National Institute for Research and Development in Microtechnologies - IMT Bucharest

Scientific Report 2014

From micro to nanotechnologies, nano-biotechnologies and nanoelectronics

Ministry of Education and Scientific Research

MINISTERUL EDUCAȚIEI ȘI CERCETĂRII ȘTIINȚIFICE

National Institute for Research and Development in Microtechnologies

IMT Bucharest

SCIENTIFIC REPORT 2014

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 merged with the Research Institute for Electronic Components - ICCE (founded in 1969).

IMT Bucharest is coordinated by the Ministry of National Education and Scientific Research, acting basically as an autonomous, non-profit research company. The institute employs 194 researchers, engineers and support staff.

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. ***CENASIC: Research Centre for Nanotechnologies and Carbon- based Nanomaterials***
4. ***CINTECH: Research Centre for Integration of technologies" (micro-nano-biotechnologies)***

IMT has 40 Romanian partners from academia and industry and 131 partners from EU countries and also partners from Argentina, Rep. of Moldova, South Africa, Korea, Norway.

70 % of funding was obtained through projects won in competition in areas such as: ICT, Health, Nanotechnologies, Enviromental, Space and Security. In 2014, at national calls, IMT has a highly rate of success (31%).

IMT- Bucharest is one of the leading national institutes in Romania, its mission being related to the development of micro- nano-biotechnologies. The main research fields are in close connections to the following KETs (Key Enabling Technologies): micro- and nanoelectronics, photonics, nanotechnologies and advanced materials and with the priorities of the Romanian National Strategy (2014-2020): Bioeconomy, ICT- Space - Security, Eco-Nano-biotechnologies and advanced materials . The research is related to: RF-MEMS, photonics, nano-biotechnologies, sensors for different applications, graphene based nanodevices, microfluidics, etc.

IMT-Bucharest offers a collaborative environment, being visible in

The 2011 ***Report of EC on Innovation*** **placed IMT** among the first 5 organizations (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)*".

2014 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 was/is involved in 12 FP7 projects (IPs, STREPs, CA) and related FP7 projects as ENIAC, ERA-NET, COST, a bilateral project with Norway - EEA Research Programme, Financial Mechanism SEE . Starting with 2014 the institute participated into 2 projects financed by ESA (European Space Agency) being involved in ESA Project: PROBA 3 Coronograph System Bridging Phase-2014 (Prime Contractor: Centre Spatial de Liège; Subcontractor for OPSE: IMT -Bucharest) **The institute** was also involved in 2014 in activities with industrial partners (Thales, Infineon), especially in the frame of EU projects.

in 2014, IMT was engaged in 4 projects financed from structural funding, devoted to "micro-and nanofluidics" (MICRONANOFAB), "nanotechnology and carbon- based nanomaterials and systems" (CENASIC), training for students (ELAMAN) and support for services in microsystems and nanotechnology (RO-BG MicroNanotech- transfrontalier cooperation).

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 countries: undergraduated, M.S. and Ph.D. studies, and also for "hands-o" training. IMT has strong links with the Faculty of Electronics, Telecommunications and Information Technology (ETTI) from University "Politehnica" of Bucharest, supervising and hosting the experimental work of Ph.D. Thesis and diploma dissertations. Since October 2009, IMT-Bucharest is covering fully a number of disciplines in the new M.Sc. programs, organized by ETTI Faculty.

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 13 th edition in 2014).

The institute is co-editing the series of volumes Micro- and Nanoengineering", in the Publishing House of the Romanian Academy (23 volumes until 2014).

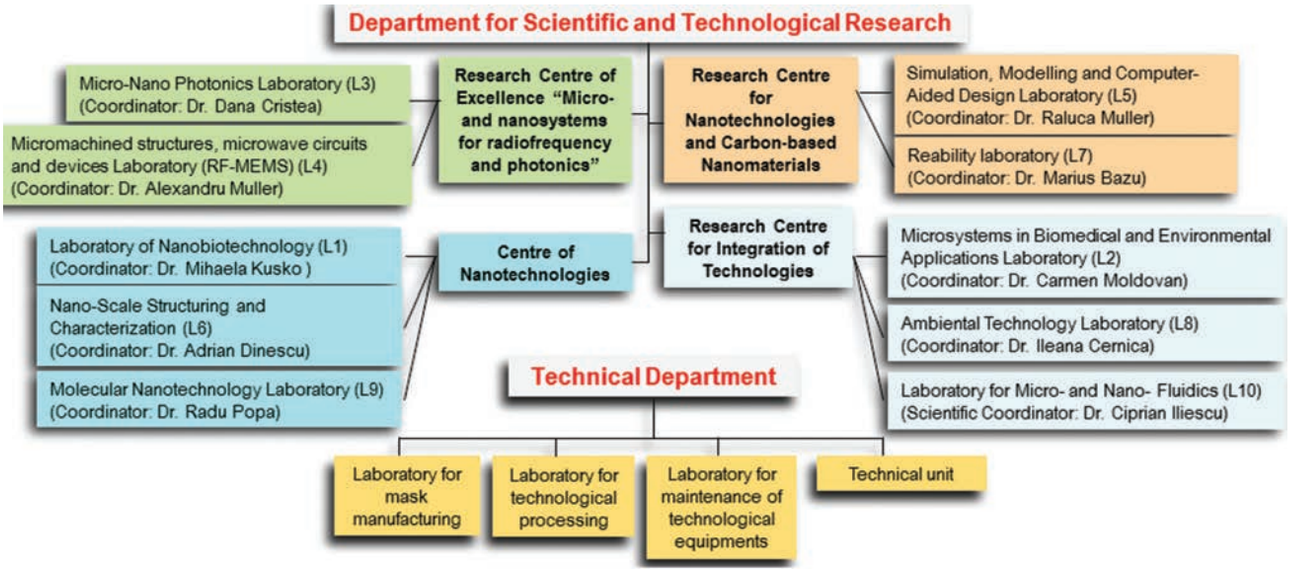
I would like to thank to all the staff for their high level work and support during 2014.

About present report

The Scientific Report 2014 starts with the organizational chart and continues with the basic figures in human and financial resources. The second part is devoted to IMT world class infrastructure and the R&D labs, presenting the successful stories obtained into 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.

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 100 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.

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. He is Technical Director starting with December 2013.

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

Human resources, funding sources and investments

IMT – Bucharest is active in R&D with a number of researchers, engineers, technicians and other support personnel. IMT has become in the last years an attraction for valuable researchers through the new infrastructures, the multitude of national and European projects in the field of Nano-biotechnologies, ICT, Space.

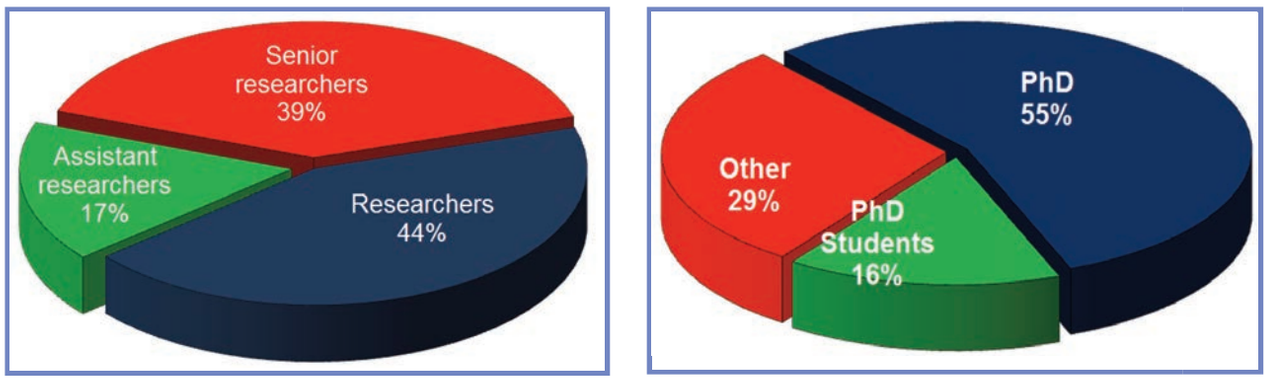


Fig 1 - Researchers active in IMT (96)

Figure 1 (a, b) provides information about the number and distribution of researchers active in IMT in 2014 (96 persons). 39% of them are senior researchers and 17% are young assistant researchers. The average age of our researchers is around 40.

Figure 2 presents information about the multidisciplinary background of the specialists active in IMT in 2014 (120 people): researchers and technical engineers, covering most of the research fields and providing also scientifical /technical services. The male (65) - female (55) number is relatively balanced

IMT – Bucharest offers an opportunity to students, especially from Politechnica University Bucharest, to develop multidisciplinary research, to be in contact with new technologies, by access to practical labs, summer stages, supervising experimental work of their diploma and PhD thesis.

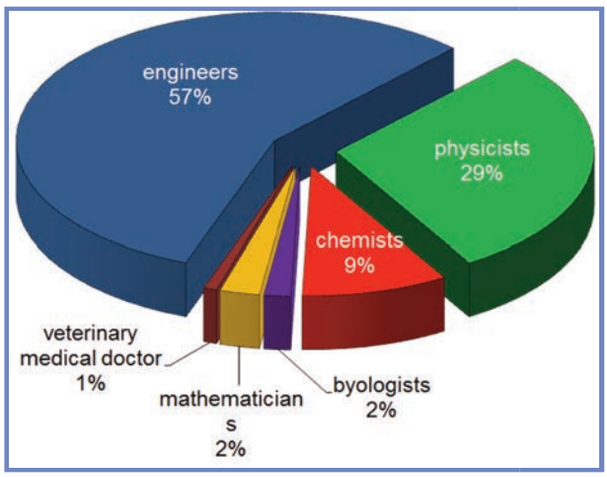


Fig.2 Multidisciplinary background of specialists active in IMT (120)

Funding sources and investments

Fig. 3 presents the funding sources in 2014. The funding comes from different sources: national R&D programs (competitive funding, through open calls): 33%, Structural Funds 11%, different European Projects 14% and other sources 12 %.

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. The turnover is very similar with 2013, the decrease, as in the previous year, is also due to the national research funding allocation in 2014.

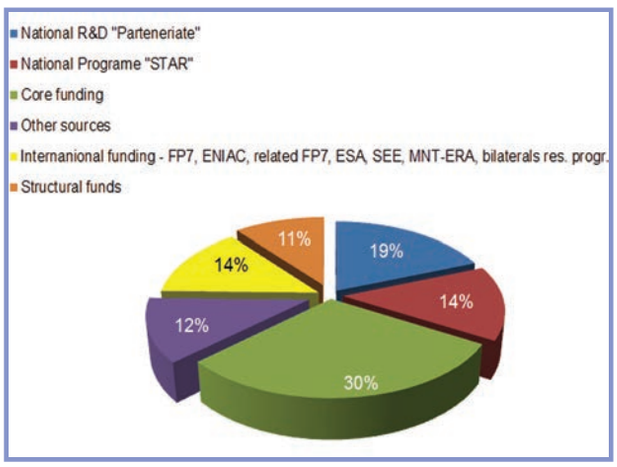


Fig.3 Funding sources in 2014

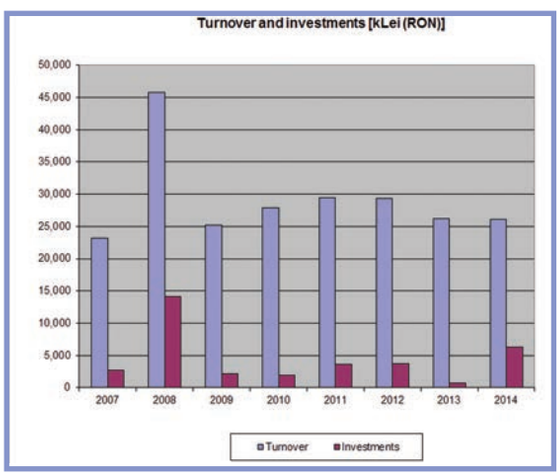


Fig.4 Turnover and investments (kLei)

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 November 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. The MINAFAB infrastructure contains a key unit, the so-called „Facility for micro-nanostructuring of devices and systems”, unique in this country. This facility is responsible for mask fabrication, photolithography and also for micro-nanostructuring using Electron Beam Lithography – EBL. IMT is very appreciated abroad for the combined use of photolitography and electron beam litography (the so-called „mix and match” technique).

The characherisation techniques (also available in other numerous laboratories accros the country) is here placed in clean rooms, next to technological equipments, allowing immediate evaluation of the materials and structures just processed. In fact, almost all complex equipments and apparatus are operated by researchers and development engineers, and their competence is providing an „added value” to the scientific and technological services to their „customers”, both from inside and outside the institute.

• 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)

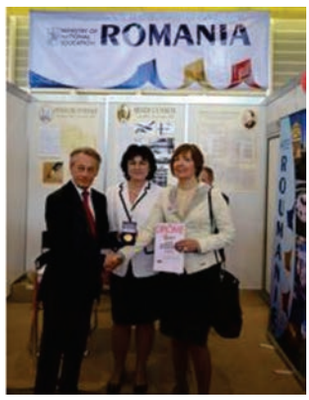
Frequency Synthesizer up to 110 GHz (Agilent, USA)

Spectrum Analyzer up to 110 GHz (Anritsu, Japan)

TECHNOLOGICAL TRANSFER INFRASTRUCTURES

CENTRE FOR TECHNOLOGY TRANSFER IN MICROENGINEERING

CTT-Baneasa is a distinct, autonomous entity of the National Institute for R&D in Microtechnologies (IMT Bucharest). CTT- Baneasa is a founding member of Romanian Association of Technology Transfer (AROTT).The major mission of the Center is to become an active professional link between research and industry, within the field of micro- and nanotechnology, including participation to various exhibitions.



Examples for 2014 are: 42nd International Exhibition of Invention, Geneva, April 2014, 2nd - 6th April 2014 (Gold medal: Miniaturized impedimetric sensor for pesticides detection), Inventika- Invention and innovation show, 2014, Romania, 15th-18th October 2014 (Gold medal: Reagent based on gold nanoparticles, its preparation procedure and its use for mapping the architecture of tumor tissue; Gold medal: Rapid manufacturing procedure by using a focused ultrasound beam; Silver medal: Miniaturized impedimetric sensor for pesticides detection; Special award from Chamber of Commerce and Industry of Valcea–Rapid manufacturing procedure by using a focused ultrasound beam); SSI 2014: International Conference and Exhibition on Integration Issues of Miniaturized Smart Systems, Viena, Austria, 26th -27th March 2014; RIDE 2014 - Research and Education Infrastructure Dissemination Event, Opatija, Croatia, 28 th -29 th May 2014; ESA Industry Space Days, ESTEC Noordwijk, The Netherlands, 3rd-4th June 2014; Solar Decathlon Europe 2014, Versailles, France, June 28–July 14, 2014.

Since 2014 CTT-Baneasa aimed at extending its role in increasing the number of value added services for industrial innovation. A new approach proposed to foster innovation and bridge the gap between R&D and market includes: a) an internal process review aimed at improving the management of intellectual property (IP) of IMT, b) commencement of technical marketing of IMT's IPs and c) industry development liaison actions. The last direction materialized in affiliation to the Magurele High Tech Cluster (MHTC), an innovative cluster of which IMT is a founding member. MHTC facilitated a 3-day working visit (November 2014) to Italy's AREA Science Park, one of the leading multi-sector science and technology parks at an international level. The visit provided an exchange of experience in administration of such a center, liaison activities with industry, management of IP and technology transfer. MHTC also facilitated IMT's participation at the 3rd Annual Forum of the EU Strategy for the Danube Region, a reputable high-level event where our institute was represented by a CTT specialist. On the other hand, CTT - Baneasa was involved in interaction with several innovative companies' members of MHTC.

CTT-Baneasa (www.imt.ro/ctt); Tel/Fax: +40212690771; E-mail: info-ctt@imt.ro
Address: 126A Erou Iancu Nicolae Street, Bucharest, 077190.

THE SCIENCE AND TECHNOLOGY PARK FOR MICRO AND NANOTECHNOLOGIES

MINATECH-RO (www.minatech.ro) science and 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 (inaugurated in 2006) is located almost entirely on the IMT premises. MINATECH-RO (Micro- and Nanotechnology Science and Technology Park) received institutional funding during 2004-2005 through the national programme INFRATECH Programme, administered by the Ministry of Education and Research.

The companies presently located in the main building are: ROMQUARTZ S.A., SITEX 45 S.R.L., D.D.S. DIAGNOSTIC S.R.L., TELEMEDICA S.A. 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 S.A. 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.hosted in the technological space of IMT.

Contact data: MINATECH-RO (www.minatech.ro); Tel: +4021269.07.67; E-mail: team@minatech.ro
Address: 126A Erou Iancu Nicolae Street, Bucharest, 077190.

Romanian-Bulgarian Services Centre for Microsystems and Nanotechnolgy
MIS-ETC Code 587

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 1st May, 2013 until 31st October, 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 of Ruse 'Angel Kanchev' and the Ruse Chamber of Commerce and Industry, representing Bulgaria.

The aim of "The Romanian-Bulgarian Services Centre for Microsystems and Nanotechnology" (RO-BG MicroNanotech) is fostering the cross-border cooperation; through the development of a regional cross-border Services Centre for Microsystems and Nanotechnology.

Official Ceremony, 24th July 2014, University "POLITEHNICA" of Bucharest

The beneficiaries are represented by SMEs, entrepreneurs, either individuals or via SMEs, local associations from the area of interest - micro and nanotechnology. All institutions finally focus on developing the **"knowledge triangle" research-education-innovation** in this region, in order to encourage a breakthrough in High-Tech technology in the cross border area, with beneficial economic and social effects for both academia and business, for both Romania and Bulgaria. Begin 2009 the "RO-BG MicroNanoTech" vision was focused to implement a new innovation policy concept designed to promote the efficient and effective use of public investment in research. Its goal is to boost regional innovation in order to achieve economic growth and prosperity, by enabling regions to focus on their strengths. **Smart specialisation** understands that spreading investment too thinly across several frontier technology fields risks limiting the impact in any one area.

The Smart specialisation needs were implemented based on our **strong partnership between businesses, public entities and knowledge institutions.** Such partnerships are recognized as essential for success. During 2014 year, the activities of Centre were focused to targeting the **regional scientific excellence**, also support **practice-based ('non-technological') innovation; to accumulate a 'critical mass' of resources; to promote knowledge skill and technological diversification;** adoption and diffusion of **knowledge and innovation**. In the field of Micro and Nanotechnology the focused action areas are: ICT; Energy; Environment; Health; Agriculture; Automotive; Space; other. The second direction is **R&D and Education in Micro and Nanotechnology** with Partnership for RDI and Partnership for Master Degree Course. Under "RO-BG MicroNanoTech" umbrella, on 24th July 2014, **2 long term cooperation Memoranda** were signed between IMT-Bucharest and University of Ruse "Angel Kanchev", and University "Politehnica" Bucharest and University of Ruse "Angel Kanchev", Other 3 Memoranda were signed between **IMT-Bucharest and business**: Chamber of Commerce of Calarasi, Giurgiu and Ruse. Were organized 10 technical and scientific events, with mass-media echoes in 5 TV spots at National/Regional broadcasting televisions (Bulgaria and Romania).

Ruse Office Opening, Official Ceremony, 30th Sept 2014, University of Ruse "Angel Kancev

In the structure of "RO-BG MicroNanoTech" Centre are two Offices, one at IMT-Bucharest and other one Office was opened at University of Ruse "Angel Kanchev" and 2 Info-Points, opened at Chamber of Commerce, Industry and Agriculture Calarasi and Giurgiu.

The "Romanian-Bulgarian Services Centre for Microsystems and Nanotechnology (RO-BG MicroNanoTech)" received the RINNO Award **"The most effective public-private partnership in the field of research and development"**. The award ceremony was organized in 26th June 2015, at Hotel Riga, Ruse, Bulgaria under aegis of the project RINNO (RINNO - a model for enhancing the benefits of Romania-Bulgaria cross - border region cooperation by using R&D&I)

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

The CENASIC project (devoted to a new research infrastructure) should support the creation of modern research center focused on applied research, involving experienced researchers and highly specialized techniques. 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 CENASIC project starting in 2010 will be finished in 2015 and his sustainability period of five years will take place during the new National RDI Programme 2014-2020. Happily enough, the RDI National Strategy includes nanotechnologies and advanced materials as one of the priorities of research, according to "smart specialization" approach. This strategy is sustained not only by the national programme, but also by structural funding devoted to competitiveness.

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.

With the investment of 6.23 Meuro in building, facilities and equipment (to be implemented until October 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 significant number of technological services.

The new building has approximately 1000 m^2, including 4 levels: the clean room (ground floor), the technical level, and two flours 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 aboratories is: Laboratory for Processing of Carbon based Nanomaterials and Nanostructures, Laboratory for Thermal Processes, Laboratory for Graphene technology, Laboratory for Chemistry of Hybrid Interfaces, Laboratory for Thin Layer Spectrometry, Laboratory for Electro-mechanical Processes and Sample Preparation, Laboratory for Electromechanical Testing & Reliability and Laboratory for Simulation and design for carbon-based MEMS/NEMS. The key equipments within the CENASIC laboratories will be: Multiprocess Furnace System, Molecular Beam Epitaxy (MBE), Plasma Enhanced Chemical Vapor Deposition, Atomic Layer Deposition tool and RF Magnetron Sputtering. A new clean room (class 1000 and 100) with about 200 m^2 will extend an existing one.

IMT has a proven experience on carbon based materials certified by results already published in literature (specifically related to graphene). According to the project, the research should be connected to 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.

CENASIC RESEARCH GROUP

A group of young researchers headed by Dr. Mircea Dragoman was created in February 2014 in order to anticipate the research to be conducted by the CENASIC centre. The focus was on graphene. The new experimental facility was not yet available, and the researchers had to use the existing facilities, within the IMT-MINAFAB centre. The financial support was provided by internal projects sustained by institutional funding (the so-called "core funding"). The plans of the multidisciplinary team are related to carbon based nanoelectronics, heterostructures based on graphene, nanophotonics based 2D materials, MEMS/NEMS based graphene and physical sensors based on carbon nanomaterials. A couple of results obtained until now are presented on the next page.

STUDY ON GRAPHENE TRANSFER BY WET CHEMICAL METHOD (Anca Istrate).

Chemical vapor deposition (CVD) on copper is one of the most advanced method in monolayer graphene (GR) synthesis, but for applications, such as solar cells, optoelectronic circuits for sensors and information processing, GR must be transferred from the growth metallic substrate to a device-compatible one. Currently, the processes used to transfer GR synthesized onto copper require chemical etching of the metal substrates using harsh chemicals like iron (III) chloride, ammonium persulfate, ferric nitrate. Nonetheless, etching steps trap ionic species at the graphene - substrate interface, impurities which will subsequently act as scattering centers, affecting the performances of the electronic device fabricated on the GR. To overcome these limitations, the present study was carried out to demonstrate a cost effective method to transfer CVD - grown GR from copper foils on Si/SiO_2 substrate without chemical etchants. The method reported herein, Soak and Peel Delamination is based on DI water capability to penetrate nanoscale hydrophobic/hydrophilic interfaces and separate them, minimizing thus unintentional doping. Using this method the GR was successfully transferred from copper foil on the Si / SiO_2 substrate. The quality of GR has been evaluated before and after transfer process by microscopy techniques (SEM, AFM) and spectroscopic analysis (Raman). A typical AFM image of the transferred GR is presented in Fig. below and reveals the presence of monolayers with lateral size of about 10 μm. The main advantage of this wet chemical method is the lack of corrosion of the metallic foil, allowing reusability of the metallic substrate for further synthesis.

