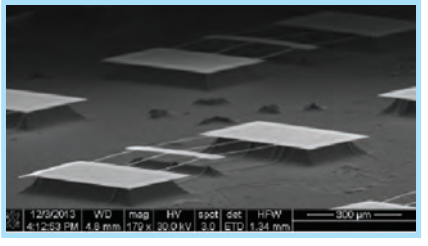
Distribution of electric field under the presence of ferromagnetic particles, median section (a) and near electrodes (b)

Design and manufacturing of an Aluminum thermal actuator on a silicon substrate

- Electrical characterization of the devices (STAR Project).

Contact: Dr. R Muller, raluca.muller@imt.ro

Optical Microscope image of the thermal actuator



SEM pictures of the aluminium structures

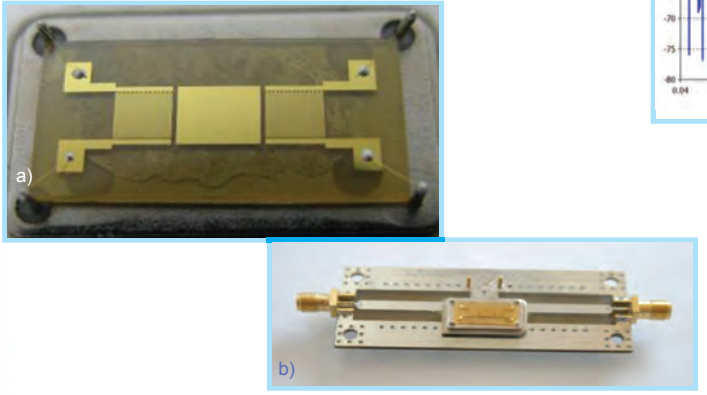
Services

- Manufacturing of a SAW (Surface Acoustic Wave) biosensor using different substrates: Lithium tantalate and Langasite.

Characterization of the devices using Vector Network Analyzer (VNA) in order to obtain **the transmission** parameters and **reflection coefficients**;

- manufacturing/characterization for ROMQUARTZ Project,

(contact PhD. student Angela Baracu, angela.baracu@imt.ro)



Surface Acoustic Wave biosensor: a) Side view of the biosensor; b) Calibration device; c) Transmission parameters; d) Reflection coefficients

Reliability Laboratory

Mission

Elaborating and using working instruments for assessing, improving and monitoring the reliability of sensors, actuators, microsystems, nanostructures and electronic components. These actions have to be performed based on a Concurrent Engineering approach, i.e. starting from the project phase and continuing during product development and usage in real life.

Domains of activity

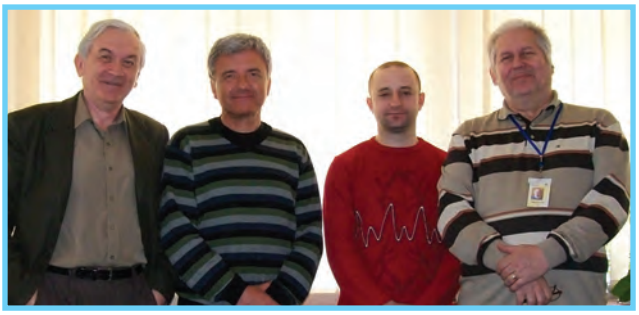
Reliability building: Design for Reliability (DfR), *Design for Manufacture (DfM), Monitoring and screening of micro and nanostructures, Reliability of components in Harsh Environment (e.g. space, aeronautics, automotive, geology, nuclear, etc.), Robust Design (e.g. developing biosensors for monitoring the quality of the environment).*

Reliability assessing: *Accelerated testing of micro and nanostructures, by using simple or combined stresses (which are simulating appropriately the real life and allow a higher acceleration of the tests), Failure analysis and physics, Analysis of virtual prototyping, Usage of fuzzy logic for reliability evaluation.*

Standardization: *Certifying, Qualification and periodic tests, Elaborating standards and other documents.*

Team

In 2013, the team L7 was formed by four specialists (electronic engineers): three senior researchers, with more than 30 years of expertise in reliability field and a young engineer.



The team L7 (from left to right): Marius Bâzu (Laboratory head), Lucian Gălăţeanu, Dragoş Vârşescu, Virgil Emil Ilian.

Co-operation projects

International projects

• FP7 project: "Frequency Agile Microwave Bonding Systems FAMOBS", identifying the most reliable technological variant of microwave thermal treatment for the encapuslant of an integrated circuit (paper presented at ESDERC 2013, Bucharest, Sept 15-17);

• FP7 project: "Nanostructured materials and RF-MEMS RFIC/MMIC tehnologies for highly adaptive and reliable RF systems – NANOTEC" – Designing and achieving a programme of reliability tests;

• Project of structural funds for the Romania - Bulgaria Cross Boarder Programme: "Romanian- Bulgarian Services Centre for Microsystems and Nanotechnology";

• Co-operation with the company FEI (the Nederlands) - L7 achieved for the foreign partner high precision thermal analyses with IR microscope;

• Co-operation with Austrian Research Institute for Chemistry and Technology (OFI) – the foreign partner achived for L7 analyses with acoustical scanning microscope.

National projects

• Co-operation with two research centres of the University Politehnica Bucharest: Centre for Microscopy - Microanalysis and Information Processing - CMMIP (led by Prof. G. Stanciu) and Centre for Quality, Reliability and Informatic Technologies - EUROQUALCOM (led by Prof. I. Bacivarov).

Referents and members in committes

M. Bâzu:

• Referent of the journals Microelectronics Reliability, IEEE Transactions on Device and Materials Reliability, Electronics and Telecomunications Research Institute Journal (Republic Korea);

• Member in the Editorial Board of the journals Quality Assurance and Bulletin of Micro and Nanoelectrotechnologies;

• Member of the National Standardization Committees no. 144 - Reliability and Maintainability and no. 378 – Nanotehnologies;

V. Ilian

• President of the National Standardization Committees no.17 - Semiconductor Devices and no. 193 - Technology of Assembling Electronic Components;

• Member of the National Standardization Committee no. 375: Audio Video and Multimedia Systems and Equipment.

Awards

M. Bâzu - "Tudor Tănăsescu" Award of the Romanian Academy, granted on December 19 for the book "Failure Analysis", published by J. Wiley & Sons (SUA).

Patents awarded in 2013

• Constructive system for making microsensors based on microorganisms photosynthesis inhibition process), no. 123507 from 30.01.2013

• Micro-biosensor for diuron detection, based on photosynthesis inhibition at cyanobacteria), nr. 123508 from 30.01.2013

• Proceeding for reliability selection of semiconductor chips with p-n junctions, based on the optical acceleration of generation-recombination at deep levels, no. 126169 from 30.01.2013.

Reliability Laboratory

Most important scientific results

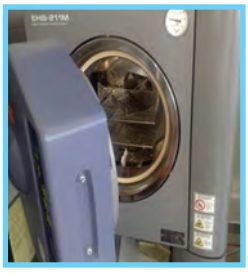
Thermal analyses performed for the company FEI (Centre of Reserch from Eindhoven, the Netherlands), well-known manufacturer of electronic microscopes (SEM, TEM, FIB, etc.)

The infrared microscope (SC 5600 + G3 L0605 / FLIR Systems), existent in L7, was adapted to be used for performing thermal analyses for a sampling room of extremely small size, which has to be used in new products of the company FEI. The temperature uniformity was checked on some successive constructive variants.