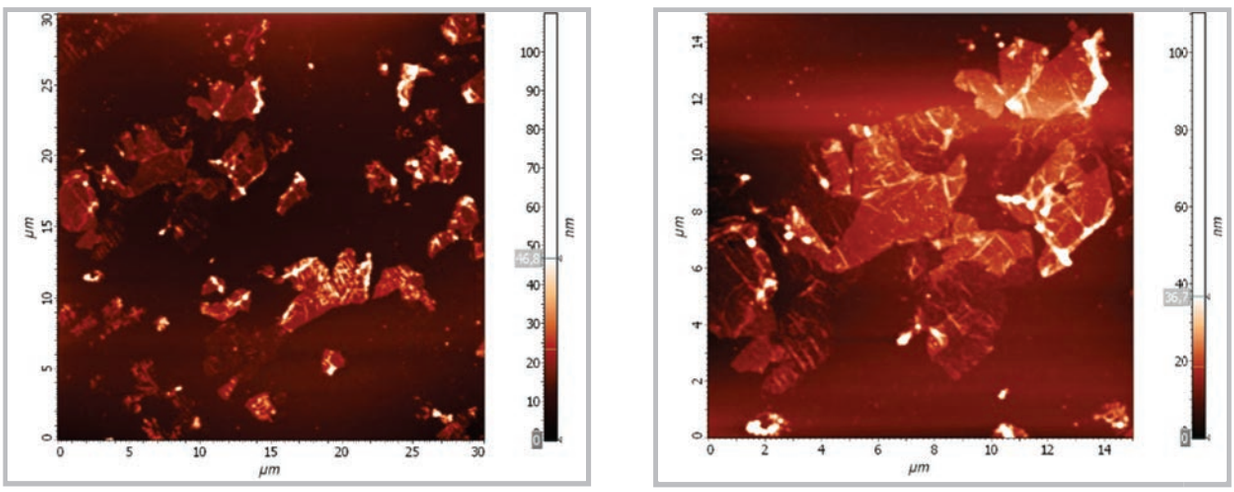
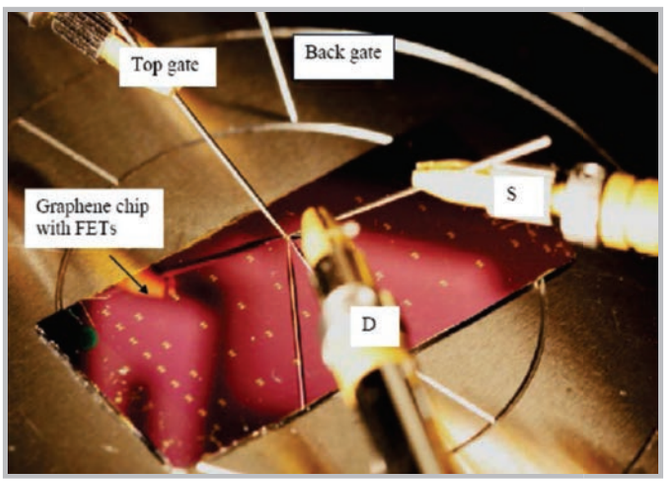


Fig. Typical AFM images of GR sheets on Si / SiO2 substrate after Soak and Peel Delamination transfer method.

BALLISTIC GRAPHENE TRANSISTORS (Mircea Dragoman, Adrian Dinescu).

Negative differential resistance (NDR) with room temperature peak-valley-ratio of 8 has been observed in a ballistic field-effect-transistor (FET) based on graphene, having an oblique top gate. Graphene FETs with a top gate inclination angle of 45^0 and a drain-source distance of 400 nm were fabricated on a chip cut from a 4 inch graphene wafer grown by CVD. From the 60 measured devices, NDR was observed only in the regions where the CVD graphene displays the Raman signature of defect less monolayers. The peak valley ratio of the nDR was 9 and tunable as a function of top gate voltage.

In other specific positions on the wafer, where graphene quality was not high enough and the Raman signature indicated the presence of defects, the ballistic character of transport is lost and the graphene FETs display nonlinear drain-voltage dependences tuned by the top and back gate voltage.



Graphene ballistic FETs on graphene chip under measurement.
From: M. Dragoman, A.Dinescu and D. Dragoman,
Negative differential resistance in graphenebased ballistic field-effect transistor with oblique top gate, Nanotechnology 25 415201 (2014).

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

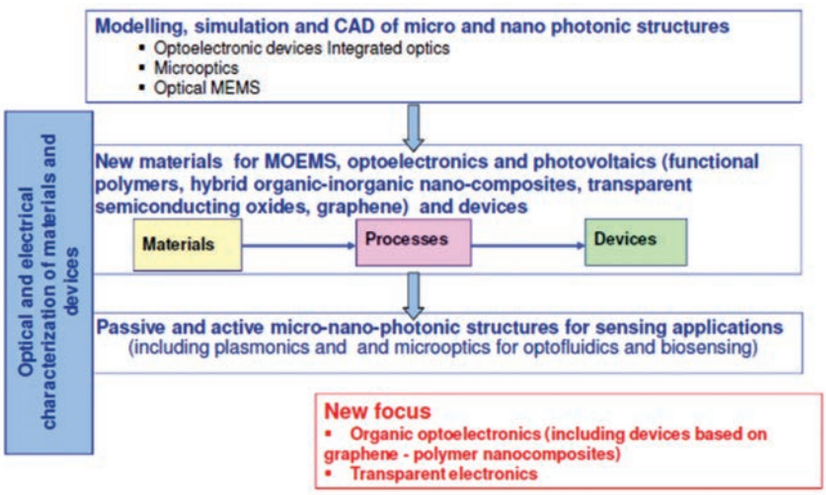
Member of "*European Centre of Excellence in Microwave, Millimetre Wave and Optical Devices, based on Micro-Electro-Mechanical Systems for Advanced Communication Systems and Sensors" (MIMOMEMS)*, funded (2008-2011) through the "Regional potential" – FP7 REGPOT.

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

Team

• **Dr. Dana Cristea** - senior researcher I, M.Sc. in electronic engineering, Ph.D.in optoelectronics & materials
• **Dr. Munizer Purica** - senior researcher I, M.Sc. and Ph.D. in physics;
• **Dr. Cristian Kusko** - senior researcher I , M.Sc. and Ph.D – physics;
• **Dr. Paula Obreja** - senior researcher II, M.Sc. and Ph.D. in physical chemistry;
• **Elena Budianu** - senior researcher II, M.Sc. in physics;;
• **Dr. Mihai Kusko** - senior researcher II, M.Sc . in physics and photonics, Ph.D in optoelectronics;
• **Dr. Florin Comanescu** - senior researcher II, Ph.D in optoelectronics;
• **Dr. Roxana Rebigan** - senior researcher III, M.Sc. in physics; Ph.D in optoelectronics;
• **Drd. Roxana Tomescu** - asistant researcher, M.Sc. and PhD student in optoelectronics
• **Ing. Rebeca Tudor** - asistant researcher, M.Sc. in optoelectronics and PhD student in optics

Research areas



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 using FDTD (Finite-Difference Time-Domain) method;

• **OptiBPM 11.0**-design of complex photonic integrated circuits for guiding, coupling, switching, splitting, multiplexing and demultiplexing of optical signals

• **OptiGrating**, LaserMod

• **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

National and international cooperations

• Cooperation with European research units (Fraunhofer IPT, CEA-Liten, LAAS-CNRS Toulouse, UNINOVA) SMEs and LE from si cu firme din Spania, Germany, Finland , Austria, France EU projects: Flexible Patterning of Complex Micro Structures using Adaptive Embossing TechnologyFLEXPAET (FP7/IP–NMP ; European Centre of Excellence MIMOMEMS (FP7-SA-Capacities), Multifunctional Zinc-Oxide based nanostructures. (MNT EraNet)

• Cooperation with national research centres (INFLPR, INCDFM), universitiesi (Universitatea " Dunarea de Jos'' Galati , UAIC Iasi, UP Bucharest) si SMEs (Optoelectronica 2001, Pro-Optica) .

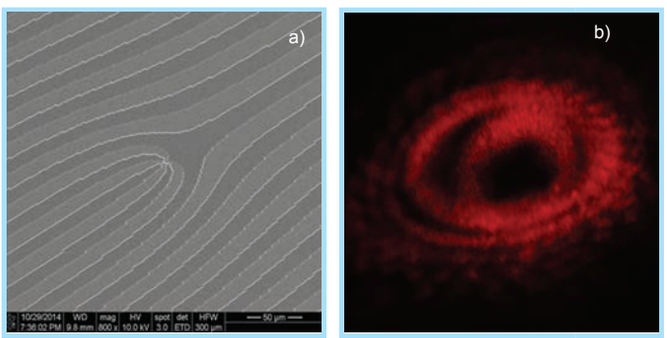
Results

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

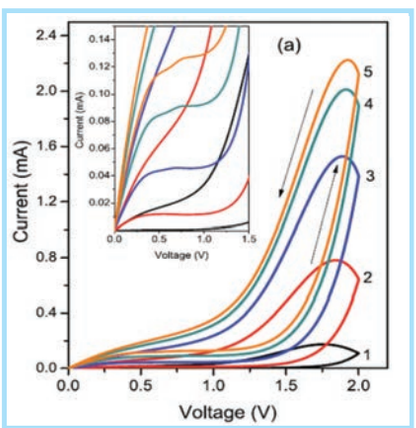
Project PN-II-PT-PCCA

Project Director: Dr. Cristian Kusko (cristian.kusko@imt.ro)

Diffractive optical elements (DOEs) for optical vortices detection were fabricated. These DOEs are dedicated for free space optical communication (FSOC) systems based on optical vortices superposition. An experimental set-up designed to superpose two independent optical vortices in the same beam for a FSOC was realized.



a) SEM image of the DOE which detects optical vortices with topological charge m=4. b) Optical image of a beam containing two superposed optical; vortices generated independently.



Current-voltage characteristics of the nanocomposite P3HT-GQD

Carbon quantum dots: exploring a new concept for next generation optoelectronic devices; (proiect PNII-ID-PCCE). Project Leader Dr. Monica Veca, IMT-OPTO Team coordinator Dr. Cristian Kusko

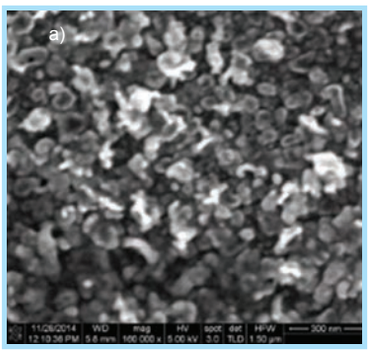
Electrical properties of the nanocomposite type p semiconducting polymer with graphene quantum dots (GQD) were investigated. The memristive behavior of structures consisting in interdigitated electrodes with the nanocomposit deposited on top was put in evidence. *(Applied Physics Letters 105, 083303 (2014).*

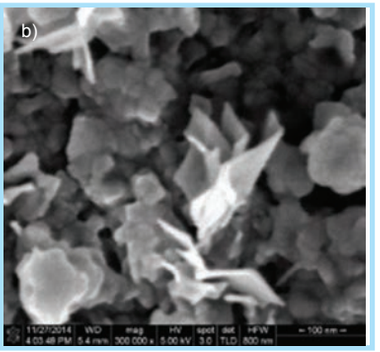
Results

1D and 2D ZnO based nanostructures and innovative technological processes for direct integration in gas sensing devices and UV radiation detection/NANOZON

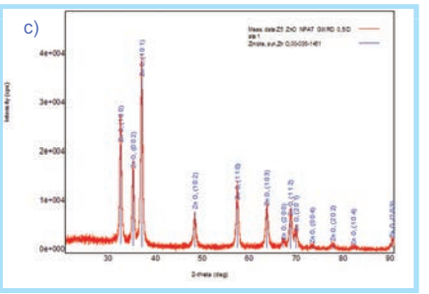
Project: PN-II-PT-PCCA , N0. 27/2014 (Dr. Munizer Purica , munizer.purica @imt.ro)

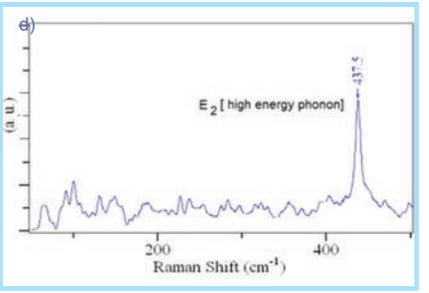
• Nanostructured ZnO layer prepared by thermal oxidation of metallic Zn on glass substrate at low temperature < 350 ^{0}C - IMTBucharest





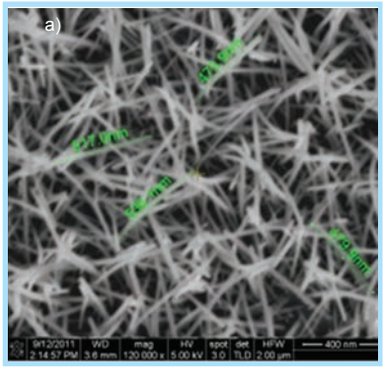
SEM images ilustrating the complex morphologymorphology of ZnO layer

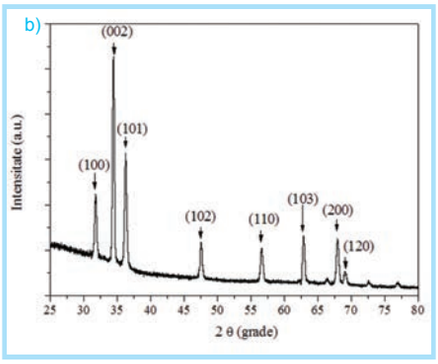




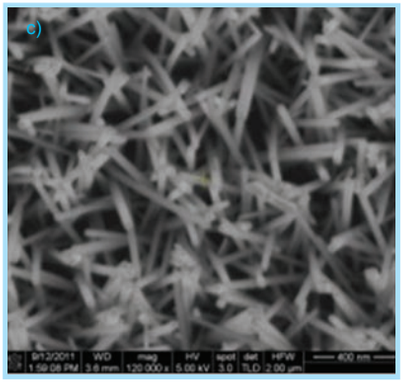
XRD pattern and Raman spectrum of ZnO layer. Sharp and narow diffraction peaks and Raman line indicate that the nanostructured layer have very good crystallinity.

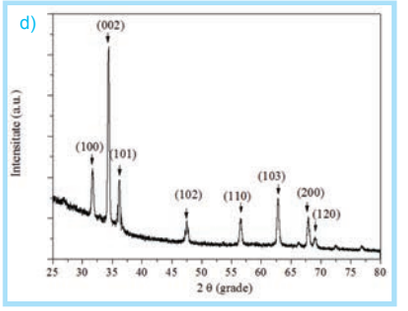
• 1D ZnO nanostructures on glass substrate grown by hydrothermally method with aspect ratio controlled by solution composition of zinc nitrate hydrate ($Zn(NO_3)_2 \cdot 6H_2O$, 98%) and hexamethylenetetramine ($C_6H_{12}N_4$, ≥99%), 1:1) at 90 ^{o}C - partner University " Dunarea de Jos" Galati





SEM micrograph and XRD spectra of 1D nanostructures grown in solution with different concentration of zinc nitrate hexahydrate: a) 0.01 M; b) 0.025 M. The XRD patterns of obtained ZnO nanowires confirm wurtzite crystalline structure with (002) peak most intense, indicating preferential orientation with their c-axis perpendicular to the substrate

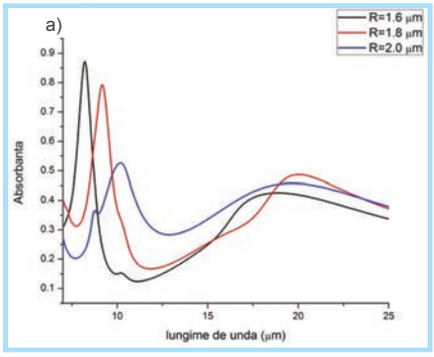


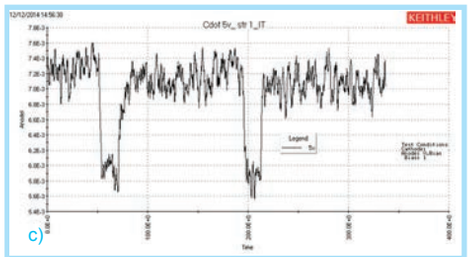


Bolometers for space applications in middle and long infrared

(STAR Project, Dr. Mihai Kusko, mihai.kusko@imt.ro)

Finite difference time domain FDTD simulations of metamaterials which present high absorption in mid and far infrared were performed. Bolometric devices based on high temperature transition in superconducting state have been fabricated and tested.



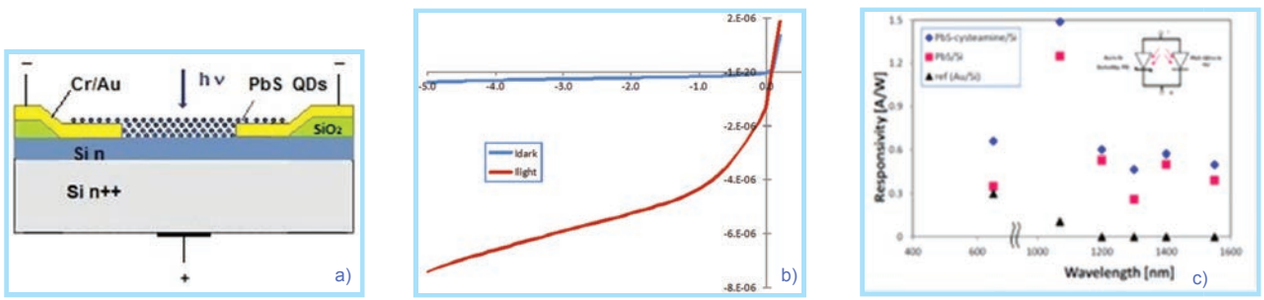


a) Absorption of metamaterial structures in infrared region. b) Bolometer sensor based on patterned YBCO thin layers c) Variation of polarization current intensity with the level of the infrared irradiation.

Results

IR photodetectors for aerospace applications (STAR) projects - Dr. Dana Cristea, dana.cristea@imt.ro)

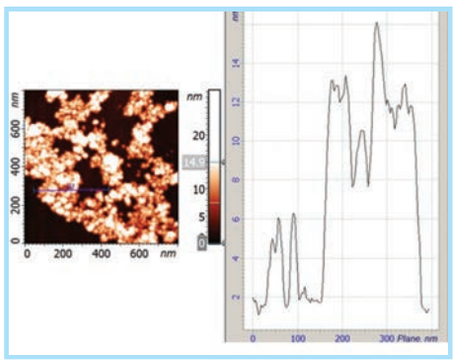
A hybrid PbS/Si photodetector with higher responsivities over a broader spectral range-from UV to SWIR. have been proposed The device consists of a Au/n-Si Schottky diode with digitated electrode in parallel with a p-PbS/n-Si heterojunction.



Hybrid PbS QDs/n-Si photodetectori n MSM- like configuration: a) schematic diagram; b) cI-V characteristics in dark and under illumination; c) equivalent circuit and s pectral responsivities in UV and IR

ZnO nanoparticles for nanoelectronics - Dr. Paula Obreja, paula.obreja@imt.ro

The synthesized zinc oxide quantum dots (ZnO QDs),with a size is in the range 3-6 nm, were spin coated on substrates with pre-patterned Cr-Au interdigitated electrodes. Current-voltage characteristic of such two terminal devices showed bipolar hysteretic response and two distinctive regions of negative differential resistance which highlight the potential of ZnO QDs for applications in resitive-switching memory devices.



AFM images of ZnO QDs

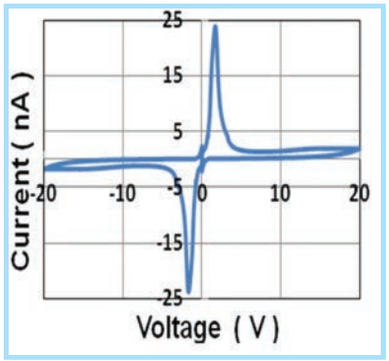
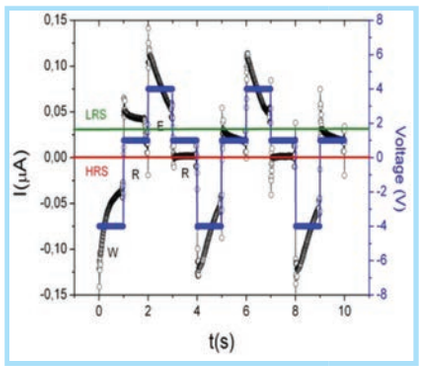


Fig.5 I - V characteristics of ZnO QDs spin coated on pre-patterned Cr/Au electrodes



Memory tests performed on the ZnO QDs deposited on the interdigital structure

Training activities:

Master courses

- Optoelectronics/Integrated optics and Microsystems in cooperation with Politehinca Univ. Bucharest
- Supervising undergraduate, master and PhD students

Scientific sevices ISO 9001, 2008 certified:

- Raman Spectroscopy, Near field optical microscopy: transmission, reflection, collection, fluorescence, Spectral elipsometry for national and international research and industrial units (e.g. . Honeywell Romania, Institute of Solid State Physics Bulgaria, Institut für Mikroelektronik Stuttgart, Germany).

Laboratory of micromachined structures, microwave circuits and devices

Activity

• Development of microwave and millimeter wave circuits based on semiconductor (Si, GaAs, GaN) micromachining and nanoprocessing
• Acoustic devices (FBARs and SAWs) based on micromachining and nanoprocessing of wide band gap semiconductors (AlN, GaN)
• Temperature and humidity sensors based on 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. Valentin Buiculescu, senior researcher II
Dr. Dan Vasilache, senior researcher III
Dr. Alina Cismaru, senior researcher III
Dr. Alexandra Stefanescu, senior researcher III
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
Fiz. Ioana Petrini, senior researcher III

Equipment: "On wafer" measurement system in the 0.1-110 GHz range (microwave network analyzer Anritsu with Karl SUSS Microtec Probe Station), Frequency Syntesizer Agilent up to 110 GHz; Spectrum Analyzer Anritsu up to 110 GHz; Tektronix digital serial analyzer DSA8200 with TDR module; Keithley Semiconductor characterization system, Optical profiler WLI - Photomap 3D; Millimeter wave power-meter in 0.1 - 40 GHz range, Measurement accessories, Computers and software for microwave electro-magnetic simulations (IE3D, Fidelity, CST and AWR software); cryostat Janis Research SHI-4H-1 (5 - 500K temperature 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
- **MOLDONANONET**, 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, Republic of Moldova, 2011 - 2014
ESA: Contract No. 4000110819/CBi "*0-level encapsulation of reliable MEMS switch structures for RF applications"*, Coord IMT, 2014 - 2016
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 – 2016): *"Nanoelectronic devices based on graphene for high frequency applications"* (coordinator Dr M. Dragoman), *"Novel technologies based on micromachining and nano-processing of GaN/Si, for advanced microwave and photonic devices"* (coordinator Dr. A. Muller) and *„Millimeter-wave Front-End for Imaging in Security and Medical Applications"* (coordinator Dr. D. Neculoiu), 1 project in Partnership (PN II) programme: *"Temperature sensor based on GHz operating AlN/Si SAW structures* " (2014-2016, coordinator Dr. A. Muller), 2 projects as partner in Partnership (PN II) programme (2012 – 2016) and 1 project coordinated by Romanian Space Agency (ROSA) STAR project *"Millimetre and submillimetre wave GaAs Schottky diodes detectors and mixers"* (2013 – 2016), coordinator Dr. A. Muller).

Referents and members in committees:

Laboratory members are referents at: Journal of Micromechanics and Microengineering, IEEE Trans on ED (A Muller); Applied Physics Letters, Journal of Applied Physics, IEEE Trans on MTT, IEEE EDL, Optics Letters, Electronics Lett., IEEE Nanotechnology (M Dragoman); Micro & Nano Letters, Electronics Lett., (A Cismaru); IEEE Trans on ED (A. Stefanescu) and IEEE EDL, IET Microwaves, Antennas & Propagation (A Bunea), IEEE Trans on MTT, ROMJIST, Int. Journal of Antennas and Propagation (D Neculoiu).

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, 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).
A. Muller is reviewer for the FP7 project *„Lifting Up the Research Potential of the Galician Telecomms Center - LIFTGATE"*.