Reliability tests for the FP 7 project "Frequency Agile Microwave Bonding Systems – FAMOBS"

Reliability tests were designed and used for identifying the technological variant ensuring the maximum reliability, among many technological variants of thermal treatment by microwaves of an encapsulant for ICs. For executing the reliability tests, two high performance machines were used: the thermal cycling equipment TSE 11A, and the equipment for Highly Accelerated Stress Test (HAST) EHS 211M, which were adapted for executing the necessary reliability tests. In the subsequent failure analysis, characterization with the scanning acoustic microscope, performed at OFI, Austria, was used. The obtained results were disseminated in a paper presented by an international research team (led by IMT-Bucharest) at ESSDERC 2013 entitled: „Reliability Tests for Discriminating Between Technological Variants of QFN Packaging".

Left: Equipment for thermal cycling TSE 11A (Espec Europe, Germany)



Right: Equipment for testing at highly accelerated stresses (Highly Accelerated Stress Test – HAST) tip EHS 211M (Espec Europe, Germany)

Equipment

- Temperature storage: *UFB 400 / MEMMERT*
  Temperature: +5°C….+220°C; Volume : 53 l
- Temperature + Low pressure: *VO 400 / Memmert*
  Temperature: +25°C…+200°C
  Presssure: 10…1100 mbar; Volume: 49 l
- Temperature + Humidity: *CH 160 / Angelantoni*
  Temperature: -40°C…+180°C
  Humidity: 20…95% RH : Volume : 160 l
- Temperature + Humidity + High pressure (HAST): *EHS-211M / ESPEC EUROPE GmbH*
  Temperature: 105°C…142°C; Humidity : 75%...100%:
  Pressure : 0.02…0.196 Mpa; Volume: 18 l
- Thermal cycling: *TSE-11-A / ESPEC EUROPE GmbH*
  Method with two rooms, variable moving speed;
  Low temperature: -65°C…0 / High tmperature: +60°C…+150°C;
  Volume: 11 l
- Vibrations + Temperature + Humidity: *TV 55240/LS / TIRA*
  Vibrations DC…3000 Hz; Temperature: -30°C…+150°C;
  Humidity: 10%...95%; Maximal weight 100 Kg; Volume: 250 l
- Mechanical shock (Free fall): *MRAD 0707-20 – Free Fall Shock Machine / Cambridge Vibration*
  Transport table: 7 in x 7 in; Maximal height of the specimen: 10 in;
  Maximal falling height of the transport table: 60 in;
  Maximal acceleration: 4500 g
- Electrical characterizing: *4200 SCS / Keithley*
  Stimuli: DC voltage: < 100V, DC current: < 1A;
  Impuls: analogic signal 30V, <40MHz;
  Measurements: voltage 0.5 µV, current 1 fA
- Thermal conditioning at measurement: *TP04300A-8C3-11 7 Thermo Stream / Temptronic*
  Temperature variations: - 80°C to +250°C, with transition time:
  up 7 sec, down 20 sec; Temperature control: +/- 0.1°C
- Thermal analysis: *IR Microscope SC 5600 + G3 L0605 / FLIR Systems*
  Sensor: InSb, Resolution (pixels): 640 x 512: Calibrated range of temperature: -20°C … +3000°C

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 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).

Centre for Research and Technologies Integration

Microsystems for Biomedical and Environmental Applications Laboratory

Mission

The main mission of the laboratory is research and development focused on the development of microsensors (chemo, bio and mechanical sensors), microstructures and electrodes, microprobes for recording 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 "Politehnica" University of Bucharest).

Main areas of expertise

Micro-Nanosensors: Development of microsensors (chemo-resistive, resonant gas sensors, accelerometers, microarrays, ISFET (Ion Sensitive Field Effect Transistors) sensors, nano-wires based sensors, electrodes for biological sensors, microprobes for recording electrical activity of cells and tissues);

Microfluidic platforms – simulation, modelling and fabrication of microfluidic platforms including microchannels, 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).

Research Team

The research team is formed by 12 persons with Electronics, Physics, Mechanics, Chemistry and Biology background.

- **Dr. Carmen Moldovan**, CS I, PhD. in electronics, Laboratory Head
- **Rodica Iosub**, CS III, chemist;
- **Cecilia Codreanu**, CS III, engineer;
- **Daniel Necula**, CS III, engineer;
- **Bogdan Firtat**, CS III, engineer;
- **Marian Ion**, CS, PhD. in physics;
- **Silviu Dinulescu** – AC, engineer;
- **Adrian Anghelescu** - CS III, engineer;
- **Costin Brasoveanu** - CS, engineer;
- **Ioana Ghinea** – technician, chemical engineer;
- **Roxana Vasilco** – CS III, biologist;
- **Alina Popescu** – CS III, chemist

Specific instruments and equipment

The Laboratory has additional expertise of:

Ink Jet Printer-Offers the capability to deposit droplets of fluid, in picoliters range, such as liquid silver or organic inks, on all types of surfaces, including flexible ones: PET (Poly-Ethylene-Terephthalate), PEN (Poly-Ethylene-Naphthalate) and Poli-Aniline (PANI) sheets;

VoltaLab 10-Electrochemical Laboratory: PGZ100 All-in-one potentiostat, VoltaMaster 4 electrochemical software for cyclic voltammetry analysis;

CNC (Computer Numerical Control)-Miniature machine composed of a miniature system for mechanical processing and a Linux environment software for design and control. The CNC equipment is used for microfluidic components development and different mechanical interfaces manufacturing.

International and national collaborations

• International cooperation with research centers and leading companies in the field from United Kingdom, Germany, Holland, Switzerland, for european research projects:

• PARCIVAL - Partner network for a clinically validated multi-analyte lab-on-a-chip platform, FP7-HEALTH (Erasmus Univ, Holland, PathoFinder, Holland, HSG-IMI, Labor Stein, Askion, Agrobiogen, EADS, Germany),

• PESTIPLAT - Integrated Platform for Pesticides Detection – MNT ERA.NET (Romelgen - Romania, HSG-IMIT si Scienion AG - Germany) - coordonated by the laboratory;

• Cooperation with research institutes and universities (INFLPR, „Politehnica" University) and romanian companies (ROMELGEN, Telemedica, DDS Diagnostic) for projects coordonated by the laboratory in the national programs:

• IMUNOPLAT (Micro-Imunosensors for Metabolic Syndrome Investigation Platform): DDS Diagnostic SRL, Carol Davila University of Medicine and Pharmacy, Telemedica SRL, University of Bucharest.

Education and training

Co-organization of courses and training sessions in international projects like Euro-Training in the field of micro and nanotechnologies.

Supervision of diploma and master thesis of the University "Politehnica" of Bucharest, Faculty of Electronics.

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

She graduated on Electronics and Telecommunications and she owns a PhD in Microsensors.

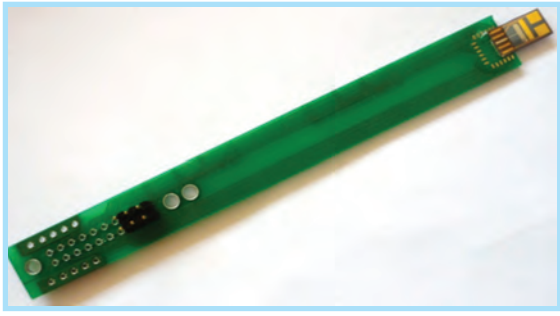
She was responsible from IMT side in the TOXICHIP project, STREP (IST), for the development of temperature, pH sensors and O_2 sensor integrated into a microfluidic platform for toxicity detection. She was involved in the 4M NoE (NMP), working on demonstrators, in Ceramic cluster, having the goal to 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. The scientific activity is published in more than 70 papers in journals, books and communications in Proceedings.

Results

Integrated MiniPlatform for detection of pesticide from agricultural products, *which include:*

- Miniature sensors on sillicon substrate: pesticide biosensors, integrated sensors for temperature and pH with microfluidics modules.



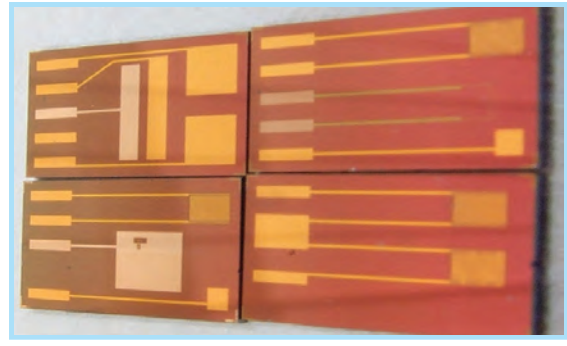
Disposable pesticide sensor

- Microfluidics modules with the heating system together with the pumping, fluid delivery and sample preparation modules.
- Portable instrument for signal processing and display
- Software for data acquisition and signal interpretation from the networks of sensors

The sensors can detect concentration of organophosphorus products and carbamates of 10-6 g/l from vegetable products, water, milk. The miniplatform is portable, it doesn't require laboratory conditions and it can be used in diferent conditions for detection of toxic concentration.

Micro-Immunosensors for Metabolic Syndrome Investigation

The area of immunosensors obtained on sillicon substrate for simultaneous detection and quantification of proteins that characterize the metabolic syndrome and to be used in medical research and diagnostics has been developed. Biosensors will be used for development of a new technology with a high degree of automation, which will replace the standard „ELISA" method, in order to accelerate the investigation of metabolic syndrome, to record and monitor risk patients for early diagnosis and reduce operational costs.



Biochips array

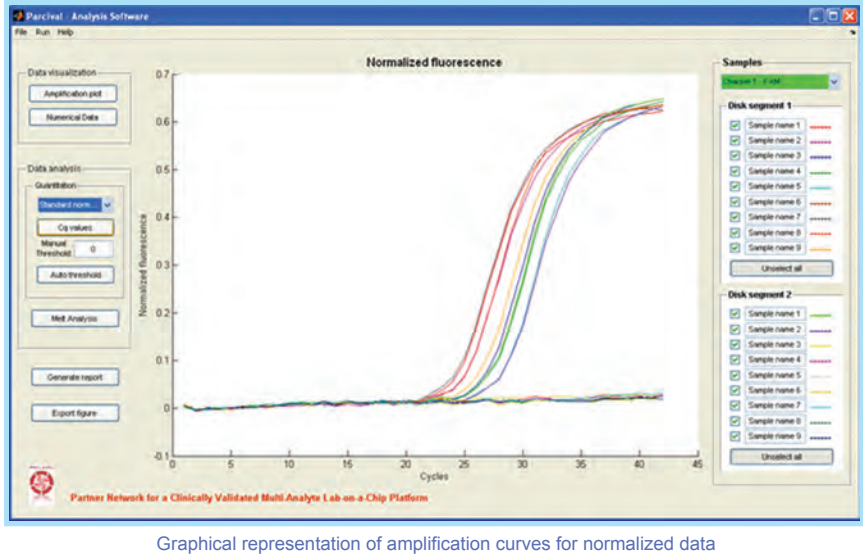
Layout for the structure of impedimetric sensor and pH sensor
the distance between electrodes is 50 µm

Systems of bio-chemical sensors on thin organic films

The technology for obtaining bio-chemical sensors systems in thin organic films has been developed. We designed sensors on flexible substrates and have been designed various test structures in order to optimize the printing process for the proposed sensors. After testing, several structures have been designed to find optimal solutions for bio-chemical sensors to be developed in this project (temperature sensor, impedimetric sensor and pH sensor).

Software modules for signal precessing

A software module for the processing device for the integrated and automatic multi-analysis platform (lab-on-a-chip type) for rapid and accurate diagnosis of infectious respiratory pathogens has been developed. The implemented module consist of a graphical user interface (GUI) with two components: one for the control of the hardware equipment of the processing device and the other one for representation of results of the software package for data analysis and processing. The algorithms for processing and analysis of numerical data supplied by the hardware equipment were implemented in the software module.



Graphical representation of amplification curves for normalized data

The software module in used for DNA PCR Analysis.

Centre for Research and Technologies Integration

Ambiental Technologies Laboratory

Mission

❖ R& D of new technologies in the areas of micro and nano sensors technologies: - technological design, technological development up to the prototype level;

- new individual technological processes
- New assembly techniques for Micro/nanosystems (based on MCM)

❖ R&D of New materials (i.e. nanocomposites):

- New material synthesis;
- Micro devices based on new materials (nanomaterials)

❖ Technological services:

- Technological assistance and consultancy (technological flows design, control gates);
- Technological compatibilities and defect analysis on technological flow analysis;
- Technological assistance for technological transfer from prototype to industrial

❖ Education, dissemination

- Associate professor and tutors for Bucharest "Politechnica" University students
- Organization of workshops for better contacts between Universiatry and R&D institutions with SME's and NTBF's

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 area of expertise

❖Design and develop individual technological processes for micro/ nano systems technology (as piezoelectric integrated microsensors, high speed photodetectors,white LED micromatrix)

❖Technological compatibilization for technologies and technological facilities

❖MCM technologies and other nonstandard assembly technologies for Micro/nano systems technological design, mainly on applications in traditional industries.

❖Nanocomposite materials synthesis and nanostructured sensing materials

❖FTIR and UV-vis spectroscopy services

❖Thermal technological services-included processes design (calcinations, RTP)

Equipments (selection)

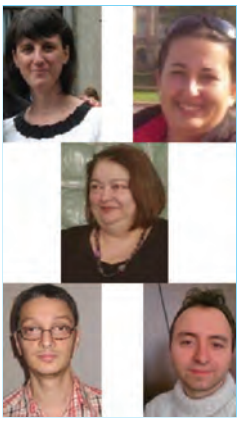
- RTP- Rapid Thermal Processing system for Silicon, Compound Semiconductors, Photonics and MEMS process, ANNEALSYS, France: Rapid Thermal Oxidation (RTO), Rapid Thermal Nitridation (RTN), Crystallization and Densification, Compound semiconductor annealing.

- High temperature furnace, sintering, annealing, desintegration, etc: Semiconductor field include annealing silicon, silicon carbide & nitride samples and solid state synthesis; Ceramics field include disintegration, long term high temperature tests and firing & sintering of ceramic samples.

- FTIR Spectrometer Tensor 27, Bruker Opticks: 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: Spectroscopic measurements are being used in many different applications, ideal for absorbance, transmittance, reflection, fluorescence and irradiance.

Research Team



PhD. Ileana CERNICA - Senior Researcher I,PhD. in microelectronics , laboratory head, ileana.cernica@imt.ro

PhD.student Alina MATEI, Senior Researcher III, MST in chemical eng; alina.matei@imt.ro

Chem.Vasilica TUCUREANU(SCHIOPU), Senior Researcher III, chemist; veronica.tucureanu@imt.ro

Eng. Florian PISTRITU, MST in electronics, senior eng.; florian.pistritu@imt.ro

EC-Eng. Andrei GHIU, MST in Mechanics and Economical faculty alumnus; andrei.ghiu@imt.ro

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

Ileana Cernica, 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 and international R&D projects as responsable from IMT. She is project evaluator national RD programs (CEEX, CNCSIS) and 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.