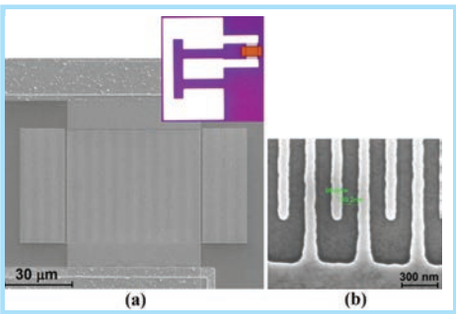
Laboratory head: Dr. Alexandru Müller, (alexandru.muller@imt.ro)

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 nanomachining: manufacturing of RF MEMS components and circuits, technological process for GaAs MMICs manufacturing of microwave passive membrane supported circuits (1997-European priority), micromachined inductors, filters and antennae, monolithically and hybrid integrated receiver front end modules, acoustic devices (FBARs and SAWs) based on micromachining and nanoprocessing of WBG semiconductors (AlN, GaN).
Dr. Müller 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".
Dr. Müller 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, 4 EU projects (FP4, FP6, FP7), 2 ENIAC-JU 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 – *the European Project* ***SMARTPOWER –*** FP7-ICT-2011-7, No 288801 ***- "Smart integration of high power electronics for industrial and RF application"***

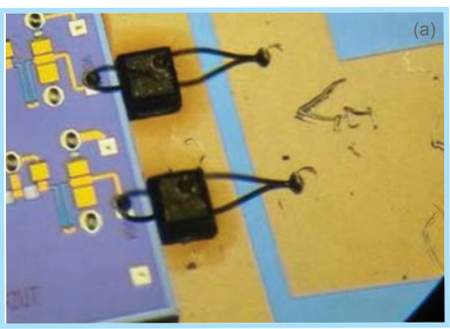


Four different single SAW resonator test structures having IDTs with finger and interdigit spacing of 200 nm, 170 nm, 150 nm and 120 nm width have been manufactured temperature sensors. The IDTs have 150 digit and interdigit spacing, 100 µm long. Reflectors having 50 fingers and 50 interdigit spacing have been placed, on each side of the IDTs at 0.95 µm distance from the IDT.

(a) SAW single resonator structure with 150 digits/interdigit spacing and 170 nm figer/interdigit spacing width; the inset presents the entire structure including the connection/measuring pads; (b) Detail of the nanolihographic process for the structure with 120 nm finger/interdigit spacing width. [A. Muller, International Microwave Symposium -IMS 2014, 1-6 June, Tampa, USA pp 46-48]

Hybrid integration of millimeter wave circuits *– 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***

Different hybrid integration techniques of GaAs active components (diodes, low noise amplifiers) with passive millimeter wave circuits were investigated. Two techniques were optimized: the hybrid integration with gold bond wires of 17 and 25 microns in diameter and the hybrid integration with conductive silver epoxy. These techniques were used to integrate GaAs components with an on-chip antenna for a millimeter wave passive imaging front end. The experimental results validated the quality of the interconnection techniques.



(a) detail of the hybrid integration of a GaAs MMIC with chip capacitors on a silicon structure; (b) detail of the hybrid integration of a GaAs diode.

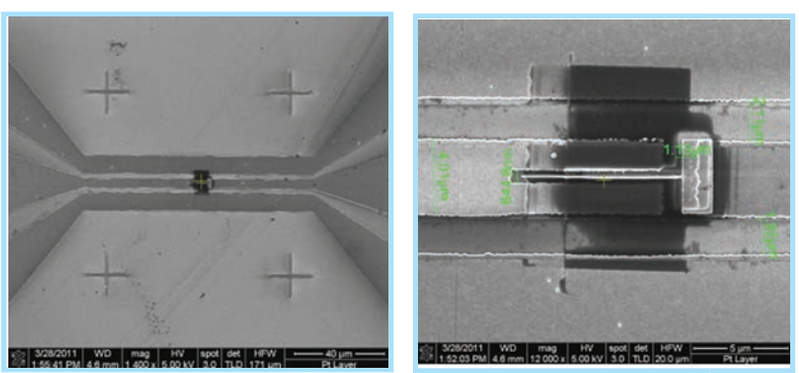
Devices on graphene for microwave, millimeter wave and submillimeter wave domain, European project ***NANO RF –*** *STREP - FP7-ICT-2011-8, No 318352* ***"Carbon based smart systems for wireless applications",***

Graphene antenna was fabricated on high resistivity Si substrate instead of low resistivity Si substrate because the last one do not allows operation in microwave antenna due to large losses . The Graphene based antenna radiates , and this was tested by placing a probe tip VNA measurement system above the antenna at different points and track the maximum and minimum transmission between them.

Graphene based antenna working on 10 GHz

National Project PN2 – IDEI PN-II-ID-PCE-2011-3-0071 ***– "Nanoelectronic devices based on graphene for high frequency applications"*** 2011-2014

Schottky diode based on Graphene was fabricated using three metals Ti , Cr , Au covering all contact structure which was deposited in separate steps for each metal. Diode is a natural phase shifter and tunable with supply voltage signals from 40-65 GHz spectrum. The phase shifter has 450 phase shift for an applied voltage of 4 V to 65 GHz .

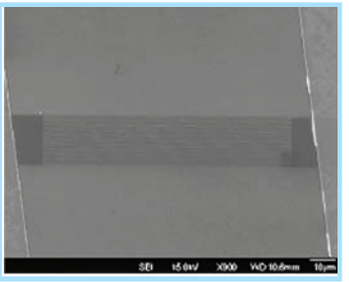


(a) Schottky diode configuration with coplanar guides (b) detail of the diode

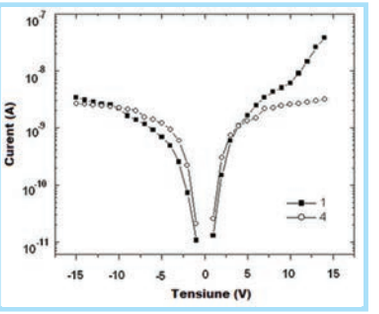
Most important scientific results

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 semitransparent Ni/Au (5nm /10 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.



SEM image of the GaN membrane suspended structure having digits/interdigits with 0.5 μm width

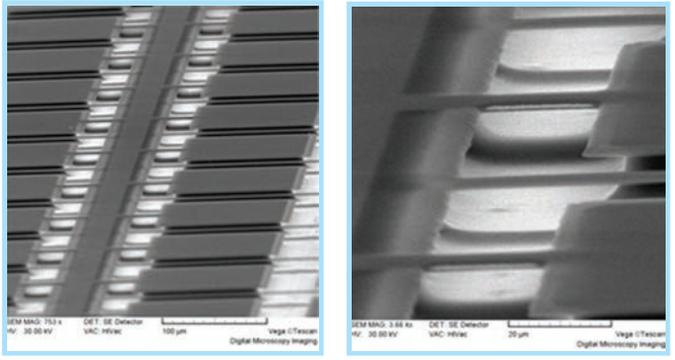


Dark current vs applied voltage for two structures

Silicon micromachining technologies for millimeter wave circuit fabrication in the IDEAS project PN-II-ID-PCE-2011-3-0830 ***"mm-wave front-end for imaging in security and medical applications"***

(a) analytical modeling for 1, 2 and 3 cells; (b) fabricated membrane supported filter structure; (c) experimental results for a 2-cell filter

Analytical design methodologies and electromagnetic models were developed for non-resonant coupled lines band pass filters, processed on thin dielectric membranes. The filter frequency selectivity can be controlled by the number of elementary cells. Filter structures were designed and fabricated for the W band (75 – 110 GHz). The filters were processed on ~2 microns thin dielectric membranes, released by the deep reactive ion etching of a high-resistivity silicon wafer. The experimental results validated the electromagnetic modelling and showed low losses of about 3 dB, much lower than rectangular waveguide based band pass filters.



Nonvolatile RAM structures

Fabrication of non-volatile RAM structures based on Ge nanocrystals in the Partnership project PN-II-PT-PCCA-2011-3, no. 9/2012

RAM nonvolatile (NV) memories were fabricated using MOS technology based on a structure of type (SiO2 / Ge - SiO2 / SiO2). Non-volatile memory based on Ge nanocrystals operate at a lower voltage with higher speed of write / erase information , compared to a conventional memory NV.

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 2014 at its 13th 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

Mission: L1 mission, as may be briefly defined, is to propose and approach research directions, and also, to sustain trainning in the field of nano-bio-technologies.

Research areas: The main activity areas are:
(i) fabrication of the nanomaterials/ functional nanostructures, studying, controlling and also, developing specific methods for the chemical surface modification for specific applications;
(ii) supporting development of some industrial safety nanoproducts for health and enviromental protection by assessing the toxicity and risks associated with nanomaterials;
(iii) design and fabrication of some devices based on silicon, silicon carbide, polymers and also, of some hybrid systems for applications in different fields, from (bio)medicine (optoelectronics biosensors) to energy (miniaturized fuel cells as clean energy sources).

Team

1. **Mihaela Kusko,** Physicist, Dr., Senior Researcher 1, head of the laboratory L1;
2. **Monica Simion**, Physicist, Dr., Senior Researcher 2;
3. **Adina Boldeiu (Bragaru)**, Chemist, Dr., Senior Researcher 2;
4. **Florea Craciunoiu,** Physicist, Senior Researcher 2;
5. **Razvan Pascu**, Engineer, Drd, Researcher;
6. **Melania Banu**, Biolog, Ms., Junior Researcher;
7. **Iuliana Mihalache,** Physicist, Drd, Researcher;
8. **Mihai Danila**, Physicist, Senior Researcher 3;
9. **Cosmin Romanitan**, Physicist, Ms, Junior Researcher
10. **Teodora Ignat,** Chemist, Dr., Senior Researcher 3.

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

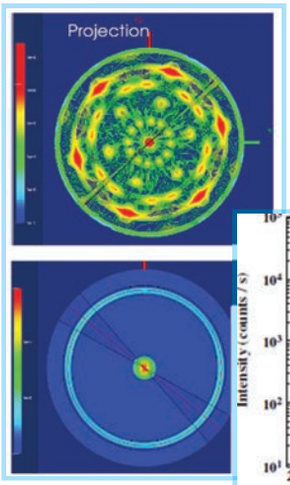
Dr. Mihaela Kusko obtained the B.Sc. degree (1998) in Solid State Physics and the PhD degree (2006) in physics, both from University of Bucharest. Since 1998 she joined IMT-Bucharest, where her main research activities are in the field of nanobiotechnologies, from study of nanomaterials and nanostructures 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.

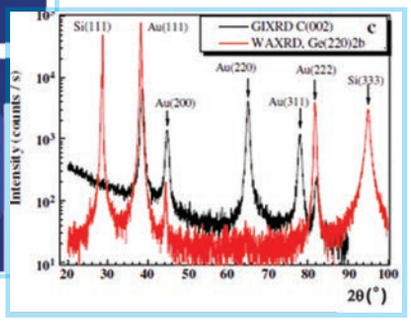
Laboratory of Nanobiotechnologies

Equipments and related scientific results

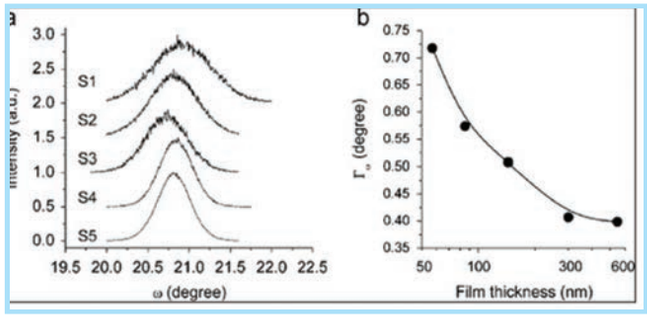
Ultra high resolution triple axis multiple reflection - SmartLab X-ray Thin film Difraction System (Rigaku Corporation, Japan), which is a leading technology in the frame of XRD complete modular systems.

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



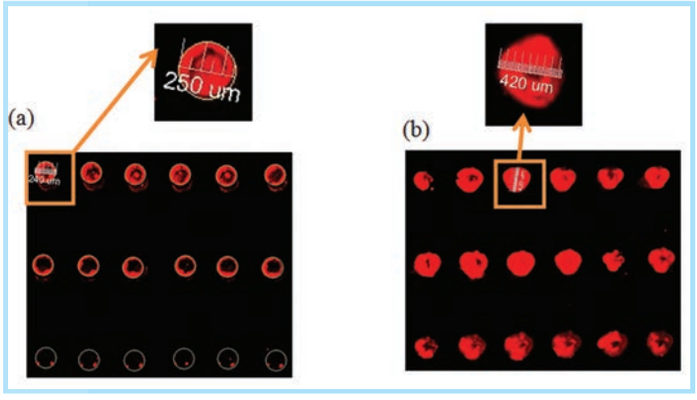


Epitaxial-like growth mechanism of the metallic gold nano-islands, clearly showed by X-ray diffraction studies; ***Thin Solid Films***, 550, 354–360, 2014



TiC thin films epitaxially grown up to a thickness of 545 nm on MgO (001) by DC reactive magnetron sputtering
Journal of Crystal Growth 389 92–98, 2014

Microarray spot plotting and scanning using: Micro-Nano Plotter – OmniGrid - and Microarray Scanner - GeneTAC UC4 (Genomic Solutions Ltd., UK) - dedicated to the microarray technology.



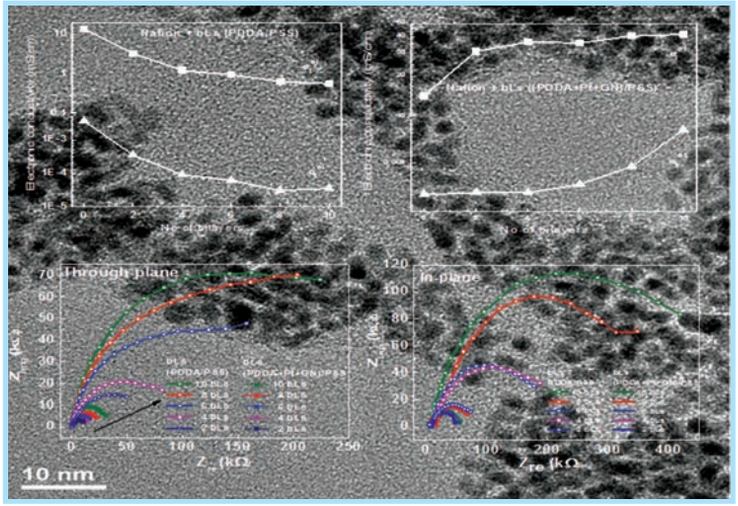
The type of colorectal cancer can be diagnosed by analysing the uninucleotidic mutations present in KRAS gene (Kirsten rat sarcoma). KRAS gene, by its translation product, plays a key-role in cell division regulation. It has been checked the enhancement of the hybridization signal intensity in microarray technology through a 3D silicon based nanowires support.

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

KRAS hybridization results on:
a) commercial glass substrate and
b) on nanostructured silicon substrate

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

Scanning Electrochemical Microscope - ElProScan (HEKA, Germany)



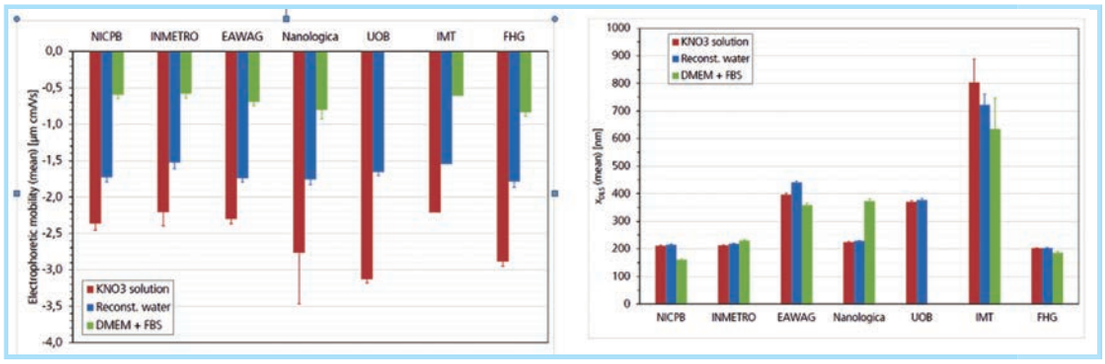
Graphene was functionally modified with PDDA and then, decorated with small and uniform PtNPs of 3.4 ± 0.4 nm. After that, nanocomposite ((PDDA + Pt + GN)/PSS)n-Nafion membranes were prepared by LbL self-assembly technique and analyzed by comparison with thecorresponding reference ((PDDA)/PSS)n-Nafion membranes using the impedance spectroscopy meas-urements, being revealed an improved electrical conduction without a major alteration of the protonic one.

Through-plane and in-plane ***Nyquist plots and protonic / electronic conductivities***, respectively, of the membrane after differentnumber of polyelectrolyte bilayers with and without graphene and Pt nanoparticles.

Colloids and Surfaces A: Physicochem. Eng. Aspects 461 (2014) 133–141

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

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

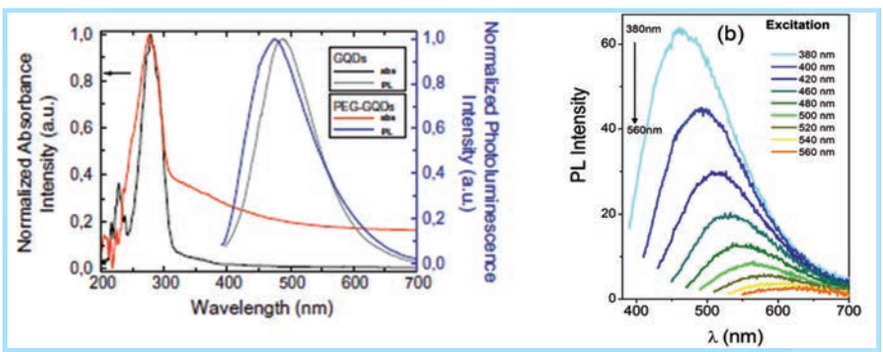


"NanoValid" FP7 Project - for quality assurance, a round-robin test regarding SiO2NPs was conducted to assess the comparability of different DLS instruments and a dispersion protocol in 7 independent laboratories, involved in this project.

Contact person: Phd. Adina Boldeiu, Phd. Teodora Ignat, adina.bragaru@imt.ro, teodora.ignat@imt.ro

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

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



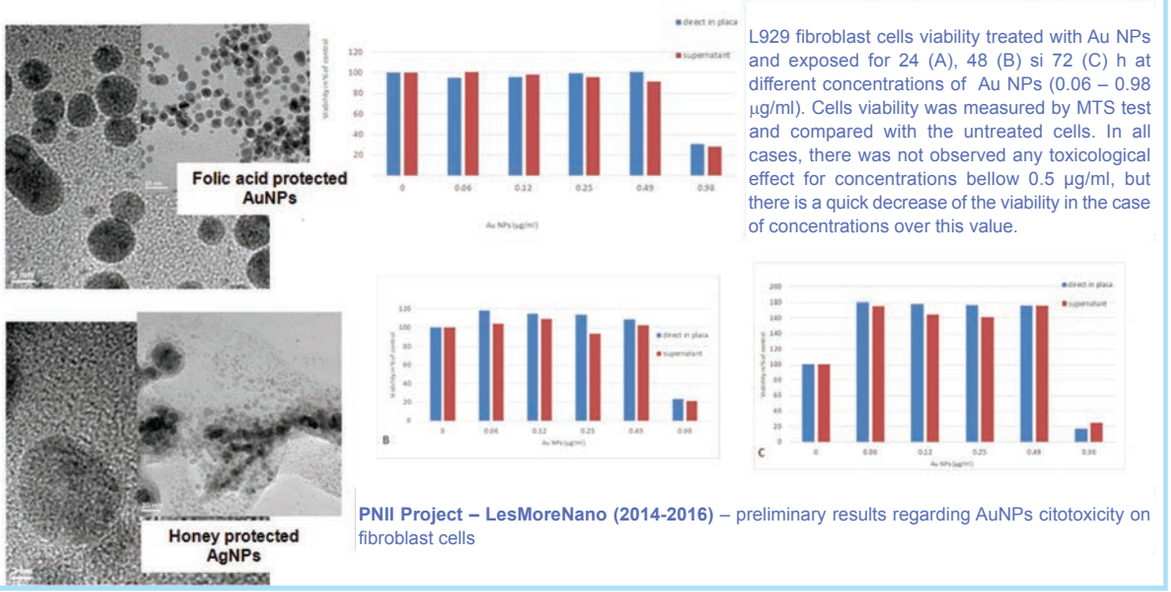
Optical characterization of GQDs – PEG600 composite - UV–Vis absorbance; photoluminescence, life time,

Organic Electronics 15 (2014) 216–225
A large charge storage and memory effect based on GQDs – PEG600 composite are demonstrated.

Applied Physics Letters 105 (2014) 083303
Graphene quantum dots (GQD) embedded in a semiconducting poly(3-hexylthiophene) polymeric matrix act as charge trapping nanomaterials.

Main Results of the laboratory projects

Evaluation of the nanoparticles toxicity



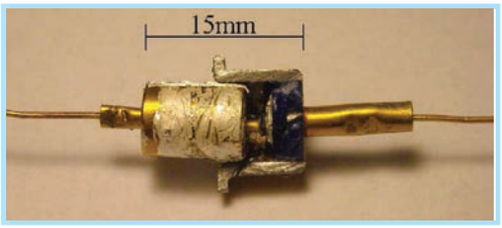
L929 fibroblast cells viability treated with Au NPs and exposed for 24 (A), 48 (B) si 72 (C) h at different concentrations of Au NPs (0.06 – 0.98 µg/ml). Cells viability was measured by MTS test and compared with the untreated cells. In all cases, there was not observed any toxicological effect for concentrations bellow 0.5 µg/ml, but there is a quick decrease of the viability in the case of concentrations over this value.

PNII Project – LesMoreNano (2014-2016) – preliminary results regarding AuNPs citotoxicity on fibroblast cells

Main Results of the laboratory projects

Devices based on silicon carbide (SiC)

SiC based temperature sensors for high temperatures > SiC based Schottky diodes



Testing structure - SiC based Schottky diode

SiC based Schottky diodes previously developed were used to obtain a temperature measurement system for ciment oven from CEPROCIM, parallel to the classical one currently used. The measured temperature domain is around 400°C.

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

SiC based gas sensors for use in toxic environments and high temperatures > MOS capacitors SiC based

MOS structures with different areas

Threre were optimized physical-chemical processes to treate the deposited oxide in order to reduce the interface charges who affects the SiC-MOS structures functionality.

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

National and international collaboration:

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/*
- **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.
- **COST** *(European Cooperation in the field of Scientific and Technical Research) Project - "Raman-based applications for clinical diagnostics (Raman4clinics)"* (2014-2018) - IMT resp. Dr. Mihaela Kusko
- **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/.
- **MNT ERA-NET** *project – "Nanostructural carbonaceous films for cold emitters – NANOCAFE"* (2009-2011)– IMT resp. F. Craciunoiu
- **MNT ERA-NET** *project – "A 'system-in-a-microfluidic package' approach for focused diagnostic DNA microchips – DNASiP"* (2008-2010) – IMT resp. M. Simion

National projects:

- **PNII- PCCA** project *"Improved production methods to minimize metallic nanoparticles' toxicity – less classic, more green – LesMoreNano"* – coordinator IMT, project director Dr. Monica Simion/ Dr. Adina Boldeiu (2014-2016) http://www.imt.ro/lesmorenano/
- **PNII- PCCA** project *"Multiplexed platform for HPV genotyping – MultiplexGen"* – coordinator IMT, project director Dr. Mihaela Kusko (2014-2016) http://www.imt.ro/multiplexgen/index.php
- **PNII- PCCA** project *"Identification of new modulators of calcium-regulated processes using genomic and chemogenomic screens in yeast – CalChemGen"* – resp IMT Dr. Monica Simion (2014-2016)
- **PNII- PCCA** project *"Dispozitiv RFID pentru trasabillitatea alimentară - Food Track"* – resp IMT Dr. Mihaela Kusko (2014-2016)
- **PNII- PCCA** proiect *"Structuri de tip array pentru preventia, diagnosticul si tratamentul individualizat al unor forme de cancer cu incidenta si mortalitate majore"* – resp. IMT A. Boldeiu (2012-2016) http://www.iob.ro/hrcarraysen.html
- **PNII- PCCA** proiect *"Senzor inteligent de temperaturi ridicate cu diode pe carbura de siliciu (SiC) pentru aplicatii industriale in medii ostile"* – resp. IMT F. Craciunoiu (2012-2016) http://www.arh.pub.ro/projects/sicset/
- **PNII- PCCA** proiect *"Detector de gaze inflamabile si toxice bazat pe matrice de senzori MOS pe carbura de siliciu"* – resp. IMT Florea Craciunoiu (2012-2016) http://www.icpe-ca.ro/en/partnershipsinprioritysareas

Nano-Scale Structuring and Characterization Laboratory

Mission

The main mission of the lab is to support the research and educational efforts of IMT Bucharest by providing the facilities, tools and expertise in the field of characterization and testing at micro and nano scale and delivering innovative solutions and services for direct nanoscale patterning through electron beam lithography (EBL) – based techniques. The staff of the laboratory collaborates with other teams in IMT Bucharest in planning and developing experiments and implementing solutions for nanoscale fabrication and characterization of materials, processes and structures.