International projects

ESA Project: PROBA 3 Coronograph System, 2016-2019 Accepted, under negociation. Contractor: Centre Spatial de Liège. Subcontractor for OPSE: IMT Bucharest. Supplier ROMAERO

PROBA-3 Coronagraph System, also known as ASPIICS (the French acronym meaning "Association de Satellites Pour l'Imagerie et l'Interférométrie de la Couronne Solaire") will provide novel solar observations to achieve the two major solar physics science objectives: to understand physical processes that govern the quiescent solar corona, and to understand physical processes that lead to coronal mass ejections (CMEs) and determine space weather.

The OPSE system consists of a set of three light emitting heads mounted on the External Occulter disc.

Contact person: Ileana Cernica

National projects:

• STAR-ROSA Project: *Active Micro-shields Systems for Protection of Space Infrastructure (MICROSHIELD)* (37/19.11.2012); Coordinator :IMT-Bucharest, Contact person : Ileana Cernica

• STAR-ROSA Project : *Microsensors matrix for air quality control in human space missions habitable areas* (SAFEAIR)(76/29.11.013); Coordinator: IMT-Bucharest, Partner: Institute of Chemistry Timisoara (Romanian Academy R&D Institute); Contact: Ileana Cernica

• PNCDI II Partnership project: *Advanced Research for Developing Methods and Techniques for Rapid Detection of Pesticides in Food Chain*, PESTI-SENZ, 2014; Coord :NIRD Electrochemical and condensed matter Timisoara; Partner: IMT-Bucharest; Contact : Alina Matei

Education and training

- Courses and laboratories for Master of Science in Optoelectronics at "Politehnica" University, Bucharest
- Coordination of degree (licence and master) thesis

Technological services

Technological and characterization processes using FTIR and RTP (ISO 9001:2008) for IMT-Bucharest, universities, another R&D and SME,NTBF's entities.

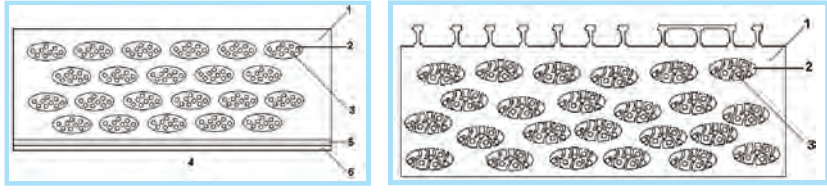
Technological design and compatibilities analysis.

Most important scientific results

Active Micro-shields Systems for Protection of Space Infrastructure (MICROSHIELD)

Principal aim: Manufacturing laboratory models of micro-shields for protect the spatial infrastructures from space debrids.

Types of nanomaterials used : ZnO , (ZnO-EA) oxide functionalized with elaidic acid, Boron carbide, Carbon nanotubes, hydroxiapatite, aerogel. Polymeric matrix made by: **PMMA (polimetilmetacrilate)**



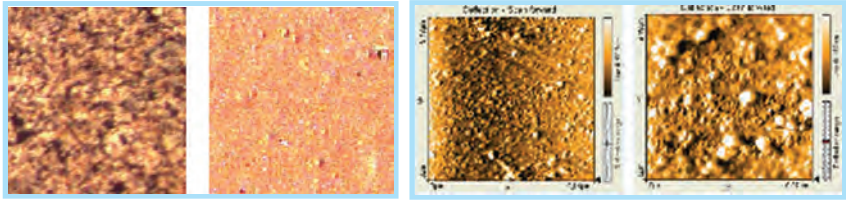
MATRIX The structure of protective elements

Deposition methods: (a) Composite deposition in matrix by injection in sockets, and (b) Boron carbide pastiles pressed in matrix sockets.

Microsensors matrix for air quality control in human space missions habitable areas (SAFEAIR)

The general strategic objective is to participate to the fundamental formation of the space culture and the punctual strategic objective is to increase the research capability and the technological expertise of the consortium members in the field of sensors for space missions, microtechnologies (colorimetric gas sensors) and nanostructured materials (porphyrins). The main goal of the project is derived: to achieve a colorimetric microsensors matrix, assembled in multichip module technologies for air quality control in space missions habitable areas (space stations and long distance spatial missions). So, we intend to obtain a matrix made from colorimetric microsensors for a friendly detection of the air quality (i.e. detection of CO, NO_x and high level of CO_2 and low level of O_2) easy to be operated, freehands and detachable where the space habitants are. The important technological challenge will be the CO_2 detection (now there are only 2-3 research teams that can detect CO_2 using colorimetric microsensors) and for it we come with a new innovative technological solution based on a microfluidic device.

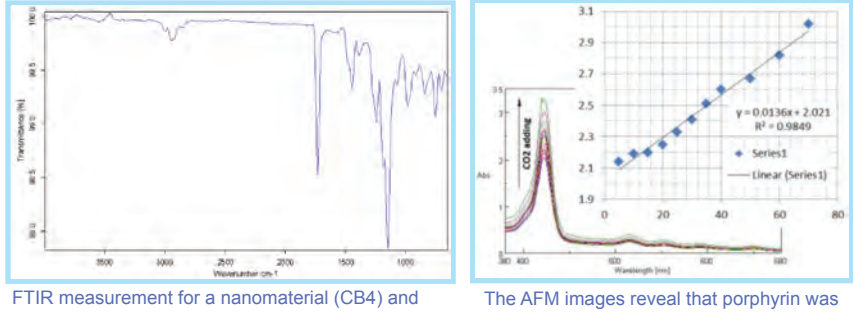
Characterisation results: Optical Microscopy



Optical microscopy images of (a)CB4 and (b)CB4 covered by PMMA polymeric thin film

The increase and widening of the Soret band of (PyTDMeOPP) porphyrin function of increasing amounts of CO_2

Characterisation results: FTIR



FTIR measurement for a nanomaterial (CB4) and polymeric thin film (PMMA)

The AFM images reveal that porphyrin was initially structured in ring aggregates (after 15') and that the most part of rings looks filled after CO_2 absorption (80')

Micro and Nanofluidics Laboratory

The Micro- and Nano-Fluidics laboratory is the result of the multidisciplinary project POSCCE, O.2.1.2 No. 209, ID 665, Microfluidic Factory for "Assisted Self-Assembly" of Nanosystems (MICRONANOFAB), which gathered experts from micro-nanotechnology and chemistry, and had the fundamental objective of fabricating a prototype of an integrated microfluidic system able to dose, encapsulate and deliver different chemicals for medical treatment.

Mission

Research, development and education in the micro and nano-fluidics domain. The primary focus of our research is the design of microfluidic devices for applications in clinical diagnostics and regenerative medicine.

Domains of activity

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 microtechnologies: cleanroom processes (e.g. glass, silicon and polymer micromachining, plasma based processes), design, simulation, fabrication and characterization of MEMS and biosensors.

Experimental analysis by microparticle resolution 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: Magnetophoretic system for detection of magnetic marked biomolecules; active magnetophoretic systems for cell separation through magnetic fields; filters for separation of microparticles with different morphological, electrical and magnetic properties; nanoparticles separation microfluidic devices.

Visualization and flow characterization: our experimental methods used for microscopic flow investigations are based on (i) contrast substances for the path lines distributions (ii) μ-PIV measurements for local hydrodynamic behavior of a steady fluid flow and quantitative measurements of the velocity profiles and vortex identification.

Team

Dr. Marioara Avram - CS I, PhD in magnetoelectronic microsensors;
Dr. Cătălin Valentin Mărculescu - CS III, PhD in fluid mechanics;
Dr. Cătălin Mihai Bălan - CS III, PhD in fluid mechanics;
Dr. Andrei Marius Avram - CS III, physicist with PhD in electrical engineering, magnetophoretic devices;
Dr. Adrian Şerban - Consultant, physicist with PhD in plasma physics
Dr. Ciprian Iliescu - CSII, mechanical engineer with a PhD in mechanical engineering

Equipment

Technology:

ICP-RIE: Plasmalab System 100- ICP - Deep Reactive Ion Etching System - Etching: Bosch process for silicon and SiC, Cryogenic process for silicon

Reactive Ion Etching (RIE) Plasma Etcher, Etchlab 200

Etching: dielectrics, semiconductors, polymers, metals

Plasma-enhanced chemical vapor deposition (PECVD): LPx CVD - Deposition: silicon oxide, silicon nitride

Wafer Bonder System- SB6L- Wafer - Substrate Bonder System - Bonding: Si on Si, glass on Si, Pressure/heat assisted polymer bonding

Characterization:

Micro-PIV- PIV for Microfluidics (Particle Image Velocimetry)

Velocity fields measurements, temperature and concentration distributions in microfluidic flows

Refractometer for layer thickness measurements - NanoCalcXR Material layer and thin films thickness measurements, refractive index measurements.

International and national cooperation

• International cooperation with European university research centers and companies from England, Spain, Germany, France, Austria, Norway.

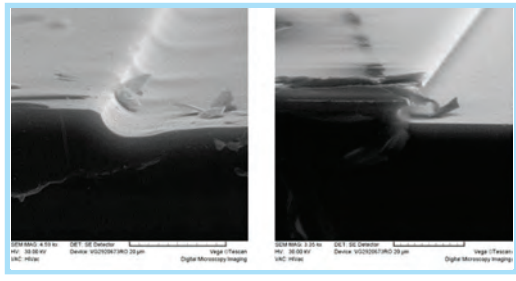
• National cooperation with research institutes, universities and Romanian companies (IXIA MEDICA, DDS, CONITRANS, CASA LETA).

Results

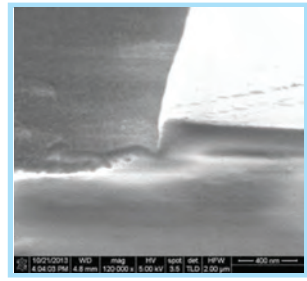
Laboratory technology for glass wet micro-processing

In our laboratory, the glass micro-processing is being performed using two methods: in the reactive ion etching system (RIE); or in a HF vapor etching system (fabricated in-house). The RIE etching is obtained in triflourmethane diluted with argon and uses a thick photoresist layer for glass masking. In this manner, structures with straight lateral walls (anisotropic etching) and 1 μm in depth were obtained.

The hydrofluoric acid (HF) vapor etching is performed in a special installation that controls the wafer temperature. The etching is isotropic with an obtained depth of app. 5 μm. Images presents the glass engravings obtained using the two mentioned methods.

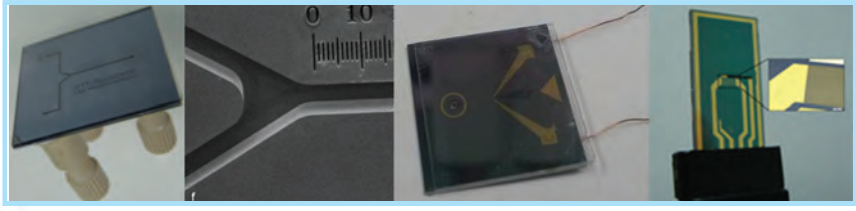


Glass etching with HF at different temperatures



RIE glass etching

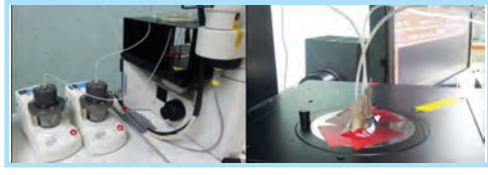
Laboratory technology for microfluidic systems fabrication



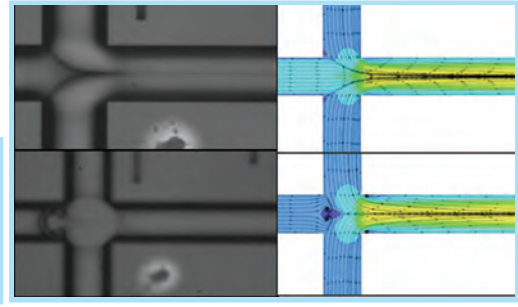
The microfluidic systems are fabricated on a silicon wafer and encapsulated with glass cover for visualizing the phenomena occurring in the microchannel. Their fabrication implies deep silicon etching processes (in ICP-RIE), metallic depositions (e-beam evaporation and sputtering), passivation layer depositions (PECVD) and thin layer etching (RIE or wet etching). In microfluidics it is desirable to have materials with very good mechanical properties, with the lack of residual stress, high elasticity modulus, low friction coefficient and high wear resistance. The figures presented show a selection of in-house fabricated devices: microfluidic system for liposome size control with a detail on the microchannel (left); magnetophoretic system for magnetoliposomes and magnetic particles manipulation (center-right), impedimetric system for dielectric constant determination for biological cells (right).

Lipid containers assembly methods in microfluidic methods

In order to identify the optimum method for obtaining and assembling liposomes in microfluidic channels by hydrodynamic focusing, first we studied the rheological behavior of the lipid solution and implicitly of the liposomes in contact with the aqueous buffer solutions. Therefore, a similarity between the liposomes interaction with the interaction between two immiscible Newtonian fluids has been performed in order to obtain numerically droplets similar to the liposomes, controlling their dimensions by flow rate ratios. Microfluidic devices were fabricated for lipid vesicles assembly by hydrodynamic focusing.



The experimental set-up for obtaining liposomes - the hydrodynamic focusing system with two lateral inlets requires the use of two microfluidic pumps. Detail on the microfluidic device and the required fluidic connectors.



(a) The liposomes solution focusing for a main inlet entry pressure of 600 mbar. The optimum flow regime was accordingly chosen to obtain the highest narrowing of the main stream. (b) The flow regime characterized by vortex secondary flows with numerical simulations comparisons.

Co-operation projects

International projects

COST project – Biomedicine and Molecular Biosciences (BM1309; 2013-2017): "European network for innovative uses of EMFs in biomedical applications" (EMF-MED) – development of a cooperative framework to support the research on beneficial biological effects of non-ionizing electromagnetic fields (EMFs) and their use in biomedical applications. Research on biological effects of EMFs has traditionally focused on health risks. Inspired by promising recent studies on useful biomedical EMF interactions and applications.

National projects

PN-II-PT-PCCA-2011-3-0052, C2/2012 "Immunoassay Lab-on-a-chip for cellular apoptosis study" (CELLIMMUNOCHIP): Co-operation with two research centers from the University "Politehnica" Bucharest and the University "Transilvania" Brasov for the development (design, fabrication and characterization) of a versatile lab-on-a-chip integrated system, which is composed of a microfluidic platform, an interdigitated micro/nano-electrodes electrochemical biosensor and an array of spin valves for superparamagnetic nanoparticles - based immunoassay, and will be applied to the study of cellular apoptosis and detection of specific antigens as clinical diagnostics application.

POSCCE, O.2.1.2 Nr. 209, ID 665, "Microfluidic Factory for Assisted Self-Assembly of Nanosystems" (MICRONANOFAB), the main objective of the project is the realization of an integrated microfluidic system able to dose, encapsulate and deliver different biological fluids for biomedical applications.