Activity areas

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 SAW structures for microwave applications, micro-nanostructures with applications in photonics, MSM-UV photodetectors, etc.

• Fabrication of graphene devices using EBL-based techniques

Team: L6 multidisciplinary team is composed of three senior researchers, three Ph.D students - one young researcher and two early stage researchers - and one economic specialist.

• Dr. Adrian Dinescu, physicist, Senior Researcher I, Head of the laboratory

• Raluca Gavrila, physicist, Senior Researcher III

• Dr. Octavian Ligor, physicist, Senior Researcher III

• Marian Popescu, electronics engineer, Young Researcher, Ph.D student

• Bogdan Ionut Bita, physicist, Ph.D. student, Research Assistant,

• Stefan Iulian Enache, electronics engineer, Ph.D. student, Research Assistant

• Mihaela Marinescu, economist, financial operations specialist

Main equipment

• Electron beam lithography and nanoengineering workstation Raith e_Line (Raith GmbH). Versatile nanolithography system for direct patterning of electron resists with 20 nm achievable resolution and electron beam-assisted deposition and etching, with modules for nanomanipulation, EBID and EBIE.

• Dip Pen Nanolithography System NScriptor (NanoInk, Inc.). 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)

• Scanning Electron Microscope TESCAN VEGA II LMU (Tescan s.r.o). General Purpose SEM with thermionic electron gun, equipped with Energy Dispersive X Ray Spectrometer (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.).

• Nano Indenter G200 (Agilent Technologies). 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.*

National and International Collaborations

• **National cooperation:** Cooperation with Romanian companies (Infineon Romania, Honeywell Romania, S.C."IOR-S.A.", Zoomsoft SRL, Storex Technologies Inc.), departments and research centers from Romanian universities (University of Bucharest: R&D Center for Materials and Electronic and Optoelectronic Devices (MDEO); Research Center for Polymeric and Mesophases Materials and Nonconventional Methods in Environmental Protection. Politehnica University of Bucharest: Mechatronics and Precision Mechanics Department - Faculty of Mechanical Engineering and Mechatronics; General Chemistry Department and Bioresources and Polymer Science Department - Faculty of Applied Chemistry and Materials Science. Technical University of Cluj-Napoca - Materials Science and Engineering Department. University Dunarea de Jos of Galati: Department of Physics chemistry and Environment - Faculty of Sciences. Petroleum – Gas University Of Ploieşti: Chemistry Department) and institutes (Multifunctional Materials and Structures Laboratory- INCDFM. Plasma Physics and Nuclear Fusion Laboratory and Low Temperature Plasma Laboratory – INFLPR)

• **International cooperation:** Colaboration with universities and companies from Italy (Istituto Nazionale di Fisica Nucleare - Laboratori Nazionali di Frascati - INFN-LNF) and Bulgaria (University of Ruse "Angel Kanchev", Georgi Nadjakov Institute of Solid State Physics- Bulgarian Academy of Sciences si Metalika - MIST OOD, Ruse).

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.

Nano-Scale Structuring and Characterization Laboratory

Projects running in 2014:

National projects : - STAR- Strategy (2012-2015) (Partner)

- Techniques and procedures for nanoscale characterization and structuring, National Program CONVERT, Basic funding- PN0929

International projects: Bilateral Inter-academic Cooperation Romania - Bulgaria) "Nanostructured and amorphous semiconductor films for sensors application" (2013 – 2015), Bulgarian Academy, Institute of Solid State Physics

In 2014 L6 has been included as a Partener in an ERA-NET project proposal ("High photoconductive oxide films functionalized with GeSi nanoparticles for environmental applications")

Teaching activities:

Classes and lab courses for Master programs, in cooperation with Faculty of Electronics, Telecommunications and Information Technology (Politehnica University of Bucharest):

- Microsystems: Master course "Microphysical Characterization of Micro and Nanostructures"
- Optoelectronics: Master course "Electronic technologies for optoelectronic applications"

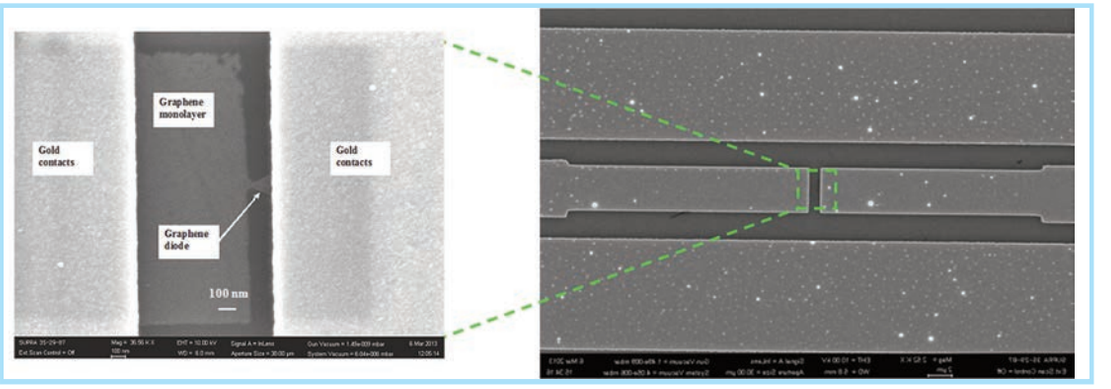
Main results

New technological developments for wafer level fabrication of nanoelectronic ballistic devices on CVD graphene

Ballistic electron transport requires the distance between the two metallic contacts placed on graphene to be less than 300 nm. This constraint establishes electron beam lithography (EBL), which ensures both the resolution and flexibility required for these applications, as a main pillar of the technologies developed for ballistic graphene devices.

Highlights: The design, measurements and characterization of the exemplified fabricated devices have been performed in collaboration with specialized partner teams in IMT Bucharest.

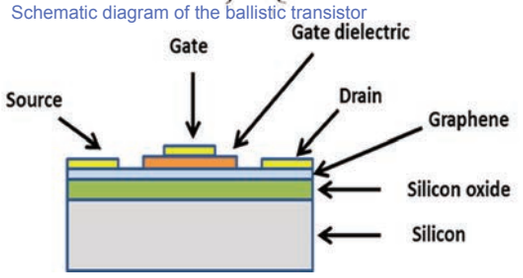
• ***Electron beam lithography-based fabrication of a rectifying device operating in the ballistic regime at room temperature***



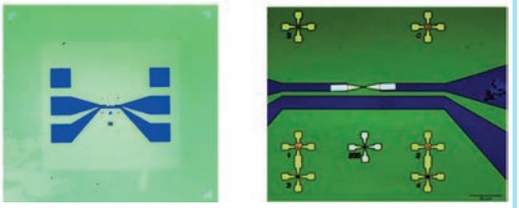
SEM image of a ballistic graphene-based diode for THz frequencies, achieved by e-beam lithography - (Mircea Dragoman, Martino Aldrigo, Adrian Dinescu, Daniela Dragoman, and Alessandra Costanzo, Towards a terahertz direct receiver based on graphene up to 10 THz, Journal Applied Physics 115, 044307 (2014))

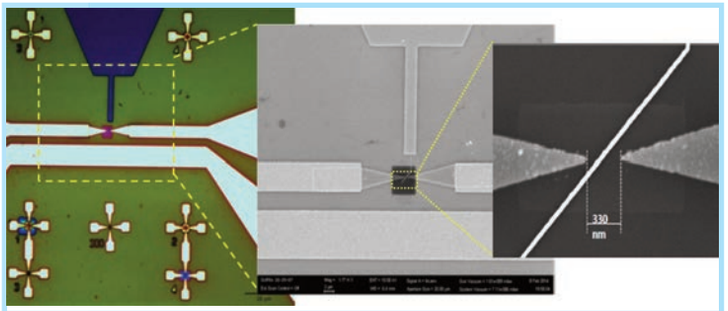
• ***Graphene-based ballistic field-effect transistor with oblique top gate fabricated by e-beam lithography***

Schematic diagram of the ballistic transistor



Optical images taken in intermediate stages of the fabrication process for the transistor





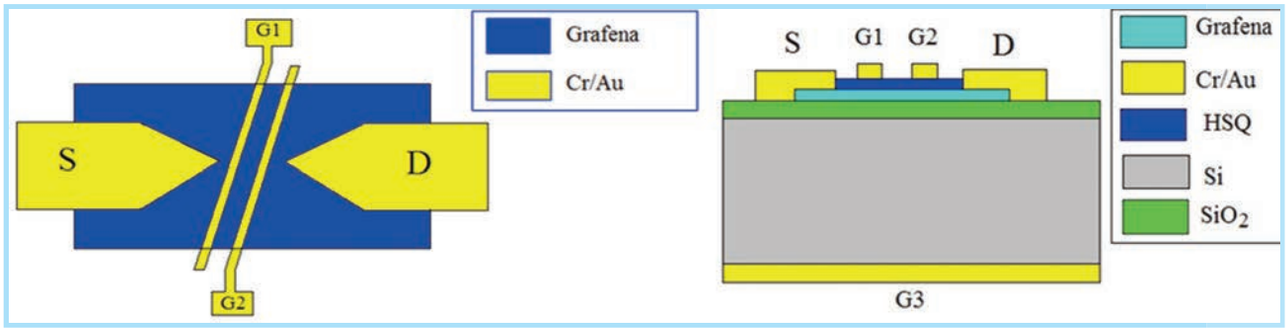
Mircea Dragoman, Adrian Dinescu and Daniela Dragoman, Negative differential resistance in graphene-based ballistic field-effect transistor with oblique top gate, Nanotechnology 25 415201 (2014).

Optical and SEM images of the final device, taken at successive magnifications. The right image shows the 45 nm gate obliquely crossing the 330 nm channel length.

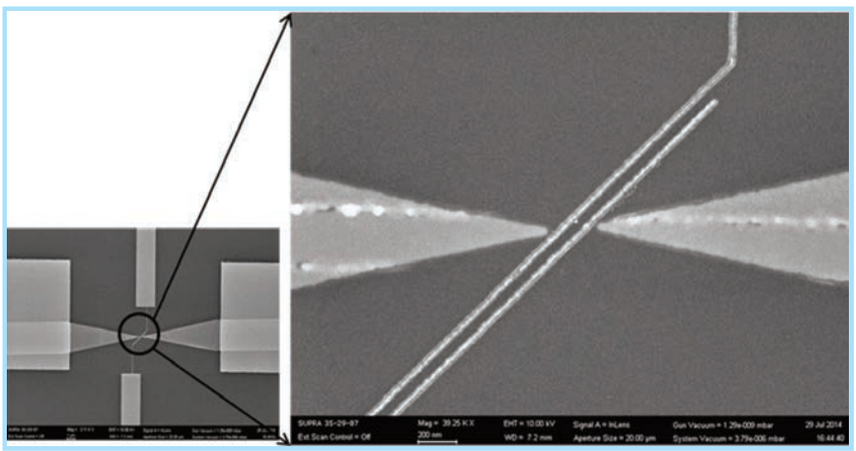
Main results

• Development of novel technology for fabrication of field effect transistors with graphene-based triple gate.

The transistor design includes the posterior gate and two superior oblique gates, sloping at 45 degrees to the graphene channel. This geometry can generate negative differential resistance in the case of the ballistic transport of electrons in graphene.



Design of the graphene channel FET. Left: top view highlighting the two top gates (G1 and G2). Right: cross-section view of the device



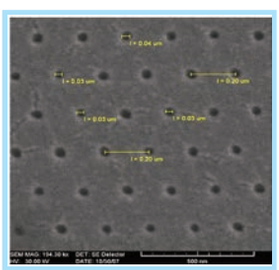
SEM micrograph of the triple gate graphene channel FET (left image). The image highlights the two superior oblique gates slantwise with respect to the graphene channel.

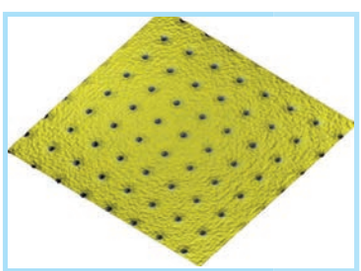
(National Program CONVERT, Basic funding- PN 09290306- 2014)

In 2014 L6 team authored 14 articles in ISI-ranked periodicals (out of which 7 as the first IMT author) and 9 international conference papers as first IMT author, among which one invited paper and 4 papers published in proceedings.

Scientific services

• Nanoscale structuring by Electron Beam Lithography (EBL) techniques.

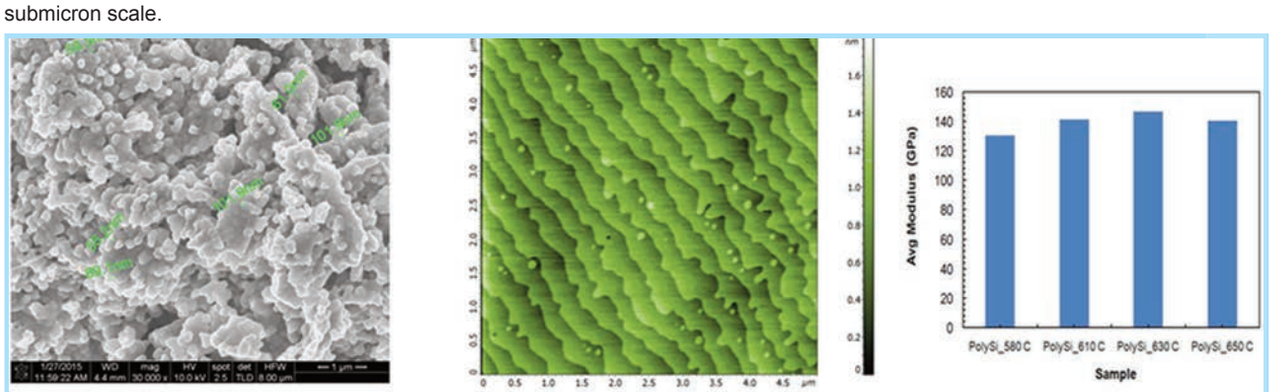




EBL
30 nm diameter holes fabricated using EBL-based techniques in PMMA 950k

• Scientific characterization services for materials and structures using

- Scanning Electron Microscopy (both conventional and field emission)
- Atomic Force Microscopy and related SPM techniques • Instrumented Indentation (Nano indentation) for mechanical characterization at submicron scale.



SEM
ZnO nanocrystalline grains obtained by sol-gel method

AFM
Monoatomic terraces on the surface of a NdGaO3 crystal

Nano-Indentation: Plot of Young's modulus for polysilicon thin films deposited by LPCVD at 580 0C, 610 0C 630 0C and 650 0C

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.

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.

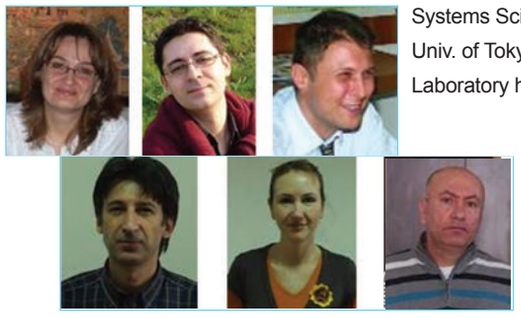
• Analytical-numerical investigation of essential mechanisms responsible for creating new properties and/or for offering solutions for functional optimization of the developed nanomaterials: electronic structure modeling and simulation (DFT, semi-empirical DFT, molecular dynamics, BIE), physical/chemical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

International and National Cooperation:

- Clemson University, USA - prof. Ya-Ping Sun
- University of Bucharest 3Nano-SAE Research Center - prof. Ioan Stamatin
- Natl. Institute for R&D in Biological Sciences, Bucharest, Romania - Dr. Sandra Eremia, Dr. Simona Litescu
- Institute of Physical Chemistry "Ilie Murgulescu", Bucharest, Romania and Forschungszentrum Jülich, Germany - Dr. Viorel Chihaia
- "Eberhard Karls" University, Tübingen, Germany - prof. Dieter Kleiner, prof. Dieter Koelle
- Karlsruhe Institute of Technology, Karlsruhe, Germany - Dr. Di Wang
- " Babes-Bolyai" University, Cluj, Romania - prof. Simion Astilean, prof. Anamaria Elena Terec
- Natl. Institute for R&D in Lasers, Plasma and Radiation Physics, Bucharest, Romania - Dr. Maria Dinescu
- University of Bucharest - prof. Adelina Ianculescu
- Loughborough University, UK - Dr. Boris Chesca
- Université Catholique de Louvain, Belgium - prof. Sorin Melinte
- Regensburg University, Germany - prof. Thomas Niehaus
- Le Havre University, France - prof. Jean-Louis Izbicki

Team:

- Dr. Lucia Monica Veca - CS I, PhD in Chemistry, Clemson Univ, USA, 2009
- Dr. Antonio Marian Radoi - CS II, PhD in Chemistry, Tor Vergata Univ., Italy, 2007.
- Dr. Titus Sandu - CS I, PhD in Physics, Texas A&M Univ., USA, 2002.
- Dr. Victor Leca - CS II, PhD in Materials Science, Twente Univ., The Netherlands, 2003.
- Dr. Cristina Pachiu - CS III, PhD in Physics, Univ. Le Havre, France, 2007.
- Dr. Radu Cristian Popa - IDT I, PhD in Quantum Engineering and Systems Science, Univ. of Tokyo, 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.

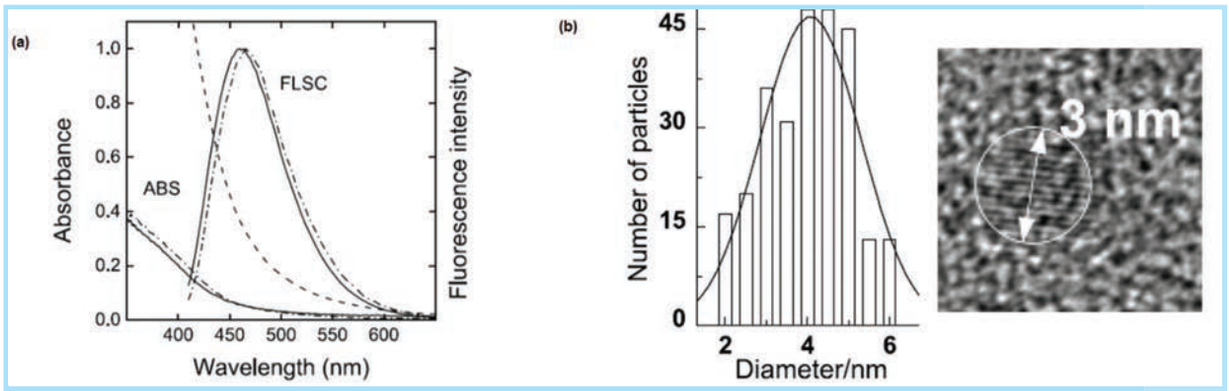
Radu Popa joined IMT Bucharest in 2007 and is presently director of the Center for Integrated Systems Nanotechnologies and Carbon Based Nanomaterials. Main scientific interests include atomistic analysis of electronic transport in molecular junctions in the framework of the rational design paradigm for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

Molecular nanotechnology laboratory

Results

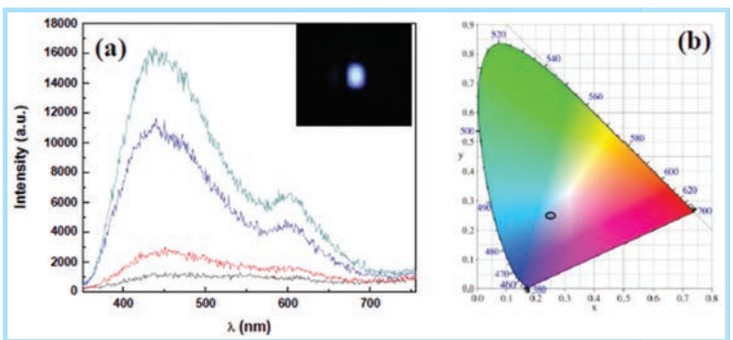
National Complex Ideas Project: PNII- ID-PCCE–2011- 2- 0069 „Carbon quantum dots: exploring a new concept for next generation optoelectronic devices" (2012-2015):

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 -13CQD (- . - . -); (b) Size distribution of EDA-CQD; (c) HR-TEM image illustrating the core diameter of the CQD. [ACS Nano 2014, DOI 10.1021/nn406628s]

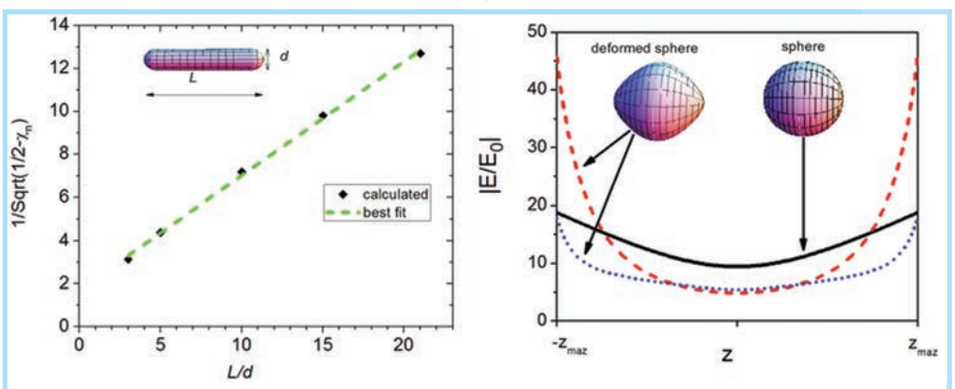
Studies of the electroluminescent properties of PEG1500N-CQD (poly(ethylene glycol) diamine passivated carbon "quantum" dots) - Monica Veca (monica.veca@imt.ro)



(a) Electroluminescence spectra of PEG1500N-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.

Localized plasmon resonance response of metallic nanoparticles of various shapes- Titus Sandu (titus.sandu@imt.ro)

The study of localized plasmon resonances in metallic nanoparticles of various shapes has been performed with an in-house method that is based on the boundary integral equation method. The studied shapes were nano-rod antennas in simple and dimer forms as well as various deformations from spherical shape. There have been studied both near- and far-field properties.



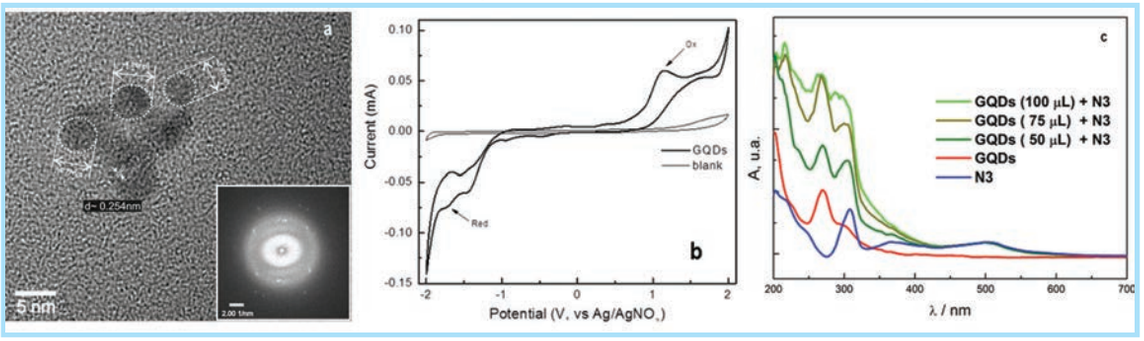
Scaling law of wavelength resonance with respect to the length of the nano-rod antenna. Verification in the quasi-static regime. [T. Sandu, Proc. Rom. Acad Series A . 15(4), pp. 338-345, (2014)].

Variation of the near-field enhancement factor of a metallic nano-sphere with respect to local modification of shape. [T. Sandu, G. Boldeiu, Digest J. Nanomater. & Biostruct. , 9(3), pp. 1255-1262, (2014)].

Results

Graphene quantum dots- Antonio Radoi (antonio.radoi@imt.ro)

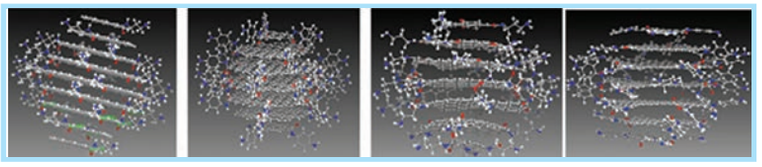
Amino functionalized graphene quantum dots – GQDs – were obtained using a microwave assisted hydrothermal synthesis, glucosamine being the carbon source. The developed GQDs were used to modify Grätzel cells, thus obtaining a type II band alignment for such hybrid solar cells.