Scientific events and publishing activities

International Semiconductor Conference - CAS 2013

The 36th edition of International Semiconductor Conference (CAS), organized by the National Institute for Research and Development in Microtechnologies (IMT Bucharest), www.imt.ro/cas took place in Sinaia, 14-16 of September, 2013. Starting with the year 1991, the conference was opened to the international scientific community and since 1995 CAS is also an IEEE event. Since 1997, the Conference profile has been gradually extended from semiconductor device physics and technology (semiconductor materials and microelectronics) to micro- and nano-technologies (including micro- an nanoelectronics, micro- and nanosystems and also nanostructures and nanostructured materials). In 2013, the main topics have been: 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).

On Monday, 14th of October 2013, a satellite event was organized: "SMARTPOWER Project Workshop, organized by the FP7 IP project “Smart integration of GaN & SiC high power electronics for industrial and RF applications” http://www.project-smartpower.com.

ESSDERC/ESSCIRC 2013

Bucharest, Romania was hosting in 2013 (for the first time in Eastern Europe) the pair of IEEE conferences: ESSDERC (European Solid-State Devices Research Conference) at its 43rd edition; ESSCIRC (European Solid-State Circuits Research Conference) at its 39th edition. IMT Bucharest was one of the organizers, along with University “Politehnica” of Bucharest, "Gheorghe Asachi" Technical University of Iasi and Infineon Technologies, Romania. The scientific conferences (17-19 September 2013) included 171 regular papers in parallel oral sessions, 6 plenary talks, 6 keynote speeches and 10 invited session papers.

Reinhard Ploss, CEO Infineon is delivering a plenary talk.

One of the conference highlights has been the panel session “Europe as engine of innovation in the semiconductor area”, with top representatives of IMEC (Belgium), LETI (France), STMicroelectronics (France), Semiconductor Manufacturing, Fraunhofer (Germany), Infineon Technologies (Germany), NXP Semiconductors (the Netherlands) and ENIAC Joint Undertaking, (Belgium). Another one was the workshop (20th of September, 2013) “Potential of Eastern European Countries in Key Enabling Technologies”, with contributions from Russia, Poland, Estonia, Slovakia, Hungary, Bulgaria, Turkey, Armenia, Republic of Moldova, and Romania. A special presentation on the subject was delivered by Dr. Andreas Wild, executive manager of ENIAC JU.

ESSDERC 2013 (Chair: Dan Dascalu, IMT Bucharest; Co-chair: Adrian Ionescu, EPFL, Laussane) was basically a European conference with 83% of accepted papers from Europe (12% from Asia and 5% from North America). Origin: 62% of papers coming from academia, 23% from research facilities, 12% from industry etc.

ESSDERC tutorials (16th of September, 2014) have been organized by Florin Udrea (University of Cambridge) along the following directions (running in parallel): “MEMS and Sensors: technology and applications”; “High Voltage technologies”; “Graphene”.

National Seminar for Nanoscience and Nanotechnology 2013

The 12th Edition of National Seminar for Nanoscience and Nanotechnology was organized by the Centre for Nanotechnologies from IMT Bucharest, on 16th of May 2013, at the Library of the Romanian Academy. The event started with a short debate on the perspectives of nanotechnologies in Romania. The scientific sessions have been devoted to Bio-nanosystems, Nanosafety, Nanomaterials, Nanoelectronics and photonics (see details on http://www.romnet.net/nano).

The 21st volume in the “Micro and Nanoengineering” series (Publishing House of the Romanian Academy) edited by IMT Bucharest (and coordinated by Acad. Dan Dascalu) has been (March 2013): RF MEMS Technologies: Recent Developments (editors: Tayfun Akin, Alexandru Muller, Dan Dascalu, Roberto Sorrentino). It contains the papers presented at the 13th edition of the MEMSWAVE conference organized by METU-MEMS Center of Middle East Technical University (METU) Ankara, Turkey, in July 2012, in Antalya, Turkey.

Visits and Education activities at IMT-Bucharest

Visit of Korea expert consulting delegation, initiatied by the National R&D Policies division of the Romanian Ministry of National Education, September 12, 2013. The visit was organized in the context of a consulting project related to the elaboration of the new National R&D policies and strategy. Dr. Raluca Muller made a general presentation of IMT Bucharest, and Acad. Dan Dascalu presented the key points of IMT development and strategic priorities in the context of Horizon 2020 and Orizont 2020 initiatives.

Visit in IMT of delegation from Republic of South Africa, Department of Science and Technology, 12 August 2013. IMT Bucharest was visited by the delegation of Department of Science and Technology from Republic of South Africa. The meeting took place in the context of continuous efforts to stimulate and consolidate the research projects and bilateral between Romania and the Republic of South Africa. IMT Bucharest was involved in various bilateral project with South-Africa (2008 – 2011). The two sides expressed their interest and willingness to continue to collaborate in international projects, to exchange experience, to realize mutual visits for researchers and PhD students.

Visit of Dr. Alexandr Ruzaev - International Center for Innovative Nanotechnologies, (InCIS) and **Dr. Otilia Culicov**, Frank Neutron Physics Laboratory, IUCN, Dubna, Russia, May, 29, 2013.

Visit of Prof. Hiroshi Iwai, Tokyo Institute of Technology - May 24th, 2013
Prof. Iwai is a professor at the Frontier Research Center and Dept. of Electronics and Applied Physics, Interdisciplinary Graduate School of Science and Engineering, Tokyo Institute of Technology, Yokohama, Japan.

Delegation from Republic of Armenia visited IMT Bucharest - 29th of March, 2013
Management of National Institute for Research and Development in Microtechnologies - IMT Bucharest had a meeting on March 29, 2013, with Republic of Armenia delegation, headed by the President of the National Academy of Sciences of Republic of Armenia, Dr. Radik M. Martirosyan. The meeting was attended by the Ambassador of Republic of Armenia in Romania, Mr. Hamlet Gasparian.

Visit in IMT Bucharest organized by Ecoplus Cluster, The Business Agency of Lower Austria - support cooperation between companies, promote innovation and ease access to research and development. 31 January 2013

The visit of the European Commissioner for Research, Innovation and Science Mrs. Maire GEOGHEGAN-QUINN at the MotoBrain project booth, Exhibition of Research Bucharest 2013 (left and center).

Discussions at the MotorBrain project booth, Exhibition of Research 2013.

Education activities at IMT-Bucharest

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.

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1. **M. Simion, M. Kusko, I. Mihalache, A. Bragaru**, *Dual detection biosensor based on porous silicon substrate*, Materials Science and Engineering B 178, 1268– 1274, 2013; FI 1.846

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, 11(2), 205-214, 2013; FI 1.167

3. **A. Bragaru, M. Kusko, E. Vasile, M. Simion, M. Danila, T. Ignat, I. Mihalache, R. Pascu, F. Craciunoiu**, *"Analytical characterization of engineered ZnO nanoparticles relevant for hazard assessment"*, Journal of Nanoparticle Research 15, 1352, 2013; FI 2.175

4. T. Nguyen Thanh, C. Robert, A. Letoublon, 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 541, 36–40, 2013; FI 1.604

5. E Kowalska, E Czerwosz, R Diduszko, A Kaminska, **M Danila**, „*Influence of PdHx formation ability on hydrogen sensing properties ofpalladium-carbonaceous films*", Sensors and Actuators A 203, 434– 440, 2013; FI 1.841

6. R. I. Zamfir, E. Popovici, F. Miculescu, **M. Danila**, A. Parau, *"Structural investigation of austenitic stainless steel layers obtained by laser surface alloying"*, Journal of Optoelectronics and Advanced Materials 15 (3 – 4), 305 – 310, 2013; FI 0.516

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8. V. Popescu, D. Raducanu, **A. Dinescu, M. Danila**, G. L. Popescu, "*Influence of Utltrasounds on Structural and Morphological Properties of Pbs Deposited on Glass Substrate*", Chalcogenide Letters 10(5), 159 – 165, 2013; FI 0.934

9. **A. Matei,** L. Dumitrescu, **I. Cernica, V. Schiopu, A. Dinescu, M. Danila, I. Mihalache,** I. Manciulea, "*Sol-gel synthesis and optical properties of ZnO powder*", Journal of Optoelectronics and Advanced Materials 15 (7 – 8), 703 – 706, 2013; FI 0.516

10. **C Kusko**, „*Self-Pulsation in a Nonlinear Plasmonic Ring Resonator*", IEEE J. of Quantum Electronics, 49, pp. 1080-1087 (2013). FI 1.83

11. M. Florea-Spiroiu, D. Achimescu, I. Stanculescu, **M. Purica, R. Gavrila**, S. Peretz , "*Anti-fog chitosan/sodium lauryl ether sulfate films*", Polymer Bulletin, Volume: 70 Issue: 12 Pages: 3305-3316 Published: DEC 2013 FI: 1,332

12. **M. Kusko**, "*Simulation and optimization of sensor based on Mach-Zehnder interferometer with reference waveguide*", Optoelectronics and advanced materials –rapid communications, Vol. 7, No. 11-12, November - December 2013, p. 927-931, FI: 0,402

13. **A.C.Obreja, D.Cristea, R. Gavrila, V.Schiopu, A. Dinescu, M.Danila, F. Comanescu**, "Isocyanate functionalized graphene/P3HT based nanocomposites", Applied Surface Science 27, pp 458– 467 , (2013) FI: 2.099.

14. **I. Mihalache, A. Radoi,** C. Munteanu, **M. Kusko, C. Kusko**, "*Charge storage and memory effect in graphene quantum dots – PEG600 hybrid nanocomposite*", Organic Electronics 15, pp. 216-225, (2014) FI: 3.836

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16. **E. Manea, C Parvulescu, M Purica, E Budianu, F Comanescu**, "*Antireflective Coatings with Nanostructured TiO_2 Thin Films for Silicon Solar Cells*", JOURNAL OF NANO RESEARCH Volume: 21 Pages: 89-94 Published: 2013 , FI: 0.341

17. M. Stancu, G. Ruxandra, N. Stanica, **A. Dinescu**, D. Ciuparu, "*Synthesis and Characterization of Nickel Nanoparticles Anchored on Chemically Functionalized Carbon Nanotubes*", Optoelectronics and Advanced Materials – Rapid Communications Vol. 7, No. 1-2, January - February 2013, p. 110 – 115 FI: 0,402

18. S. Mosneag, V. Popescu, **A. Dinescu** and G. Borodi, *"Utilization of Granular Activated Carbon Adsorber for Nitrates Removal From Groundwater of the Cluj Region*", Journal of Environmental Science and Health. Part A, Toxic/hazardous substances & environmental engineering, vol. 48, Issue 8, p. 918-24 (2013) FI: 1,25

19. V Popescu, D Raducanu, **A Dinescu, M Danil**a, G L Popescu, "*Influence of ultrasounds on structural and morphological properties of PbS deposited on glass substrate*", Chalcogenide Letters, vol. 10, Issue 5, p. 159-165, May 2013 FI: 0,934

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21. C Albu, **A Dinescu**, M Filipescu, M. Ulmeanu, M Zamfirescu, "*Periodical Structures Induced by Femtosecond Laser on Metals in Air and Liquid Environments*", Applied Surface Science, vol. 278 (2013), p. 347-351 FI: 2,112

22. E Pavel, S Jinga, E Andronescu, B S Vasile, G Kada, A Sasahara, N Tosa, A Matei, M. Dinescu, **A Dinescu**, O R Vasile, "*2 nm Quantum Optical Lithography*", Optics Communications 291 (2013), ps. 259-263 FI: 1,438

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24. C Dumitriu, **M Popescu**, G Voicu,I Demetrescu, "*Influence of Anodizing Potential on Titanium Dioxide Nanotubes Morphology*", Revista de Chimie, no. 6/ 2013 (64) FI: 0.538

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26. M Volmer, **M Avram**, *Signal dependence on magnetic nanoparticles position over a planar Hall effect biosensor*, Microelectronic Engineering, 108, 2013, pp.116-120. FI: 1.224

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30. **E.-M. Pavelescu**, R. Kudrawiec, J. Puustinen, A. Tukiainen, M. Guina, "*Effects of 7-MeV electron irradiation on photoluminescence from 1-eV GaInNAs-on-GaAs epilayers*", J. Luminescence, Vol. 136, pp. 347-50, 2013. FI: 2,144

31.**Gh. Sajin**, I.A. Mocanu, **F. Craciunoiu**, "*MM-wave metamaterial adjustable antenna on magnetically biased ferritic substrate*", International Journal of Antenna and Propagation, IJAP, Vol. 2013, article ID 696483, 9 pages, ISSN: 1687-5869 (Print), ISSN: 1687-5877, FI: 0,683

32. D Dragoman, **M Dragoman**, "*Geometrically induced rectification in two-dimensional ballistic nanodevices*", J. Phys. D: Appl. Phys. 46 (2013) 055306 (6pp) FI: 2.528

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36. D.D. Nesheva, I.E. Bineva, **M. Danila, A. Dinescu**, Z.M. Levi, Z.I. Aneva, **R. Muller**, "*Effect of the sublayer thickness and furnace annealing on the crystallographic structure and grain size of nanocrystalline ZnxCd1-xSe thin films*", Bulgarian Chemical Communications, October 17-18, 2013, Proceedings of the Jubilee Scientific Session on "Interdisciplinary Chemistry", Volume 45, Special Issue B (pp. 11-17), Bankya, Bulgaria FI: 0.320

37. N. Plugaru, M. Valeanu, **R. Plugaru**, and J. Campo, "*First principles calculations, neutron, and x-ray diffraction investigation of Y3Ni13B2, Y3Co13B2, and Y3Ni10Co3B2*", Journal of Applied Physics 115, 023907. FI: 2.21

38. E. Vasile, S. Mihaiu, **R. Plugaru**, "*Scanning Transmission Electron Microscopy Investigation of ZnO:Al Based Thin Film Transistors*", Digest Journal of Nanomaterials and Biostructures, Volume: 8 Issue: 2, Pages: 721-727, Published: APR-JUN 2013. FI 1.09

39. **T. Sandu**; *Eigenmode Decomposition of the Near-Field Enhancement in Localized Surface Plasmon Resonances of Metallic Nanoparticles*, Plasmonics, 8, 391-403 (2013) FI: 2.425

40. **T. Sandu, G. Boldeiu, V. Moagar-Poladian**, Applications of electrostatic capacitance and charging, J. Appl. Phys. 114, 224904 (2013); FI: 2.21

41. Eremia, S.A., Vasilescu, I., **Radoi, A**., Litescu, S.C., Radu, G.L., *Disposable biosensor based on platinum nanoparticles-reduced graphene oxide-laccase biocomposite for the determination of total polyphenolic content*. (2013) Talanta, 110, pp. 164-170, FI: 3.498