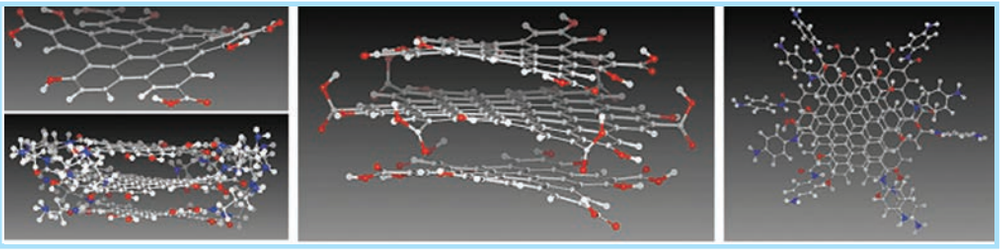
(a) HR-TEM illustrating graphene quantum dots; (b) Cyclic voltammetry (50 mV/s) depicting electrochemical behaviour of GQDs; (c) UV-Vis spectra of GQDs, dye (N3) and GQDs and dye.

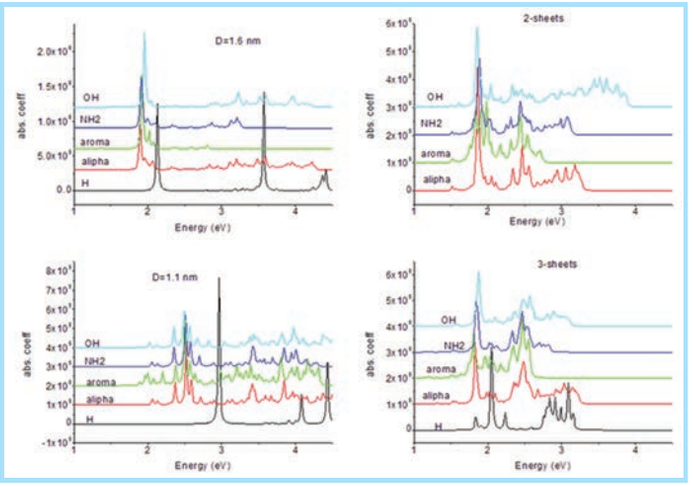
Theoretical studies on the electronic structure and optical properties of functionalized carbon dots - Radu Popa, Titus Sandu (radu.popa@imt.ro, titus.sandu@imt.ro)

Using the DFT-TB semi-empirical formalism (Density Functional based Tight Binding) we performed extensive numerical simulations aiming at disclosing the physico-chemical mechanism underlying the "strong" photoluminescence observed in functionalized crystalline (graphitic) carbon dots. The models considered range between 1.1 - 2.4 nm, are designed with various edge modifications - such as simple H passivation, insertions of various groups: carboxyl, hydroxyl, aliphatic and aromatic diamines (propylenediamine, phenylenediamine) - as well as with a variable number of graphitic layers - 1, 2, 3 layers - thus reaching graphene quantum dot (GQD) models of up to 800 atoms. The results indicate that: the ligands considered so far contribute to the modulation of absorption and emission energies only through their contribution to electronic states at energies lower than HOMO ("deep", i.e., non-Kasha, radiative recombination centers); the relevant excitation transitions occur in the p network; the degree of oxidation/ functionalization plays an important role in the distortion of the graphitic stacking and this may lead to a decrease of the role played by intrinsic transitions. When using aliphatic/aromatic diamines as ligands, the significant PL enhancement discovered so far over the natural carboxyl and hydroxyl groups is at the n-p* transition peak. We will investigate next more realistic GQD models.



Models of functionalized graphitic carbon dots.





Simulated absorption spectra for various GQD models.

Simulation, Modelling and Computer Aided Design Laboratory

Mission

Research, development and applications of simulation, modeling and design techniques of micro-electro-mechanical and microfluidic systems oriented to collaborative research projects, ***education*** (courses, labs), services (enabling access to hardware and software tools) and ***consulting*** (design/optimization) in the field of micro-nano-bio/info technologies.

The lab L5 plays a key role in supporting the research activities of other laboratories of IMT Bucharest. Further, L5 is developing **techniques for rapid prototyping** from micro- to macro scale, micro-sensors and MOEMS and MEMS actuators and investigate new classes of advanced materials with applications in nanodevices (ZnO).

Expertise

• **Design, simulation and development/optimization of MEMS/MOEMS** devices and components (cantilevers, membranes, microgrippers) and **microfluidic** (valves, pumps, microchannels, mixers, filters) for microelectronic and biomedical applications;

• **Modeling and simulation** for **multiphysics problems**; mechanical, thermal, electrical, piezoelectric, **as well as coupled field** (static and transient) **analysis**;

• **Rapid prototyping**: from micro- to nano scale: 3D Printer;

• **Design and manufacturing** of MOEMS and MEMS microsystems/actuators and microsensors;

• **Characterization of physical phenomena** in wide band gap semiconductors;

• **Development of technology** for preparing and doping process for ZnO transparent films and nanostructures, with potential in different device applications, in transparent electronics, photovoltaic cells, functional sensors in UV domain including functioning in harsh environments and space;

• **Atomistic simulations** and analysis by ab initio calculations of the electronic structure of ZnO systems.

Research team:

1. Dr. Eng. Raluca Muller, senior researcher I, PhD in electronics, laboratory head
2. Dr. Phys. Rodica Plugaru, senior researcher I, PhD in physics
3. Dr. Phys. Gabriel Moagar-Poladian, senior researcher II, PhD in physics
4. Dr. Mat. Oana Tatiana Nedelcu, senior researcher III, MS in mathematics and PhD in electronics
5. Dr. Eng. Franti Eduard, senior researcher III, PhD in electronics
6. Dr. Mat. Rodica-Cristina Voicu, senior researcher III, PhD in mathematics
7. Dr. Mat. Irina Stanciu, senior researcher III, PhD in electronics
8. Dr. Eng. Anca ISTRATE, researcher, PhD in materials engineering
9. Dr. Eng. Lucian Petrica, PhD in electronics
10. PhD student Eng. Angela Baracu, junior researcher, PhD student in electronics
11. Phys. Constantin Tibeica, senior researcher, physicist
12. Phys. Victor Moagar-Poladian, technological development Eng. III, physicist
13. Eng. George Boldeiu, physicist
14. Ramona Corman, master in electronics

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 100 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

Equipments

■ **Hardware:**

• 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;

■ **Classroom equipped with computer network for training;**

■ **Software for Modelling and simulation:**

COVENTORWARE 2013 – software package dedicated to design, modelling and simulation for MEMS and microfluidics. It contains modules for design (2D layout, 3D models generator) and simulation modules for main physical phenomena in microsystems functionalities.

SEMulator3D – generating complex 3D models for thin films, structures and devices obtained by silicon technology.

COMSOL 4.3 – Software package for simulation of physical phenomena such as: mechanics of solids, heat transfer, fluidics, acoustics, RF-MEMS.

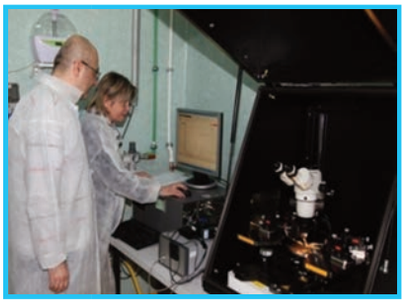
ANSYS Multiphysics 12.1 – software package for FEM simulations taking into account several physical phenomena (mechanical, thermal, electromagnetic, fluidic and coupled). Ways for realizing complex simulations: ***Sequential method*** (thermal-structural, electromagnetic-thermal-structural, electrostatic-fluidic-structural, CFX and FLOTRAN) and, respectively, ***Direct coupling*** (acoustic-structural, piezoresistive, piezoelectric, electromagnetic, electro-thermo-structural-magnetic).

MATLAB 2013 – mathematical software: numerical computation, visualisation and programming. It can be used to algorithm development, data acquisition, data visualization, data analysis, scientific and engineering graphs.

SOLIDWORKS – design software for 2D and 3D complex geometry, capable to export CAD files to other simulation software tools; it has additional modules for projects reporting and for growing the productivity of CAD and PDMWorks. It includes management solutions for design data, suited to single or group management of SolidWorks projects.

MATHEMATICA 7 – Software for numeric and symbolic calculus; suitable for solving linear and non-linear equations, integral and differential equations, statistics, 2D and 3D graphics.

ORIGINPRO 8 – Software for data processing and graphing software for scientists and engineers: graphic, interpretation/interpolation by statistical processing.



■ **Characterization facilities:**

- Semiconductor Characterization System with Manual Probe Station Model-4200 SCS/C/Keithley, EP6/ Suss MicroTec.

- Equipments for thin films synthesis by sol-gel method.

■ **Technology:**

- 3D Printer Selective Laser Sintering EOS Formiga P100

- 3D Printer based on Single Photon Photopolymerization MiniMultiLens system from EnvisionTEC

- Laser microengraving system

Services:

● Computer aided Modelling and Simulation (using FEM, FVM, BEM) for MEMS/NEMS and microfluidic systems;

● Electrical I-V and C-V characterization for semiconductor research and test. I-V low current, pulsed I-V, capacitance vs. voltage (C-V), capacitance vs. frequency (C-f), and capacitance vs. time (C-t) measurements, characterization of oxides trapping phenomena. Measurements in the temperature range: 77-400 K;

● Synthesis and deposition by sol-gel-spin coating of thin films with different electrical properties (resistivity), optical properties (transmission, absorption) and photoluminescence for applications in electronics, sensors, transparent conductive coatings of different substrates;

• Rapid prototyping using 3D Printer Selective Laser sintering for the following applications:

• Manufacturing of models for design, architecture, educational purposes;

• Manufacturing of molds;

• Manufacturing of robotic components having certain degrees of freedom;

• Manufacturing of customized housings and encapsulations of different types for MEMS structures;

• Manufacturing of macro scale models of MEMS devices for testing their concept and working principle;

Simulation, Modelling and Computer Aided Design Laboratory

National and International collaborations

• **ENIAC MotorBrain:** "Nanoelectronics for Electric Vehicle Intelligent Failsafe Powertrain" – ENIAC-2010-1, (2011 - 2014) Coordinator: Infineon Technologies AG Germany, Project responsible from IMT L5 - Dr. Gabriel Moagăr-Poladian;

• **EraNet:** "3 Scale modeling for robust -design of vibrating micro-sensors" (3SMVIB), 2012-2015 – Coorinator Open Engineering SA. Belgium, Project responsible from IMT- Dr. Raluca Müller;

• **IDEAS Project:** "Prospective research regarding rapid prototyping processes for applications in the field of micro and nanosystems realization", (2011–2014), Project Director: Dr. Gabriel Moagar-Poladian;

• **STAR:** „Investigation of semiconductor oxide materials performance for space environment applications" (MATSPACE) Project: nr.94/2013-2015, IMT Coordinator, Project director: Dr. Rodica Plugaru;

• **STAR:** "Reliability design of RF-MEMS switches for space applications" -REDEMS Project, 2012-2015, UTCN Coordinator, IMT Partner

• **STAR:** "Tribomechanical Characterization of MEMS Materials for Space Applications under harsh environments"- MEMSMAT Project, 2013-2016 UTCN Coordinator, IMT Partner;

• **COOPERATION PN II Project:** "Micro-electro-fluidic system for biological cells separation and electroporation (MEFSYS)", (2014-2016), IMT Coordinator, Project Manager: Dr. Oana Nedelcu;

• **Proiect PN II:** "Development of new electro-insulating nanocomposite materials for increasing durability of e– Fiz.Victor Moagăr-Poladian;

• **Basic Funding Project:** MEMS microsystems for manipulation in micro-robotics, National Program CONVERT-PN0929;

• **POSDRU- "ELAMAN"** Support for students for a successful career in the field of applied electronics in medicine, automatics and nanotechnologies" UPB Coordinator, IMT partner - Dr. Raluca Müller.

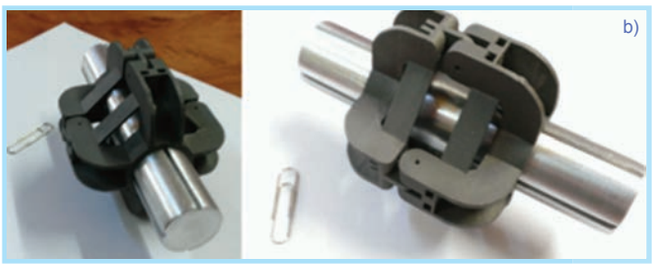
Scientific Results

Demonstrator: ***Torque sensor within the MotorBrain***

ENIAC project: "Nanoelectronics for Electric Vehicle Intelligent Failsafe Powertrain" –IMT project responsible Dr. Gabriel Moagăr-Poladian.

The metal version of the torque sensor by using a Ti64 alloy,designed and simulated by IMT was manfactured in Germany (EOS GmbH company)

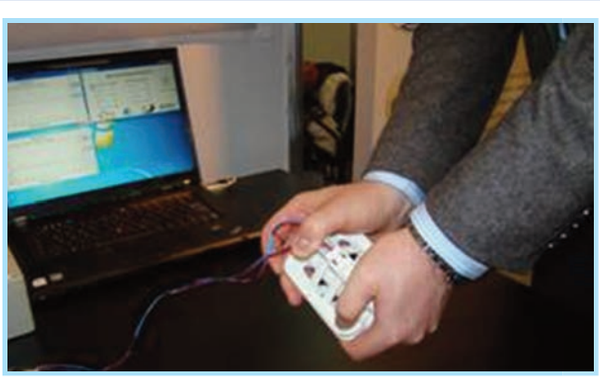
a.) Photo image showing the true size of the torque sensor metal parts.



b.) The torque sensor mounted on the metallic shaft.

Parameter	*Initial / expected value*	*Obtained value*
Torque range	*0 – 300 Nm*	*0 – 300 Nm*
Accuracy	*1 % full-scale (3 Nm)*	*1 % head of scale (3 Nm)*
Maximum rotation speed	*10.000 rpm*	*10.000 rpm*
Maximum working temperature	*180° C*	*200° C*
Redundancy	*At least 2x*	*4x*
Intrinsic linearity of the sensor	*Preferred*	*Achieved*

Main results for the torque sensor

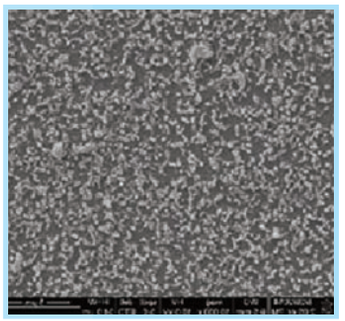


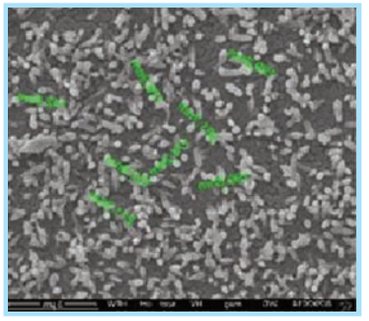
The MotorBrain project presented at the Expo Research Romania 2014 to Education and Research Minister Mihnea Costoiu and State Secretary Tudor Prisecaru.

Scientific Results

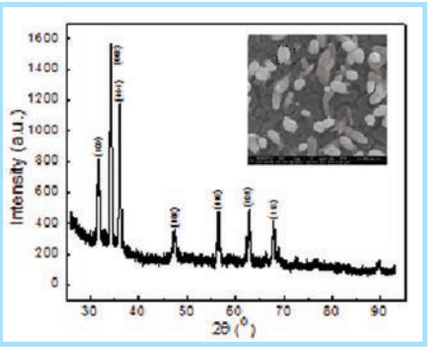
► Project STAR - Nr. 94/2013-2015, Project director: Dr. Rodica Plugaru

- Synthesis of ZnO based materials and structural, optical and electrical properties characterization.
- Synthesis of ZnO nanostructure arrays, nanorods type, by microwave- assisted process.



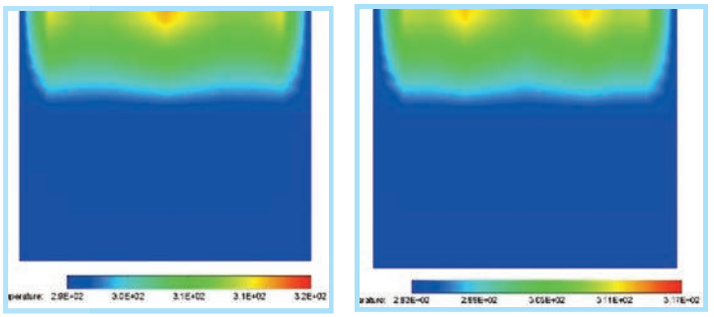


FE-SEM images of 1D nanostructure arrays.

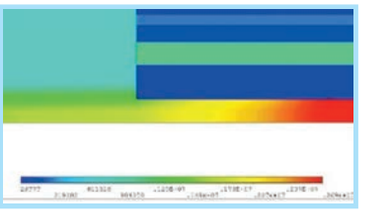


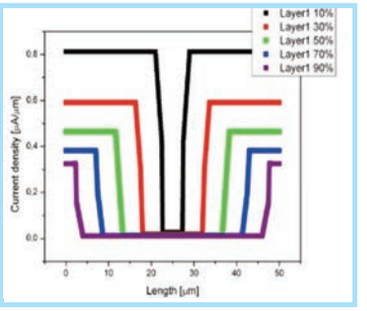
X-ray diffraction patterns of nanostructure arrays.

Numerical computational study of the effect of radiations on the thermal and electrical properties of ZnO based materials: • Development of theoretical models for investigation of radiations effect on the materials properties: „slab" structures with various radiation-induced defects configurations.
• Coupled thermal-electrical and electrical response of FET transistors with ZnO thin films as active channel region, when various densities and areas of radiation - induced defects are present in ZnO material.



Temperature distribution in the cross section of the FET channel containing embedded: (a) one line of defect pillars; (b) two lines of defect pillars.



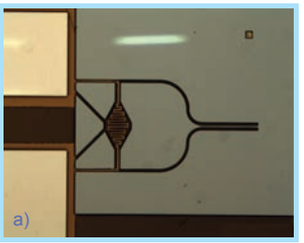


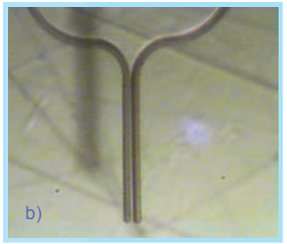
Current density variation through the FET channel containing layers with different defects concentration.

► Design, simulation and experimental realization of microgrippers

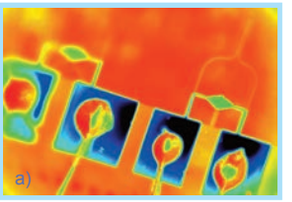
National Program CONVERT-PN0929- Contact: Dr. Rodica Voicu.

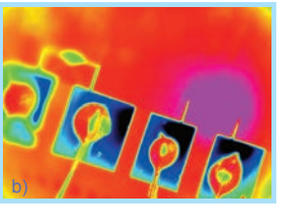
Design, simulation and experimental realization of microgrippers MEMS structures for micromanipulation of MEMS and optical microcomponents (lenses, fibers), cells, tissues and biological microparts; microgripper fabrication using biocompatible polimers.





Microgripper images: a) optical image of the structure fabricated using SU8 and gold; Different operation stages of the micromanipulator arms for an electrical current applied: b) 0 mA (initial stage); c) 32 mA (opening)

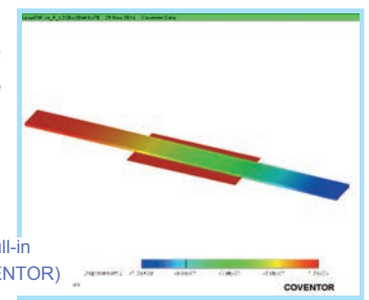




a) Thermal map for the micromanipulators without heating due to the electrothermall effect (left); b) Thermal map where can be observed the electrical resistors heated (right)

► ERANET, nr. 7-063/2012 -3SMVIB

Electro-mechanical coupled simulations using Coventorware program for determination of the **pull-in tension and out of plane displacement** of the designed structures by numerical analyses.
- Technological realization presented on next page.



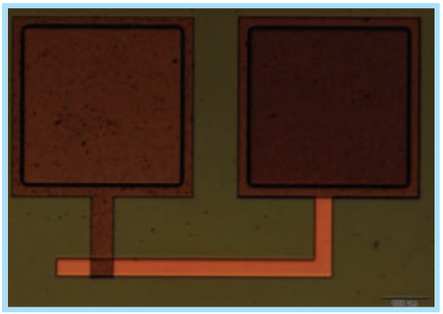
Vertical displacements of the microcantilever actuated up to pull-in tension (U_{P-I} = 22.5 V) (L=230 μm, le=80 μm) (simulations COVENTOR)

Scientific Results

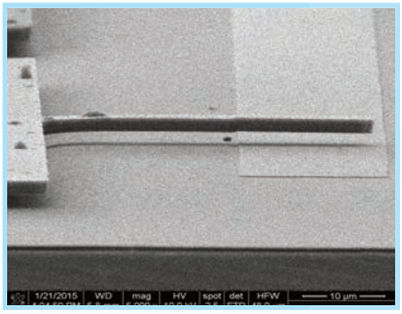
► ERANET, nr. 7-063/2012 -3SMVIB

(continue from previous page)

- Technological realization of the doped polysilicon microcantilevers with a thickness of 2 μm, designed for vibrational measurements .



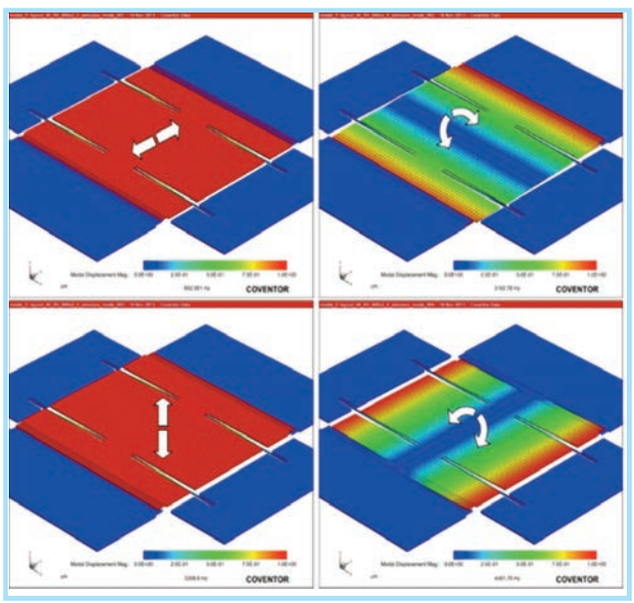
Optical image of the doped polysilicon microgripper for vibrational measurements



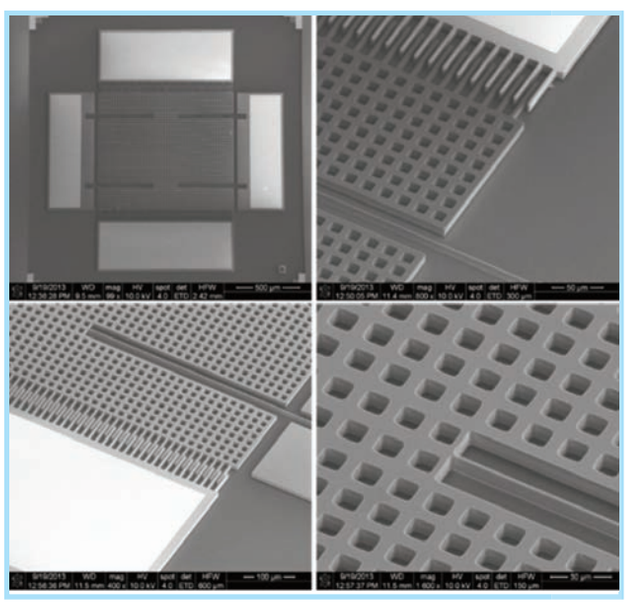
SEM image of the microcantilever fabricated using doped polysilicon for vibrational measurements

- Design and fabrication of test structures for vibrational sensors using SOI wafers

- **Mobile structures with in plan displacement**
- **Interdigited electrods for capacitive detection of the electrostatical actuator**



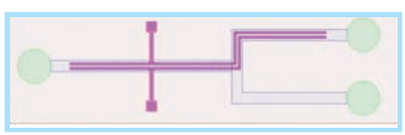
First 4 modes of the designed structures



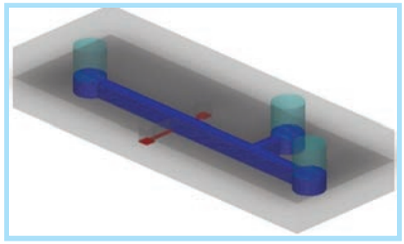
SEM images of the fabricated strucures using DRIE

► COOPERATION PN II Project (Dr. Oana Nedelcu): "Micro-electro-fluidic system for biological cells separation and electroporation (MEFSYS)"

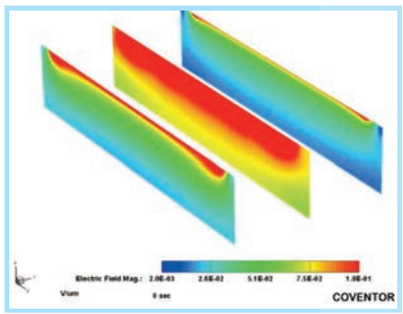
- Design of various configuration for electrodes;
- Electrostatic and microfluidic analysys by simulation for initial configuratios; analysis of electric field distribution related to requests for separation by dielectrophoresis and electroporaion; analysis of cells distribution (in flow and dielectrophoresis);
- Design and simulation of optimized configuration as function of simulation results for initial versions.