42. Vasilescu, I., Eremia, S.A.V., **Radoi, A**., Radu, G.-L., Litescu, S.-C. Lipid hydroxide determination on a ferrocenemethanol modified electrode, (2013) Analytical Methods, 5 (8), pp. 2013-2019, FI: 1.855

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44. C.M. Mihailescu, D. Stan, **R. Iosub,** M. Savin, **C. Moldovan**, „*Dezvoltarea unui nou imunosenzor capacitiv „label-free" pentru detectia Escherichia Coli O157:H7*", Revista Romana de Medicina de Laborator, Supliment la vol. 21 nr.2/4, iunie 2013, pag S77-78, ISSN 1841-6624, F I 2012: 0,097

45. **Mocanu I A, Craciunoiu F., Sajin Gh. I.**, "*Metamaterial Antenna on Magnetically Polarized Ferrite Substrate*", University Politehnica of Bucharest Scientific Bulletin Series A – Applied Mathematics and Physics, Vol. 75, (2013), Issue 3, pp. 187-194, ISSN 1223-7027. F I: 0.30

46. **L Petrica**, R Hobincu, "*OPINCAA: A Light-Weight and Flexible Programming Environment For Parallel SIMD Accelerators*", ROMJIST , Vol 15, Impact factor 0.154

Invitated Papers

1. **A. Dinescu**, **A. Muller**, **M. Purica**, **R. Gavrila**, **M. Dragoman**, **R. Muller**, *Electron beam lithography for SAW and graphene based devices*, NANO2013, 19th Seminar on Electron and Ion Beam fabrication for Nanotechnology

2. **A Dinescu**, "*Nanoscale structuring using electron beam lithography*", Workshop "Biomimetic sensing using nano-objects (BioSuN)", 17-19 iunie 2013, Magurele, Romania 2013, (http://www.infim.ro/biomimetic-sensing/

3. **M Dragoman**, "*Graphene Nanoelectronics", Workshop "Biomimetic sensing using nano-objects (BioSuN)*", 17- 19 iunie 2013, Magurele, Romania 2013, (http://www.infim.ro/biomimetic-sensing/

Papers published in nonISI periodicals

1. **Marius Bazu**, Titu Bajenescu, *Reliability Building for Electronic Components*, Anul XIX, Numărul 73, Ianuarie-Martie 2013

3. **Gh. Sajin,** I.A. Mocanu, **M Carp**, "*Improving MM-Wave Left-Handed Transmission Line Antenna by Stub Matching*", International Journal of Engineering and Innovative Technology (IJEIT), Volume 3, Issue 2, August 2013, pp. 135 – 140, ISSN 2277-3754; online available at: http://www.ijeit.com/Vol%203/Issue%202/IJEIT1412201308_24.pdf

4. **Gh. Sajin,** I.A. Mocanu, M. A. Voicu, "*Method of CRLH antenna impedance measurement by means of on-wafer characterization equipment*" Advances in Science and Technology Vol. 77 (2013), pp. 253 – 257, ISSN 1662-0356, DOI: 10.4028/www.scientific.net/AST.77. Available online since 2012/Sep/11 at: http://www.scientific.net/AST.77.253

5. I.A. Mocanu, **Gh. Sajin, F. Craciunoiu**, "*Metamaterial Antenna on Magnetically Polarized Ferrite Substrat*", University Politehnica of Bucharest Scientific Bulletin Series A – Applied Mathematics and Physics, Vol. 75, (2013), Issue 3, pp. 187-194, ISSN 1223-7027. Available online at: http://www.scientificbulletin.upb.ro/rev_docs_arhiva/full382_166868.pdf

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1. **R Pascu, F Craciunoiu, M Kusko**, *A promising technology of Schottky diode based on 4H-SiC for high temperature application*, IEEE Proceeding of PRIME 2013, 297-300

2. E.-S. Malureanu, **F. Craciunoiu**, *Wavelet solution of the Schrodinger equation for a triangular potential barrier and applied results on a mom tunnel junction,* IEEE CAS 2013 Proceedings (36th IEEE International Semiconductor Conference – CAS 2013, 14- 16 Oct. 2013, Sinaia, Romania), pag. 65 - 68

3. L. Sirbu, L. Ghimpu, **M. Danila, R. Muller, A. Matei, F. Comanescu,** A. Ionescu, O. Grigore, T. Dascalu, A. Sarua, *Porous and RF sputtering InP for portable THZ-TDS in pharmaceutical and medical applications,* CAS 2013- 36th Edition of International Semiconductor Conference,IEEE event, 14-16 October, Sinaia, Romania, Volume 1 Proceeding (pp. 69 – 72), ISSN : 1545-827X

4. F. Draghici, M. Badila, G. Brezeanu, G. Pristavu, I. Rusu, **F. Craciunoiu, R. Pascu**, *4H-SiC Schottky contact improvement for temperature sensor applications,* IEEE CAS 2013 Proceedings pag. 163 - 166

5. **G.I. Sajin,** I.A. Mocanu, **F. Craciunoiu,** S. Ciocan, *Steering capability of a mm-WAVE lefthanded transmission line antenna*, IEEE CAS 2013 Proceedings pag. 101 - 104

6. **A. Baracu,** M. Nedelcu, **F. Craciunoiu, R. Voicu, R. Muller**, *SH-SAW sensors on Langasite for mass detection in liquid media,* IEEE CAS 2013 Proceedings pag. 115 - 118

7. **R. Rebigan, A. Avram, F. Craciunoiu, R. Tomescu, E. Budianu, M. Purica, M. Popescu**, *Silicon plasma processing for antireflective micro - textured surfaces with applications for solar cells,* IEEE CAS 2013 Proceedings pag. 119 - 122

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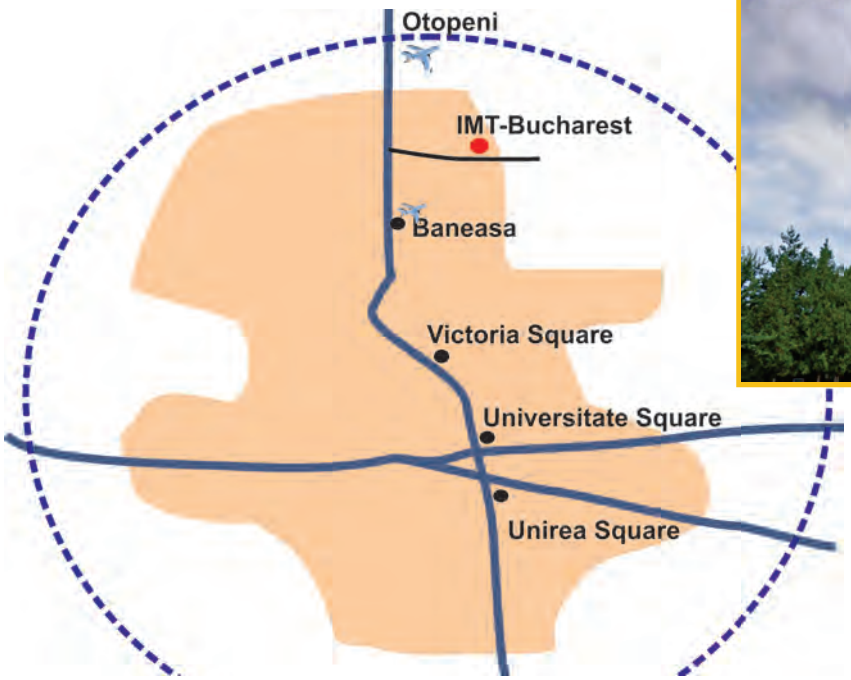

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