Layout 2D: reservoires (inlet / exiit), microchannel, microelectrodes



3D Structure



Electric field distribution (V/μm) in 3 sections

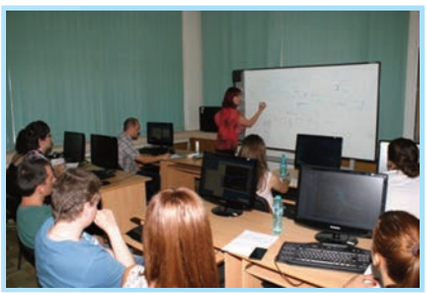
Versions of microfluidic systems with electrodes for cells separation and electroporation

Simulation, Modelling and Computer Aided Design Laboratory

Services

■ **Education and training:**

- Courses and laboratory for Master programme **"Smart sensors and microsystems SENZI",** Faculty of Electronics,Telecommunications and Information Technology, University Politehnica of Bucharest
- **Laboratory for undergraduate students (year IV) related to "Microsystems" course,** Faculty of Electronics,Telecommunications and Information Technology, University Politehnica of Bucharest
- **Coordination of diploma work**
- Summer Internship in the frame of **"ELAMAN" POSDRU Project**
- For MS students from the Electronic Technology, Optoelectronics and Reliability Dept. of the Faculty of Electronics from Politehnica University of Bucharest. The subject of the course:
  - **G. Moagăr-Poladian** – Light-based Additive Manufacturing Technologies



Students from Faculty of Electronics,Telecommunications and Information Technology – Practice in ELAMAN POSDRU Project

■ **International Patent requests (IDEAS project):**

G. Moagăr-Poladian – "Procedure of Rapid Manufacturing by Using Focused Ultrasound", PCT / RO2014 / 000029

Prizes:

a) ***Special prize of the Vâlcea County Industry and Commerce Chamber at the Inventika 2014 Invention Fair***, Bucureşti, România, October 2014. Title of the invention: Procedure of Rapid Manufacturing by Using Focused Ultrasound. Author: Gabriel Moagăr-Poladian.

b) ***Gold Medal at the Inventika 2014 Invention Fair,*** Bucureşti, România, October 2014. Title of the invention: Procedure of Rapid Manufacturing by Using Focused Ultrasound. Author: Gabriel Moagăr-Poladian.

c) ***Prize of 3M Romania company at the contest "Premiază Inovaţia"*** („Award Innovation") organized 3M România company. Title of the invention: Procedure of 2D and 3D light assisted fountain pen nanolithography. Author: Gabriel Moagăr-Poladian.

■ **Education and training:**

- **G. Moagăr-Poladian** – „Light-based 3D Printing methods", at Faculty IMST – Engineering and Management of Technological Systems, University Politehnica of Bucharest. Participants where students and MScs from the mentioned Faculty;
- **R. Müller** - Research activities in IMT at - "Upgrading the capacity of NIRDTP to develop sensing applications for biomedicine using magnetic nanomaterials and nanostructured materials" workshop, organised by INCDFT Iasi in REGPOT-CT-2013-316194-NANOSENS Project;
- **V. Moagăr-Poladian** – „From idea to prototype by using additive manufacturing: Structures with negative Poisson coefficients" at IMST – Engineering and Management of Technological Systems Faculty, University Politehnica of Bucharest. Participants where students and MScs from the mentioned Faculty.

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

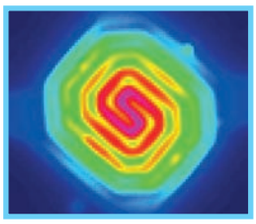
Reliability building: Design for Reliability (DfR), Design for Manufacture (DfM), Monitoring and screening of micro and nanostructures, Reliability of components in Harsh Environment (e.g. space, aeronautics, automotive, geology, nuclear, etc.), Robust Design (e.g. developing biosensors for monitoring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

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

From left to right: Eng. Niculae Dumbrăvescu, Senior Sci. Res.3; Dr. Marius Bâzu, Senior Sci. Res.1; Eng. Daniela Bucur, Electronic Engineer; Eng. Roxana Marinescu, Research Assistant; Dr. Lucian Gălăţeanu, Senior Sci. Res.1; Ing. Dragoş Vârşescu, Electronic Engineer. Missing in the photo: Eng. Virgil Emil Ilian, Senior Sci. Res.2.



Thermal map obtained with the Infrared Microscope SC 5600 + G3 L0605 / FLIR Systems

Co-operation projects

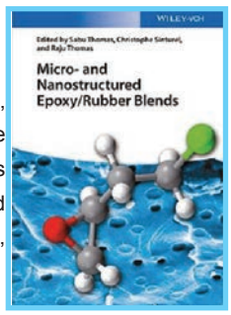
- Thermal analyses with Infrared Microscope for the company FEI (the Netherlands) and for a IMT project focused on obtaining microgrippers;
- Project PROBE-3 ASPIICS OPSE HARWARE (Contract No. 4000111522 / 14 / NL / GLC) with ESA - European Space Agency;
- Project of structural funds for the : "Romanian-Bulgarian Services Centre for Microsystems and Nanotechnology" - MICRONANOTECH;
- Project PC7: "Nanostructured materials and RF-MEMS RFIC/MMIC tehnologies for highly adaptive and reliable RF systems – NANOTEC" – design and executing a programme of reliability tests.

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.

Most important publications:



Book chapters: M. Bâzu, T. Băjenescu, chapters „Reliability Testing" and „Failure Analysis", in: Thomas, Siturel, Thomas (Eds.), Micro- and Nanostructured Epoxy/Rubber Blends (3-527-33334-7), September 2014, J. Wiley & Sons

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 "Tudor Tanasescu" Award of the Romanian Academy (2013) and of AGIR (General Association of Romanian Engineers) Award (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).

Reliability Laboratory

Most important scientific results

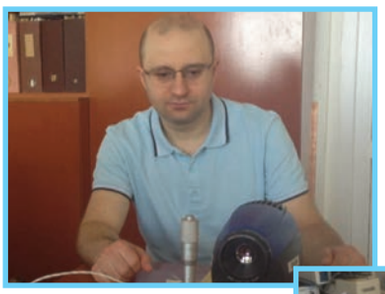
The results of high precision thermal analyses achieved with Infrared Microscope for the company FEI were reported in contributions to high level international conferences:

• Luigi Mele, Pleun Dona, Joerg Jinschek, Marius Bazu, Virgil Emil Ilian, Dragos Varsescu, Stan Konings, MEMS-based heeting and electrical biasing holder, 3rd International Symposium on Advanced Electron Microscopy for Catalysis, Monastery Seeon, Germany, September 3-6, 2014.

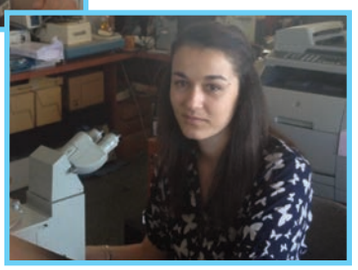
• D. Varsescu, V.E. Ilian, M. Bazu, Thermographic analysis with enhanced emissivity, IEEE CAS 2014 – International Semiconductor Conference, Sinaia, Romania, October 13-15, 2014.

• Virgil Emil Ilian, Marius Bâzu, Virgil Liviu Mircea Ilian, Lucian Gălățeanu, Dragoş Vârşescu, Niculae Dumbrăvescu, Roxana Marinescu, Thermography as a tool in the development of micro devices, International Conference on Quality and Dependability CCF 2014, Sinaia, September 17-19, 2014.

For the project with ESA (PROBE 3), the programme for characterizing, testing, accepting and qualifying the LEDs to be used for the OPSE device was established.



Thermal analyses of microgrippers for a IMT project
(Ing. Dragos Varsescu)



Optical analyses for the Romanian-Bulgarian Centre MICRONANOTECH
(Ing. Roxana Marinescu)

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

Centre for Research and Technologies Integration

Microsystems for Biomedical and Environmental Applications Laboratory

Mission

The Laboratory's main activity is research and development on microsensors (chemical, bio and mechanical), microstructures and microelectrodes, microprobes for detecting the electrical activity of cells and tissues, integrated microfluidic technologies (in silicon, polymers or biomaterials), signal processing, data acquisitioning and graphical interfaces, platforms and integrated systems development for food monitoring and biomedical applications, as well as education in micro-chemo-biosensors and technology, and design and simulation services for applications using bio-, chemo-, or micromechanical sensors.

Main areas of expertise

Micro-Nanosensors: Development of microsensors (chemo-resistive, resonant gas sensors, accelerometers, micro-arrays, ISFET sensors, nanowire-based sensors, electrodes for biological sensors, microprobes for recording electrical activity of cells and tissues);

Modules and microfluidic chips: Simulation, modelling and development of microfluidic platforms: microchannels, tubes, microfluidic connectors, reservoirs and mini pumping systems;

Sensor platforms, Integrated systems: Platforms which integrate microsensors with microfluidic systems, data acquisitioning, signal processing and grafical interfaces, working autonomously and with autonomous power;

Simulation and modelling: simulation/modelling using CAD tools specific to MEMS (CoventorWare, COMSOL, CADENCE).

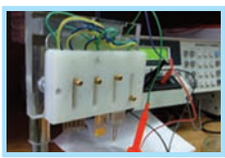
Research Team

1. Dr. Carmen Moldovan - CS I, PhD in Electronics
2. Dr. Nicolae Marin – CS I, PhD in Electronics
3. Rodica Iosub - CS III, Chemist;
4. Cecilia Codreanu – CS III, Engineer;
5. Daniel Necula - CS III, Engineer;
6. Bogdan Firtat - CS III, Engineer;
7. Dr. Marian Ion - CS, Physicist;
8. Silviu Dinulescu – AC, Engineer;
9. Adrian Anghelescu - CS III, Engineer;
10. Costin Brasoveanu – CS, Engineer;
11. George Muscalu – Junior Engineer;
12. Ioana Ghinea – Technician, chemical engineer;
13. Roxana Vasilco – CS III, Biologist;
14. Alina Popescu – CS III, Chemist.

Equipment

Ink Jet Printer-capable of depositing picoliter droplets of conductive fluids (liquid silver or organic inks) on a wide range of surfaces, including flexible ones: Poly-Ethylene-Terephthalate (PET) substrates, Poly-Ethylene-Naphthalate (PEN) and Poly-Aniline (PANI);

VoltaLab 10-all-in-one electrochemical laboratory, with all-in-one PGZ100 potentiostat, electrochemical software Voltamaster 4, for cyclic voltammetry analysis, chronoamperometry and impedance spectroscopy;



CNC (Computer Numerical Control)— Miniaturized tool for mechanical processing with design and control software running on Linux machine. The CNC equipement is used to develop microfluidic components and fabricate various mechanical interfaces for connecting our sensors with the measurement instruments.

International and national collaborations

• *International cooperation* with research institutes and renowned companies in the field, from The United Kingdom, Germany, France, Holland or Switzerland, as part of European research projects:

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

• **PESTIPLAT** - Integrated Platform for Pesticides Detection – MNT ERA.NET (Romelgen - Romania, HSG-IMIT and Scienion AG - Germany) – coordinated by our laboratory;

• *Cooperation with research institutes and universities* (INFLPR, „Politehnica" University Bucharest) and Romanian firms (ROMELGEN, Telemedica, DDS Diagnostic) in a few national projects which were coordinated by our laboratory:

• **IMUNOPLAT** Micro Immunosensors Platform for Metabolic Syndrome Investigation): DDS Diagnostic SRL, Univ of Medicine& Pharmacy "Carol Davila" Bucharest, Telemedica SRL, Univ. of Bucharest.

• **AMI_DETECT** (Microbiosensor arrays fabrication and portable DETECTion apparatus development for Acute Myocardial Infarction diagnostic): DDS Diagnostic SRL, „Politehnica" Univ Bucharest, Telemedica SRL, ROMELGEN SRL.

• **E-NOSE** (Electronic nose for detecting small quantities of explosive or environmentally hazardous gasses): ICF „Ilie Murgulescu", IMT, Romelegen.

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:*

- Miniaturised sensors on silicon substrate: pesticide biosensors, integrated temperature and pH sensors with microfluidic modules;
- Microfluidic module integrated with the heating system and pumping modules, fluid delivery and sample preparation;
- Portable instrument for sensor data processing and displaying;
- Software for data acquisition and interpreting results given by the sensor array.

Automated platform for use with the pesticide sensor

Single-use sensor for pesticide detection

These sensors can detect concentrations of organophosphoric and carbamate products of 10-6 g/l from vegetable products, water or milk. The mini-platform is portable, does not need laboratory conditions and can be used in any situation where toxic concentrations evaluation is necessary.

Microbiosensor array fabrication and portable detection of Acute Myocardial Infarction

We have designed the microsensor array and the fluorescence detection device for the acute myocardial infarction and determined initial specifications and operating conditions, so that we are able to further develop fabrication technology for microsensors with fluorescence detection and to build a POC (point of care) apparatus which follows the protocol illustrated in the following figure.

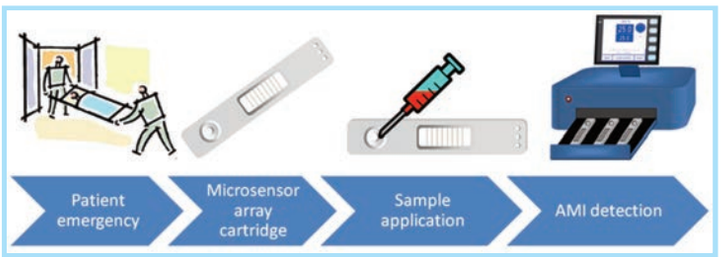


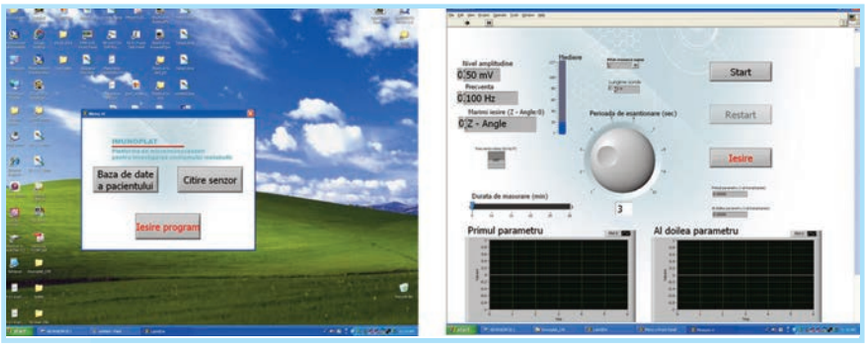
Fig 6. Apparatus and microsensor concept for detecting myocardial infarction

Layout for our impedimetric and pH sensors (distance between electrodes is 50 µm)

Bio-chemical sensors systems on organic thin 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 reading data from our sensors

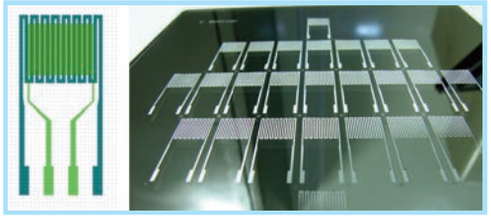


User interface for the micro-immunosensors platform for metabolic syndrome investigation

We have created a program to process measured data coming form our micro-immunosensors platform for metabolic syndrome detection. The program has a user graphical interface that allows access to the patient's database and accesses the sensor readout panel. The latter allows the user to adjust the measurement system's parameters such as amplitude, frequency, sampling period or measurement time. The sensor's behavior is plotted accordingly on graphs.

Layout and mask set for gas sensors

We have developed and realised the layout of a test sensor for detection of pollutants and explosive gasses at very low concentrations. We have created the masks needed for fabrication and processed the test structures.



Sensor's layout (left) and a picture of mask (right)

Education and Training

Co-organizing courses and training sessions for international projects like Euro-Training in micro- and nano-technologies;
Supervised bachelor and master's thesis projects of students form the Faculty of Electronics of „Politehnica" University of Bucharest.

Centre for Research and Technologies Integration

Ambiental Technologies Laboratory

Mission

❖ Research, development, inovation of new technologies of micro/nano sensors

• Technological design, technological development up to the prototype level

• Development of new individual technological processes

• Assembly techniques development (based on MCM)

❖ Research, development, inovation of new materials (ex. Nanocomposites)

• New materials synthesis

• Development of devices/structures based on new materials (nanomaterials)

❖ Technological services

• Technological assistance and consultancy (technological flows design, control gates, etc.)

• Technological compatibility analysis and defects on technological flow

• Technological assistance to transition from prototype to zero series to industrial

❖ Education, dissemination

• Associate Professor at Politehnica University of Bucharest, Faculty of Electronics and Telecommunications

• Organization of workshops, presentations on laboratory profile (contact with industry)

All the activity referred to above is carried out with the aim of improving wellbeing conditions (including applications in the health care system) and for traditional industries up-grading.

Areas of activity

❖ Design and modelling of technologies and technological processes for micro / nanotechnologies (ex. piezoelectric integrated microsensors, white led micromatrix, high speed photodetectors for fiber-optic coupling)

❖ Technological compatibilization for technologies and technological facilities

❖ MCM technologies and other nestandard assembly technologies for M/NST , especially for applications in traditional industries

❖ Synthesis of nanocomposites and nanostructured materials and applications of these materials (ex. coatings with different characteristics)

❖ FTIR and UV-vis spectroscopy characterisation

❖ Design and processing specific thermal processes (calcinations, RTP)

New directions for the future:

❖ Microsensors based on nanomaterials (2D layered materials beyond grapheme included)

❖ Devices for space industry

❖ Applications of nanostructured materials and M/N sensors in space and security domain

Equipments (selection)

Tehnologies

- RTP- Rapid Thermal Processing system for silicon, compound semiconductors, Photonics and MEMS process (ANNEALSYS, France) , Fabrication in 2010

Aplications: Rapid Thermal Oxidation (RTO); Rapid Thermal Nitridation (RTN); Crystallizationd and/or annealing; Densifications Compound Semiconductors annealing

- High temperature furnace, Carbolite used for: sintering, annealing, calcination, etc. Fabricat ion in 2011

Aplications: Semiconductor field include: annealing silicon, silicon carbide and nitride samples and solid state synthesis; Ceramics fields include: desintegration, calcinations, long therm high temperature, firing and sintering of ceramic samples.

Characterization:

- FTIR Spectrometer Tensor 27, Bruker Opticks

- UV-Vis Spectrometer AvaSpec-2048 TEC, AVANTES

Research Team

1. PhD. Ileana CERNICA - Researcher I, PhD. in microelectronics , laboratory head

2. PhD. student Alina MATEI - Researcher III, MST in chemical engineer;

3. Chem.Vasilica TUCUREANU(SCHIOPU)- Researcher III, chemist;

4. Eng. Florian PISTRITU – MST in electronics;

5. Eng. -Ec. Andrei GHIU – MST in mechanics.

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.

Ambiental Technologies Laboratory

National and international collaborations

Partners Univeristies: 6

Politehnica University Bucharest (Centre of Optoelectronics, Department of DCAE - Faculty of ETTI; CEM- Science of Materials Faculty; Mechanics Faculty); Transilvania University Brasov, Technical University Timisoara.

Partners Institutes of R&D and Romanian Academy: 5

National Institute for Electrochemistry and Condensed Matter Timisoara, ICIA Cluj, ICM Petru Poni Iasi, Institue of Chemistry of Romanian Academy Timisoara, ICECHIM Bucharest

Partners SME and IND: 3

ROMQUARTZ, ECONIRV, ROMAERO

Foreign partners: 3

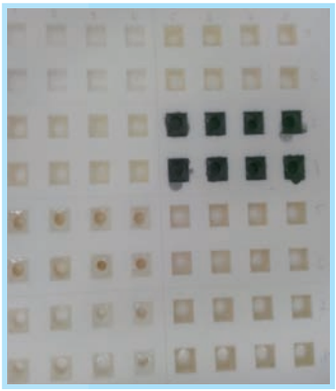
ESA, CSL Liege, INAF Torino

Most important scientific results

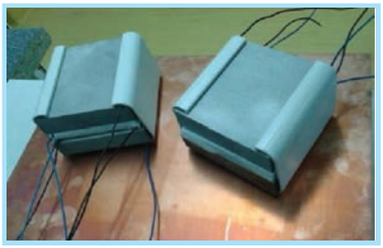
Projest: Active Micro-shield Systems for Protection of Space Infrastructure (STAR-ROSA)

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

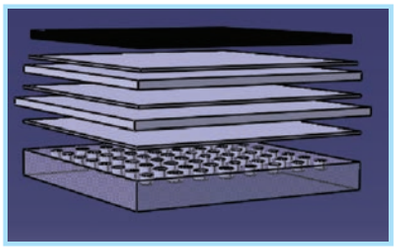
Achievements:



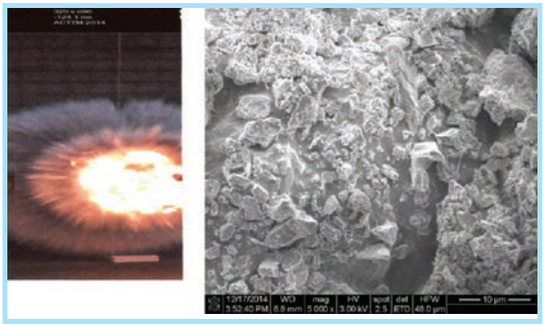
The constitutive element of shield



Experimental model intelligent shield



Shield structure (representation in 3D with CATIA software)



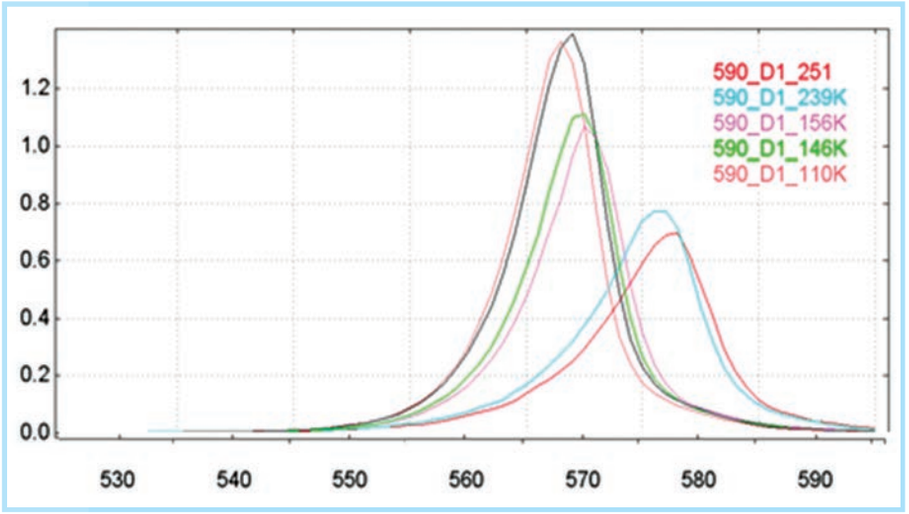
Ballistic test and SEM characterization of the impact of sand blasting with size <0.4mm and speed of 1000m/s

Project: PROBA-3 Coronagraph System – OPSE (ESA)

Prime Contractor: Centre Spatial de Liège

Subcontractor for OPSE: National Institute for R&D in Microtechnologies - IMT Bucharest

Achievements: Spectral characteristic variation of the various LED to negative temperatures



Most important scientific results

Project: Microsensors matrix for air quality control in human space missions habitable areas – SAFEAIR (STAR-ROSA)

Partner : Institute of Chemistry of Romanian Academy Timisoara

Achievements: Synthesis and characterization of porphyrins

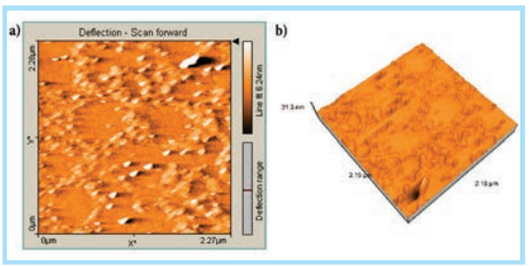
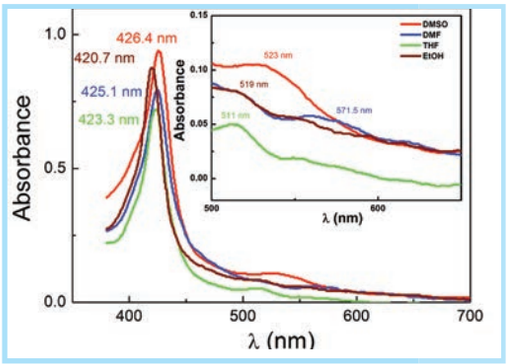
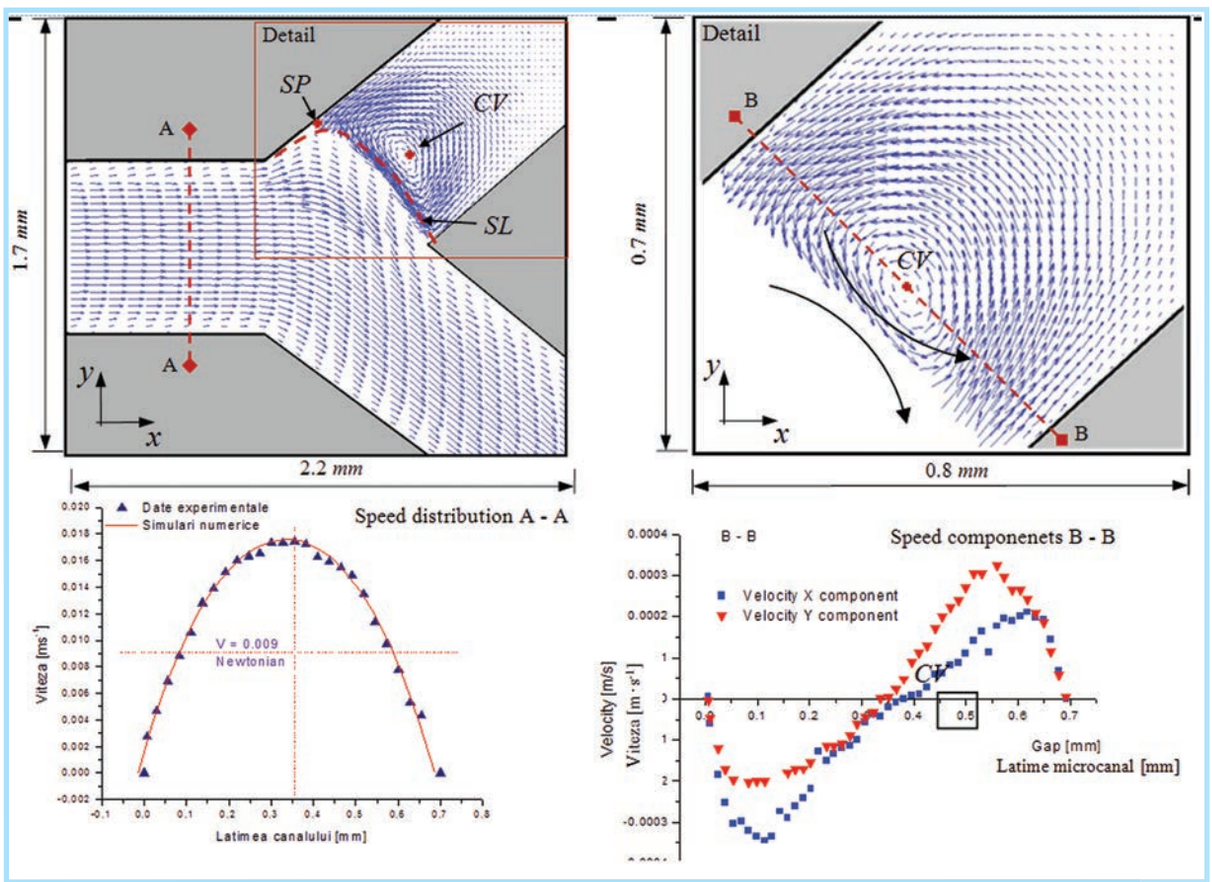


image in contact mode for Fe-III-chloride 5,10,15,20-tetrakis (3,4-dimethoxyphenyl) porphyrin b) 3D



UV-vis spectra overlapping of chloride Fe-III-5,10,15,20-tetrakis (3,4-dimethoxyphenyl) porphyrin in various solvents: DMSO, DMF, EtOH, and THF - *left image*



µPIV measurements on speed fields and speed profiles in Y bifurcation with a single entrance (results obtained for a newtonian fluid - deionized water), by highlighting the boundary line SL, stationary point SP and swirl center CV (research in collaboration with Micro and Nanofluidics Laboratory)

Education and training:

Courses and laboratories for Master of Science in Optoelectronics in collaboration with UPB

Coordination of degree (licence and master) thesis from UPB.

Services:

Scientific characterization using FTIR and RTP equipments in accordance with ISO 9001: 2008 for IMT and research institutions in collaboration.

Micro and Nanofluidics Laboratory

The Micro- and Nano- Fluidics Laboratory is the result of the POSCCE, O.2.1.2 No. 209, ID 665 project, Microfluidic factory for assisted self-assembly of nanosystems (MICRONANOFAB), a multidisciplinary project which reunites specialists from fields like micro-nanotechnology, chemistry, molecular biology. The fundamental objective of the project is to obtain a prototype of an integrated microfluidic system, able to dose, encapsulate and deliver different chemicals for targeted medical treatment.

Mission

Research, development and education in the field of micro and nanofluidics. The main activities of the laboratory are to design and simulate lab-on-a-chip microfluidic devices for applications in clinical diagnosis and regenerative medicine.

Field of activities

- CFD modeling of Newtonian and non-Newtonian fluids: single and multiphase flows, fluid mixing, induced fluid turbulences, heat transfer, implementation of user defined functions for additional flow parameters, magnetohydrodynamics.
- Design of microfluidic devices for applications in clinical diagnosis and regenerative medicine.
- Rheologic investigation of fluid flow and applications for lab-on-a-chip devices
- Experimental nano and microtechnolgoy: cleanroom processing of polymers, glass and silicon, fabrication and characterization of lab-on-a-chip microfluidic devices with integrated electrochemical, imedimetric, magnetic and spintronic biosensors.
- μPIV measurements of fluid flows, device and protocols development for micro-mixing and particle manipulation by dielectrophoresis and magnetophoresis.
- Cell assimilation of nanoparticles, studies on cell apoptosis induced by magnetic hyperthermia. Investigations on the morphology of tumor cells architecture by UV fluorescence, SEM, SNOM and spectroscopy analysis.
- Microfluidic investigations: hydrodynamic focusing of liposomes.
- Molecular transport in microfluidic devices, magnetophoretic systems for cell detection and separation, filters for sorting cells depending on their morphological, electrical, and magnetic properties.

Team

Dr. Marioara Avram - Senior researcher, simulation, design, microfabrication and characterization of lab-on-a-chip devices with integrated biosensors;

Dr. Cătălin Valentin Mărculescu - Principal researcher, simulation of Newtonian and non- Newtonian fluid flows, single and multiphase flows, fluid mixing, induced fluid turbulences, heat transfer, implementation of user defined functions for additional flow parameters, magnetohydrodynamics, manipulation of particles by dielectrophoresis and magnetophoresis;

Dr. Cătălin Mihai Bălan - Principal researcher, device and protocols development for micro-mixing and particle manipulation by dielectrophoresis and magnetophoresis;

Dr. Andrei Marius Avram - Principal researcher, physicist, Experimental nano and microtechnolgoy: plasma assisted etching and deposition processes, design, fabrication and characterization of lab-on-a-chip microfluidic devices;

Drd. Tiberiu Alecu Burinaru – Reasearch assistant, nanofluidic modeling of biomolecular interactions.

Stud. Andreea Margareta Speriatu – Junior reasearch assistant, development of microfluidic devices with integrated porous membranes for mixing and separation of nanoparticles.

Stud. Cătălina Bianca Tîncu – Junior reasearch assistant, experimental characterization and measurements of biosensors integrated on microfluidic platforms.

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

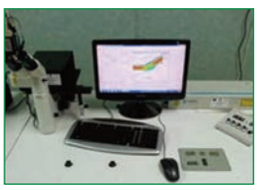
Characterization:

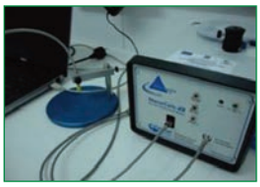
Micro-PIV- PIV for Microfluidics (Particle Image Velocimetry)

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.





Micro and Nanofluidics Laboratory

National and international cooperations

• International cooperation with university research centers and companies in UK, Spain, Germany, France, Austria and Norway
• International cooperation with Romanian university research centers and companies (SUUB, DDS, Spital LOTUS, UPB, UTBv).

Patent

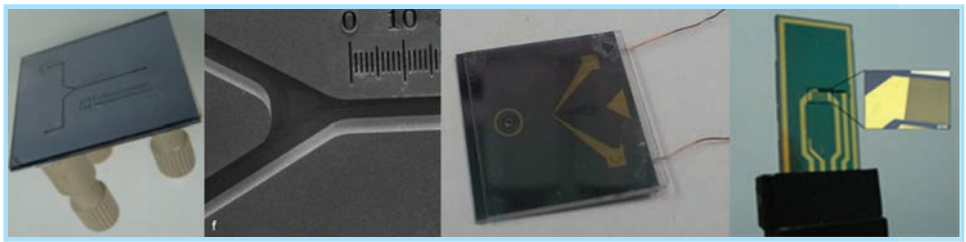
Patent no. 128557/29.08.2014, Gold nanoparticle based reagent, preparation and use for the mapping of tumor tissue architecture

Awards

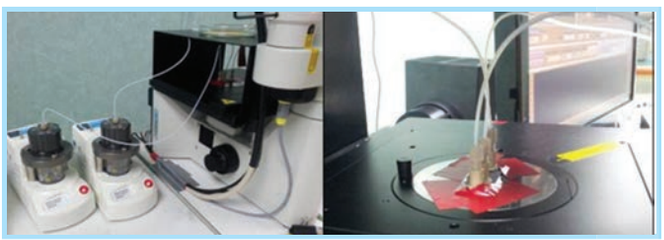
• Gold medal at the INVENTIKA innovation and inventions saloon, Bucharest, October 2014.

Results

Laboratory technology for the fabrication of lab-on-a-chip devices

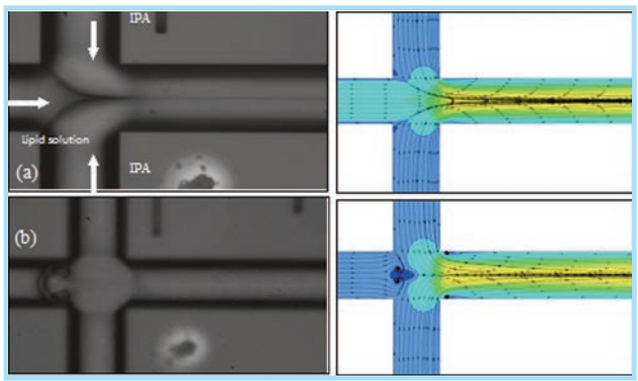


The microfluidic systems are fabricated on a silicon substrate and encapsulated using a glass cover, to allow direct observation of the fluid flows. The fabrication consists of deep silicon etching, thin metal films deposition, thin dielectric layers deposition, and film etching. Microfluidics require materials with good mechanical properties, low stress, high elastic modulus, low friction coefficient. Several devices are presented: (from left to right) microfluidic system for turbulent flow study and a detail on the interest area; magnetophoretic system for the manipulation of particles with magnetic properties, electrochemical system for determining the dielectric constant of biological cells.



Experimental set-up for obtaining liposomes in a system with 2 lateral flows for hydrodynamic focusing.

Assembly methods for lipid containers in microfluidic systems



The rheologic behavior of the lipid solution and of the liposomes in contact with aqueous solutions was studied. Numerical modeling shows the liposome formation can be controlled by controlling the flow ratio between the pressure on the inlet for the lipid solution and the pressure on the inlet for the buffer solution. Microfluidic devices for lipid structures assembly by hydrodynamic focusing were fabricated.

(a) Liposome solution focusing for inlet pressure of 600 mbar and side pressures of 985 mbar.
(b) Flow regime characterized by secondary vortex flows, side pressures of 1000 mbar.
On the right side: numerical simulations for each of the flow regimes.

Patent no. 128557/29.08.2014, Gold nanoparticle based reagent, preparation and use for the mapping of tumor tissue architecture.

The invention refers to the preparation procedure of a reagent based on colloidal gold and its use for tissue mapping, the purpose being to determine tumor limits both on the surface and in depth, including the emphasis of the tumor cell nests in the proximity of the tumor. This imagistic effect can be explained theoretically by Localized Surface Plasmonic Resonance (LSPR) at the interface between the gold nanoparticles and the dielectric environment in which they are immersed, the light intensity of the plasmons being all the stronger, as long as the refraction index of the environment where the nanoparticles have been transported by endocytosis is larger and, implicitly, the dielectric permittivity of the environment is larger. The technical problem set forth to be solved is the mapping of the tumor tissue architecture in order to determine the edges of the tumor both on the surface and in depth. In order to solve this problem, plasmonic resonance through gold nanoparticles with an average diameter of 5.6 nm, was studied experimentally by inducing it in the tumor tissue B16 melanoma of mice, which resembles most the type of cutaneous melanoma found in humans. The main purpose of the experiments was the histopathological investigation of the tumor tissue in UV light with an excitation wavelength of 450 nm, after the administration of gold nanoparticles suspended in sodium citrate solution. The invention has the advantage that it proposes a non-toxic, easily obtainable reagent, which is efficient in utilizing it in a safe method of analysis, both of the tumor and its surroundings, but also of the tumor roots in the healthy tissue.

Scientific events and publishing activities

International Semiconductor Conference - CAS 2014

The 37th 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, 13-15 of October, 2014. 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 2014, 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).

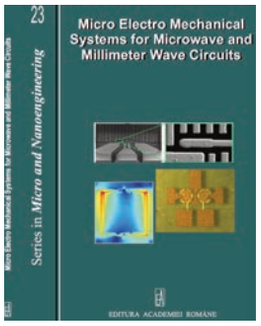
The invited papers presented were focused on: miniaturization trends in space technology, characterization modeling and design of electronic components, nano-devices modeling, graphene, microwave devices, silicon friendly materials and device, materials for sensing.

Invited speakers at CAS 2014 edition: ***Marius Ioan Piso***, Romanian Space Agency;
Martin Pfost, Robert Bosch Center for Power Electronics, Reutlingen Univ., Reutlingen, Germany.
Luis Fonseca Chacharo, IBM-CNM Barcelona, Spain.
Stefano Bellucci, Istituto Nazionale di Fisica Nucleare (INFN)–(LNF), Roma, Italy.
Bogdan-Catalin Serban, Honeywell Romania SRL (SWLB),
Philippe Galy, STMicroelectronics, Crolles, France
Dominique Planson, Univ. de Lyon, INSA de Lyon, CNRS, France
Dan Neculoiu, IMT Bucharest, Romania

National Seminar for Nanoscience and Nanotechnology 2014

The 13th Edition of National Seminar for Nanoscience and Nanotechnology was organized by the Centre for Nanotechnologies from IMT Bucharest, on 15th of May 2014, at the Library of the Romanian Academy. The event was focused on a debate regarding the perspectives of nanotechnologies in Romania under the title: “From excellence to competitiveness: Key Enabling Technologies - KET” in the frame of the National RDI Strategy 2014-2020. The participation delivered presentations on topics: What is the Romanian research potential in KET?, research results, experimental infrastructures, European partnership and application prospects.

In his opening remark, Academician Ionel-Valentin Vlad, President of the Romanian Academy pointed out the importance of the Key Enabling Technologies, including nanoelectronics and photonics, for implementation of the National RDI Strategy 2014-2020. The State Secretary in Ministry of National Education, Prof. Dr. Eng. Tudor Prisecaru underlined in his speech the importance of Key Enabling Technologies (KETs) in European research and industries for competitiveness and markets.



Publishing activities

The 22nd and 23th volumes in the “Micro and Nanoengineering” series (Publishing House of the Romanian Academy) edited by IMT Bucharest (and coordinated by Acad. Dan Dascalu) have been published in 2014. The 22nd volume “New Applications of Nanomaterials” (editors: Alina Catrinel Ion, Dan Dascalu, Gabriela Carja, Magdalena Lidia Ciurea) contains the papers presented at the 12th edition of the National Seminar for Nanoscience and Nanotechnology, Bucharest, May 2013. Volume “Micro Electro Mechanical Systems for Microwave and millimeter Wave Circuits” (editors: Mehmet Kaynak, Alexandru Muller, Dan Dascalu, Roberto Sorrentino) contains the papers presented at the 14th edition of MEMSWAVE 2014, June 30 – July 2, La Rochelle, France.

Visits and Education activities at IMT-Bucharest

"The Open doors day" organised by IMT-Bucharest on the 16th of December 2014.
On this opportunity were presented by the participants three infrastructure investments for research development, financed on different scale, each one being in diverse stages of implementation. Although this event wasn't one with large participation it can be qualified as the predecessor of a larger debate about the research infrastructures role in national politics CDI in the next period 2014-2020.
Speakers at this event:

- Dr. Raluca Müller, General Manager of IMTBucharest presened "IMT Bucharest performance in European Projects",
- Acad. Nicolae Zamfir, General Manager of IFIN – H.H presented ""ELI-NP implementation and scientific perspectives",
- Dr. Marian Zamfirescu, Dr. Florin Jipa, INFLPR presented "CETAL- laser infrastructure for research in micro- and nanofabrication domain".
- Acad. Dan Dascălu, "IMT-MINAFAB evolution: micro and nanofabrication research centre"

During this event, IMT Bucharest was visited by the 11th grade students from "Sf. Sava" National College.

Visit of European Commission delegation, 18 March 2014, IMT Bucharest
IMT Bucharest was visited on March 18, 2014 by Dr. Christos Tokamanis, Head of Unit "Advanced Materials and Nano Technologies", "Key Enabling Technologies" Department , Directorate-General "Research & Innovation" and Dr. Herbert von Bose, former director at DG RTD, Industrial Technologies, from European Commission. During the meeting, the European officials underlined the importance of Romanian R&D for "Horizon 2020" implementation. Also, the delegation members have visited the technological facilities (clean rooms) CVD, Simulation, Rapid prototyping and Microwaves laboratories of IMT Bucharest.

IMT Bucharest at Researcher's Night 2014, 26 September 2014

"Co-operation between R&D Groups and SMEs - a brokerage event"- Project "Romanian-Bulgarian Services Centre for Microsystems and Nanotechnology"- RO-BG MicroNanotech (MIS-ETC Code: 587), 16 April 2014, IMT Bucharest.

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.

POSDRU- "ELAMAN" *Support for students for a successful career in the field of applied electronics in medicine, automatics and nanotechnologies*; UPB Coordinator, IMT partner
IMT Bucharest is hosting internship in micro and nanotechnologies for students.

Papers published in ISI ranked periodicals (with impact factor)

1. *Charge storage and memory effect in graphene quantum dots-PEG(600) hybrid nanocomposite*, **I Mihalache, A Radoi**, C Munteanu, **M Kusko, C Kusko,** ORGANIC ELECTRONICS Volume: 15 Issue: 1 Pages: 216-225 Published: JAN 2014 Impact Factor: 3.676
2. *Detection of electromagnetic waves with a single carbon atom sheet*, **M Dragoman**, PROCEEDINGS OF THE ROMANIAN ACADEMY SERIES A-MATHEMATICS PHYSICS TECHNICAL SCIENCES INFORMATIO SCIENCE Volume: 15 Issue: 2 Pages: 208-215 Published: APR-JUN 2014 Impact Factor: 1.115
3. *Enhanced architectures for room-temperature reversible logic gates in grapheme*, D Dragoman, **M Dragoman**, APPLIED PHYSICS LETTERS Volume: 105 Issue: 11 Article Number: 113109 Published: SEP 15 2014 Impact Factor: 3.515
4. *GaN/Si based single SAW resonator temperature sensor operating in the GHz frequency range*, **A Muller**, G Konstantinidis, **V Buiculescu, A Dinescu**, A Stavrinidis, **A Stefanescu**, G Stavrinidis, **I Giangu, A Cismaru,** A Modoveanu, SENSORS AND ACTUATORS A-PHYSICAL Volume: 209 Pages: 115-123 Published: MAR 1 2014 Impact Factor: 1.943
5. *Negative differential resistance in graphenebased ballistic field-effect transistor with oblique top gate*, **M Dragoman, A Dinescu**, D Dragoman, NANOTECHNOLOGY Volume: 25 Issue: 41 Article Number: 415201 Published: OCT 17 2014 Impact Factor: 3.672
6. *Smart antennas based on grapheme*, **M. Aldrigo, M Dragoman**, D Dragoman, JOURNAL OF APPLIED PHYSICS Volume: 116 Issue: 11 Article Number: 114302 Published: SEP 21 2014 Impact Factor: 2.185
7. *Applications of electrostatic capacitance and charging*, **T Sandu, G Boldeiu, V Moagar-Poladian**, JOURNAL OF APPLIED PHYSICS Volume: 115 Issue: 2 Article Number: 029901 Published: JAN 14 2014 Impact Factor: 2.185
8. *Bandgaps in the dispersion of waves on a string of dust particles floating in plasma*, **C Ticos**, University politehnica of Bucharest Scientific Bulletin-series A-Applied Mathematics and Physics Volume: 76 Issue: 2 Pages: 193-198 Published: 2014 Impact Factor: 0.280
9. *Electroluminescence of carbon 'quantum' dots - From materials to devices*, **L M Veca**, A Diac, **I Mihalache**, P Wang, GE LeCroy, **EM Pavelescu, R Gavrila**, E Vasile, A Terec, YP Sun, CHEMICAL PHYSICS LETTERS Volume: 613 Pages: 40-44 Published: OCT 3 2014 Impact Factor: 1.991
10. *HOW SHAPE AFFECTS PLASMONIC PROPERTIES OF METALLIC NANOSPHERES*, **Sandu, T.; Boldeiu, G**.; DIGEST JOURNAL OF NANOMATERIALS AND BIOSTRUCTURES Volume: 9 Issue: 3 Pages: 1255-1262 Published: JUL-SEP 2014 Impact Factor: 1.123
11. *Independent and combined information transfer from axicon and helical phase distributions*, Mihailescu, Mona; Preda, Liliana; **Kusko, Cristian**, APPLIED OPTICS Volume: 53 Issue: 21 Pages: 4691-4699 Published: JUL 20 2014 Impact Factor: 1.649
12. *Laser parallel nanofabrication by single femtosecond pulse near-field ablation using photoresist masks*, F Jipa, **A Dinescu**, M Filipescu, I Anghel, M Zamfirescu, R Dabu, OPTICS EXPRESS Volume: 22 Issue: 3 Pages: 3356-3361 Published: FEB 10 2014 Impact Factor: 3.525
13. *Near-field and extinction spectra of rod-shaped nanoantenna dimers*, **Sandu, Titus**, PROCEEDINGS OF THE ROMANIAN ACADEMY SERIES A-MATHEMATICS PHYSICS TECHNICAL SCIENCES INFORMATION SCIENCE Volume: 15 Issue: 4 Pages: 338-345 Published: OCT-DEC 2014 Impact Factor: 1.115
14. *Quantum optical lithography from 1 nm resolution to pattern transfer on silicon wafer*, E Pavel, SI Jinga, BS Vasile, **A Dinescu** V Marinescu, R Trusca, N Tosa, OPTICS AND LASER TECHNOLOGY Volume: 60 Pages: 80-84 Published: AUG 2014 Impact Factor: 1.649
15. *Design of Antimicrobial Membrane Based on Polymer Colloids/Multiwall Carbon Nanotubes Hybrid Material with Silver Nanoparticles*, E Rusen, A Mocanu, LC Nistor, **A Dinescu**, L Calinescu, G Mustatea, SI Voicu, C Andronescu, A Diacon, ACS APPLIED MATERIALS & INTERFACES Volume: 6 Issue: 20 Pages: 17384-17393 Published: OCT 22 2014 Impact Factor: 3.672
16. *Improved antibacterial behavior of titanium surface with torularhodin-polypyrrole film*, C Ungureanu, S Popescu, G Purcel, V Tofan, **M Popescu**, A Salageanu, C Pirvu, MATERIALS SCIENCE & ENGINEERING C-MATERIALS FOR BIOLOGICAL APPLICATIONS Volume: 42 Pages: 726-733 Published: SEP 1 2014 Impact Factor: 2.736
17. *Toward Structurally Defined Carbon Dots as Ultracompact Fluorescent Probes*, GE LeCroy, SK Sonkar, F Yang, **LM Veca**, P Wang, KN Tackett, JJ Yu, E Vasile, HJ Qian, YM Liu, P Luo, YP Sun, ACS NANO Volume: 8 Issue: 5 p: 4522-4529, MAY 2014 Impact Factor: 12.033
18. *Design and FEM analysis of a new micromachined electro-thermally actuated micromanipulator*, **R C Voicu, R Mulle**r, ANALOG INTEGRATED CIRCUITS AND SIGNAL PROCESSING Volume: 78 Issue: 2 Special Issue: SI Pages: 313-321, Published: FEB 2014 Impact Factor: 0.401
19. *Fabrication of thin dielectric membranes for microwave applications*, **A Avram, AC Bunea, C Obreja, M Avram, B Bita, C Parvulescu, M Popescu, D Neculoiu**, DIGEST JOURNAL OF NANOMATERIALS AND BIOSTRUCTURES Volume: 9 Issue: 3 Pages: 1263-1269 Published: JUL-SEP 2014 Impact Factor: 1.123
20. *Influence of geometry and material properties on resonant frequencies and sensitivity of MEMS cantilever-type structures*, G Ionascu, A Sandu, **E Manea, R Gavrila**, CD Comeaga, L Bogatu, D Besnea, JOURNAL OF OPTOELECTRONICS AND ADVANCED MATERIALS Volume: 16 Issue: 5-6 Pages: 579-590 Published: MAY-JUN 2014 Impact Factor: 0.563
21. *On-Chip Controlled Surfactant DNA Coil Globule Transition by rapid solvent exchange using hydrodynamic flow focusing*, C. Iliescu, **C Marculescu,** S Venkataraman, B Languille, H. Yu, , G. Tresset, LANGMUIR Volume: 30 Issue: 44 Pages: 13125-13136 Published: NOV 11 2014 Impact Factor: 4.384

Papers published in ISI ranked periodicals (with impact factor)

22. *Optimization of Membrane Processes with Applications in Transport and Adsorption of Nitrate Ions*, DE Pascu, **OT Nedelcu**, M Segarceanu, M Totu, C **Trisca-Rusu**, LF Pascu, AC Nechifor, REVISTA DE CHIMIE, Volume: 65 Issue: 12 Pages: 1407-1412 Published: DEC 2014 Impact Factor: 0.677

23. *A Sensitive A(3)B Porphyrin Nanomaterial for CO_2 Detection*, E Fagadar-Cosma, D Vlascici, G Fagadar-Cosma, A Palade, A Lascu, I Creanga, M Birdeanu, R Cristescu, **I Cernica**, MOLECULES Volume: 19 Issue: 12 Pages: 21239-21252 Published: DEC 2014 Impact Factor: 2.095

24. *Charge transport and memristive properties of graphene quantum dots embedded in poly(3-hexylthiophene) matrix*, **A C Obrej, D Cristea, I Mihalache, A Radoi, R Gavrila, F Comanescu, C Kusko**, APPLIED PHYSICS LETTERS Volume: 105 Issue: 8 Article Number: 083303 Published: AUG 25 2014 Impact Factor: 3.515

25. *First principles calculations, neutron, and x-ray diffraction investigation of $Y_3Ni_{13}B_2$, $Y_3Co_{13}B_2$, and $Y_3Ni_{10}Co_3B_2$*, N Plugaru, M Valeanu, **R Plugaru**, J Campo, JOURNAL OF APPLIED PHYSICS Volume: 115 Issue: 2 Article Number: 023907 Published: JAN 14 2014 Impact Factor: 2.185

26. *Gold nano-island arrays on silicon as SERS active substrate for organic molecule detection*, **T Ignat**, MA Husanu, R Munoz, **M Kusko, M Danila,** CM Teodorescu, THIN SOLID FILMS Volume: 550 Pages: 354-360 Published: JAN 1 2014 Impact Factor: 1.867

27. *Hierarchical nanostructures of PbS obtained in the presence of water soluble polymers,* A Mocanu, E Rusen, A Diacon, **A Dinescu**, POWDER TECHNOLOGY Volume: 253 Pages: 237-241 Published: FEB 2014 Impact factor: 2.269

28. *Impact of RF and DC Plasma on Wood Structure*, **A Avram**, V Covlea, A Matei, M Bazavan, B Butoi, **B Bita**, E Barna, A Jipa, ROMANIAN REPORTS IN PHYSICS 01/2014; 66(3) Impact Factor: 1.137

29. *Influence of film thickness on the morphological and electrical properties of epitaxial TiC films deposited by reactive magnetron sputtering on MgO substrates*, NC Zoita, V Braic, **M Danila**, AM Vlaicu, C Logofatu, CEA Grigorescu, M Braic, JOURNAL OF CRYSTAL GROWTH Volume: 389 Pages: 92-98 Published: MAR 1 2014 Impact Factor: 1.693

30. *Influence of pH on the formulation of TiO2 nano-crystalline powders with high photocatalytic activity*, A Molea, V Popescu, NA Rowson, **A Dinescu**, POWDER TECHNOLOGY Volume: 253 Pages: 22-28 Published: FEB 2014 Impact Factor: 2.269

31. *Instability of structural defects generated by electron irradiation in GaInNAs quantum wells*, **E. M. Pavelescu**, M. Dumitrescu, M.Guina, JOURNAL OF LUMINESCENCE Volume: 154 Pages: 584-586 Published: OCT 2014 Impact Factor: 2.367

32. *Memory effect in carbon quantum DOT-PEG(1500N) composites*, **I Mihalache, LM Veca, M Kusko,** D Dragoman, CURRENT APPLIED PHYSICS Volume: 14 Issue: 12 Pages: 1625-1632 Published: DEC 2014 Impact factor: 2.026

33. *Nafion based nanocomposite membranes with improved electric and protonic conduction*, **A Boldeiu, E Vasile, R Gavrila, M Simion, A Radoi, A Matei, I Mihalache, R Pascu, M Kusko**, COLLOIDS AND SURFACES A-PHYSICOCHEMICAL AND ENGINEERING ASPECTS, Volume: 461Pages: 133-141 Published: NOV 5 2014 Impact Factor: 2.354

34. *Nanocrystalline Sm0.5Sr0.5CoO3-delta synthesized using a chelating route for use in IT-SOFC cathodes: Microstructure, surface chemistry and electrical conductivity*, **R Scurtu, S Somacescu,** JM Calderon-Moreno, D Culita, I Bulimestru, N Popa, A Gulea, P Osiceanu, JOURNAL OF SOLID STATE CHEMISTRY Volume: 210 Issue: 1 Pages: 53-59, Published: FEB 2014 Impact Factor: 2.200

35. Photocatalytical Inactivation of Enterococcus faecalis from Water Using Functional Materials Based on Natural Zeolite and Titanium Dioxide, **C Bandas, C Orha,** C Misca, C Lazau, P Sfirloaga, S Olariu, CHINESE JOURNAL OF CHEMICAL ENGINEERING Volume: 22 Issue: 1 Pages: 38-43 Published: JAN 2014 Impact Factor: 0.872

36. *Pt nanoparticles on graphene - polyelectrolyte nanocomposite: Investigation of H_2O_2 and methanol electrocatalysis*, **A Bragaru**, E Vasile, **C Obreja, M Kusko, M Danila, A Radoi**, MATERIALS CHEMISTRY AND PHYSICS Volume: 146 Issue: 3 Pages: 538-544, Published: AUG 14 2014 Impact Factor: 2.129

37. *The influence of the iron based nanoparticles density in growth of carbon nanotubes by C-LCVD method*, **I. P. Morjan**, A. Badoi, C Ceaus, JOURNAL OF OPTOELECTRONICS AND ADVANCED MATERIALS Volume: 16 Issue: 3-4 Pages: 429-434 Published: MAR-APR 2014 Impact Factor: 0.563

38. *Towards a terahertz direct receiver based on graphene up to 10 THz*, **M Dragoman, M Aldrigo, A Dinescu**, D Dragoman, A Costanzo, JOURNAL OF APPLIED PHYSICS Volume: 115 Issue: 4 Article Number: 044307 Published: JAN 28 2014 Impact Factor: 2.185

Invited Papers

1. *Probing the nano-bio interactions by optical and electrical spectroscopies*, **M Kusko, M Simion**, Advanced Spectroscopies on Biomedical and Nanostructured Systems, Cluj-Napoca, Romania, September 7-10, 2014

2. *Nanoscale Patterning Using Electron Beam Lithography For Graphene Based Devices*, **A. Dinescu, M. Dragoman, D. Cristea, R. Muller**, 18th INTERNATIONAL SCHOOL ON CONDENSED MATTER PHYSICS "Challenges of Nanoscale Science: Theory, Materials, Applications" - 18 ISCMP, 1-6 September 2014, Varna, Bulgaria

3. The Possibilities and Limitations of Scanning Electron Microscopy in Advanced Characterization of Micro and Nano Materials and Structures, **A Dinescu**, University "DUNAREA DE JOS" GALATI CSSD-UDJG 2014 - second edition, 15-16 may 2014, Galati, Romania

Papers published in periodical without impact factor

1. *Aspects regarding synthesis and applications of ZnO nanomaterials*, **A. Matei, V. Tucureanu**, L. Dumitrescu, Buletinul Universitatii Transilvania Brasov, Vol. 7 (56) No. 2 [2014]
2. *Compact, Wearable Antennas for Battery-Less Systems Exploiting Fabrics and Magneto-Dielectric Materials*, A Costanzo, D Masotti, and **M Aldrigo**, Electronics, Volume 3, Issue 3, 474-490, Published: 18 August 2014.
3. *Confocal spheroidal capacitors: Analytical versus boundary integral equation calculations of their capacitance*, **T Sandu**, PROCEEDINGS OF PLUMEE, Issue No.1 - Volume 4 (2014);
4. *Facile Synthesis of Gold Nanostructures Using a One-Step Chemical Method*, S Mihai, **A Dinescu**, L CNistor, D Ciuparu, ADVANCED SCIENCE, ENGINEERING AND MEDICINE, Volume 6, Number 4, April 2014, pp. 399-404(6)
5. *Laser Ablation Versus Vacuum Evaporation For Crystalline Bismuth Oxide Thin Films Preparation*, S. Condurache-Bota, M. Praisler, C. Constantinescu, **R. Gavrila**, N. Tigau, C. Gheorghies, ANNALS OF "DUNAREA DE JOS" UNIVERSITY OF GALATI, MATHEMATICS, PHYSICS, THEORETICAL MECHANICS FASCICLE II, Year VI (XXXVII) 2014, No. 1
6. *Magnetic hyperthermia on mouse B16 melanoma using superparamagnetic nanoparticles*, **M Avram, M Volmer, V Tucureanu, A Avram, A Radoi**, I Petrescu, Studia Universitatis "Vasile Goldiş", Seria Ştiinţele Vieţii (Life Sciences Series), Vol. 24, supplement 1, pp. 39-45, www.studiauniversitatis.ro (revista cat. B+) [2014]
7. *Research strategy on developing additive manufactured bespoke ophthalmic instruments assisted by an online integrated platform*, Mihaela-Elena LUPEANU, Allan E.W. RENNIE, Maria Magdalena ROŞU, Gabriel MOAGĂR-POLADIAN, U.P.B. Sci. Bull., Series D, Vol. 76, Iss. 2, p. 143, (2014).
8. *Two Packaging Solutions for High Temperature SiC Diode Sensors*, G. Brezeanu, F. Draghici, M. Badila, **F. Craciunoiu**, G. Pristavu, **R. Pascu**, F. Bernea, Materials Science Forum 778-780, 1063-1066, 2014

Papers published in proceedings and presented at conferences

1. *0-level encapsulation of reliable MEMS switch structures for RF applications*, **D Vasilache**, ISD Industry Space Days 2014, 3-4 June 2014, ESTEC Noordwijk The Netherlands.
2. *A probabilistic model of the adhesive contact forces between rough surfaces in the MEMS stiction context*, V. Hoang Truong, L.Wua, M. Arnsta, J-C. Golinvala, **R. Muller, R. Voicu** , S. Paquayc and L. Noelsa, Book of abstracts of the 6th International Conference on Advanced Computational Methods in Engineering, ACOMEN 2014 23–28 June 2014, Ghent, Belgium.
3. *ASPIICS: an externally occurlted coronagraph for PROBA -3. Design evolution*, E. Renotte, E. C. Baston, A. Bemporad, G. Capobianco, **I. Cernica**, R. Darakchiev, F. Denis, R. Desselle, L. De Vos, S., M. Focardi, T. Górski, R. Graczyk, J.P. Halain, A. Hermans, C. Jackson, C. Kintziger, J. Kosiec, N. Kranitis, F. Landini, V. Lédl, G. Massone, A. Mazzoli, R.k Melich, D. Mollet, M. Mosdorf, G. Nicolini, B. Nicula, P. Orleański, M.C. Palau, M. Pancrazzi, A. Paschalis, R. Peresty, J.Y. Plesseria, M. Rataj, M. Romoli, C. Thizy, M. Thomé, K. Tsinganos, R. Wodnicki, T. Walczak, A. Zhukov, Proc. SPIE 9143, Space Telescopes and Instrumentation: Optical, Infrared, and Millimeter Wave, 91432M, [2014]
4. *Bolometers for space applications in middle and long infrared*, M Kusko, ESA industry Space Days- 3-4 iunie 2014, ESTEC Noordwijk, Olanda
5. *Capacitance of Back-Gated Nanowires in Various Dielectric Embeddings*, **G. Boldeiu, V. Moagar- Poladian, T. Sandu**, 37th IEEE International Semiconductor Conference – CAS 2014, 13- 15 Oct. 2014, Sinaia, Romania, IEEE CAS Proceedings 2014, pp. 273-276.
6. *Colorimetric and optical CO2 sensor based on Fe(III) metalloporphyrin*, E Fagadar-Cosma, **I Cernica**, A Palade, A Lascu, I Creanga, D Vlascici, M Birdeanu, New Trends and Strategies in the Chemistry of Advanced Materials with Relevance in Biological Systems, Technique and Environmental Protection New Trends and Strategies in the Chemistry of Advanced Materials, 5-6 June 2014 Timisoara, Romania
7. *Composites adhesives based on synthetic and lignocellulosic monomers*, L. Dumitrescu. I. Manciulea, **A. Matei**, Proceeding of the 5th International Conference Advanced Composite Materials Engineering, COMAT, Brasov, Romania, [2014]
8. *Design and Analyses of a laterally driven MEMS electro-thermally Microgripper*, **R. Voicu, R. Müller, F. Craciunoiu, A. Baracu**, Conference SSI2014, Viena, Austria, March 26-27, 2014;
9. *Design and Analysis of Polysilicon Thin Layers and MEMS Vibrating Structures*, **R. Voicu**, M. Michalowski, Z. Rymuza, **R. Gavrila, C. Obreja, R. Müller, A. Baracu**, Conference DTIP 2014 - SYMPOSIUM on Design, Test, Integration & Packaging of MEMS/MOEMS, Proc. DTIP 2014 -SYMPOSIUM on Design, Test, Integration&Packaging of MEMS/MOEMS, ISBN, p. 129-133, 2014, Cannes, France, 2014;
10. *Design and building up of an electro thermally actuated cell microgripper*, A Somà, S Iamoni, **R Voicu, R Müller**; International Conference on Mechanical Engineering (ME '14)- Recent Advances in Mechanical Engineering and Mechanics-10, Venetia, Italia, Martie, 15-17, 2014; Procedings - ISBN: 978-1-61804-226-2, pp. 125-130, 2014
11. *Design and Characterization of a Micromachined Receiver for W Band Applications*, **A.C.Bunea, D.Neculoiu**, P.Calmon, A.Takacs, 44th European Microwave Week, EuMW –2014, 5 – 10 October 2014, Rome, Italy,
12. *Design and fabrication of a MEMS chevron-type thermal actuator*, **A. Baracu, R. Voicu, R. Muller, A. Avram,** M. Pustan, R. Chiorean, Book of Abstract of 11th International Conference on Nanosciences and Nanotechnologies (NN14), 8-11 July 2014, Thessaloniki, Greece.

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12. *Design and fabrication of a MEMS chevron-type thermal actuator*, **A. Baracu, R. Voicu, R. Muller, A. Avram,** M. Pustan, R. Chiorean, Book of Abstract of 11th International Conference on Nanosciences and Nanotechnologies (NN14), 8-11 July 2014, Thessaloniki, Greece.

13. *Detecting electromagnetic waves with a single atom sheet,* **M. Dragoman**, WS- Advnced in the Carbon based mart systems for wireless application, European Microwave Conference, Roma, Italia, 2014.

14. *Diffraction patterns from holographic masks generated using combined axicon and helical phase distributions*, M. Mihailescu, L. Preda, **C. Kusko**, E. I. Scarlat, International Conference "Advanced Topics in Optoelectronics, Microelectronics and Nanotechnologies, Constanta, Romania, 21-24 aug. 2014

15. *DLC Hard Protective Coatings Synthesized by Pulsed Laser Deposition,* Nita, L. Duta, G.E. Stan, C Popescu, V. Craciun, M. Husanu, **B. Bita**, R. Ghisleni, C. Himcinschi, A. C. Popescu, EMRS SPRING MEETING, Symposium: G - Carbon- or nitrogen-containing nanostructured thin films, Lille, France – May 26th - 30th 2014

16. *Effect of Li, Cu And N Doping on The Morphology, Optical And Electrical Properties of Zno Thin Films Prepared by Spin-Coating Technique*, **A I Danciu, I Mihalache, B Bita, R Plugaru**, 14th INTERNATIONAL BALKAN WORKSHOP ON APPLIED PHYSICS - IBWAP 2014, July 2-4, 2014, Constanta, Romania, Book of Abstracts, S1 P25 pp.74.

17. *Electro-Thermal Actuators for Space and Micro-Nano Biomanipulation Applications*, **R C Voicu**, **R Müller, A Baracu, C Tibeica,** C Barleanu, M Pustan, NEMS 2014 - International Seminar on Nanomechanical Systems, Paris, France, June 30 - July 2, 2014.

18. *Exploitation of graphene as HIS and RIS for devices in the MW and THz frequency ranges*, **M. Aldrigo, M. Dragoman**, A. Costanzo, and D. Masotti, 44th European Microwave Conference (EuMC) 2014, pp. 355-358, 2014.

19. *Fabrication of spiral phase plates for optical vortices*, **R Tudor, M Kusko, C Kusko, F Craciunoiu, A Avram, D Vasilache**, IEEE CAS 2014 Proceedings (37th IEEE International Semiconductor Conference – CAS 2014, 13- 15 Oct. 2014, Sinaia, Romania) pag. 139 – 142.

20. *Failure Modes and Mechanisms of Electrolytic Capacitors*, T. Bajenescu, **M. Bazu**, International Conference on Quality and Dependability CCF 2014 Sinaia, September 17-19, 2014.

21. *Failure risks for silicon and non-silicon transistors*, **M. Bazu,** T. Bajenescu, International Conference on Quality and Dependability CCF 2014, Sinaia, September 17-19, 2014.

22. *First principles study of the semiconductor to metal transition, dc conductivity and magnetism in (Al,Ti) codoped ZnO,* **R. Plugaru, T. Sandu,** N. Plugaru, EMRS-2014-Fall Meeting.

23. *Floating Connector for Surface Integrated Waveguide Components and Its Extended Applications*, **A. Ştefănescu, V. Buiculescu, I. Giangu**, APMC 2014 - Asia-Pacific Microwave Conference, Session WE1D waveguide and Transmission Line structures, 4-7 November, 2014, Sendai , Japan, http://apmc2014.org/

24. *Fluorescence and Fluorescence Quenching in a Two-Level System,* **T Sandu**, 37th IEEE International Semiconductor Conference – CAS 2014, 13- 15 Oct. 2014, Sinaia, Romania IEEE CAS Proceedings 2014, pp. 269-271.

25. *From Hydrophilic to Hydrophobic of ZnO Surface* **L. Sirbu, L. Ghimpu, R. Muller,** From Hydrophilic to Hydrophobic of ZnO Surface, 5th Conference of Physicists of Moldova (CPM-2014), Chisinau- 2014, 22 - 25 OCTOMBRIE 2014, Book of Abstracts

26. *GaN/Si Acoustic Devices Towards Sensing Applications*, **A. Stefanescu,** A.Stavrinidis, **V. Buiculescu, I. Giangu**, F. Bechtold, **A. Dinescu**, G.Stavrinidis, T. Kostopoulos, G. Konstantinidis, **A. Muller**, 7th Wide Band Gap Semiconductor & Components Workshop Proceedings pp. 299 – 302, 11 - 12 September 2014, ESA-ESRIN, Italy, http://congrexprojects.com/2014-events/14c10/home

27. *GaN-based SAW structures resonating within the 5.4-8.5 GHz frequency range, for high sensitivity temperature sensors*, **A. Muller**, G. Konstantinidis, I**. Giangu, V. Buiculescu, A. Dinescu, A. Stefanescu**, A. Stavrinidis, G. Stavrinidis, A Ziaei, International Microwave Symposium (IMS), session "TH2F: Sensors and Sensor Systems 1-6 June 2014, Tampa, USA http://www.ims2014.org/

28. *Graphene-based nano-rectenna in the far infrared frequency band*, **M. Aldrigo, and M. Dragoman**, 44th European Microwave Conference (EuMC) 2014, pp. 1202-1205, 2014.

29. *High Temperature SiC-Sensors*, G. Pristavu, F. Draghici, M. Badila, G. Brezeanu, **R. Pascu, F. Craciunoiu**, 2014 IEEE 20th International Symposium for Design and Technology in Electronic Packaging (SIITME), 329-332, 2014

30. *Hybrid PbS QDs/silicon multispectral photodetector integrable with silicon ICs*, **D Cristea, P Obreja, A Dinescu**, 15th edition of Trends in Nanotechnology International Conference (TNT2014), Barcelona-Spain, October 27-31, 2014, http://www.tntconf.org/2014/

31. *Hydrogen gas sensors based on silicon carbide (SiC) MOS capacitor structure*, **R Pascu**, J Neamtu, **F Craciunoiu**, G Brezeanu, D Ovezea EMRS 2014 Fall Meeting, Varsovia, Polonia

32. *In Situ Generation of Polyaniline Inside Zeolite Pores for Retention of Ions and for Controlled Drug Delivery*, **A. C. Nechifo**r, A Ivan, SI Voicu, V Danciulescu, R Trusca, Edited by: Antoniac, I; Cotrut, CM; Antoniac, A, Conference: 5th international Conference on Biomaterials, Tissue Engineering and Medical Devices (BiomMedD 2012) Location: Constanta, ROMANIA Date: AUG 29-SEP 01, 2012, BIOMMEDD V Book Series: Key Engineering Materials Volume: 583 Pages: 91-94 Published: 2014

Papers published in proceedings and presented at conferences

22. *First principles study of the semiconductor to metal transition, dc conductivity and magnetism in (Al,Ti) codoped ZnO,* **R. Plugaru, T. Sandu,** N. Plugaru, EMRS-2014-Fall Meeting.

23. *Floating Connector for Surface Integrated Waveguide Components and Its Extended Applications*, **A. Ştefănescu, V. Buiculescu, I. Giangu**, APMC 2014 - Asia-Pacific Microwave Conference, Session WE1D waveguide and Transmission Line structures, 4-7 November, 2014, Sendai , Japan, http://apmc2014.org/

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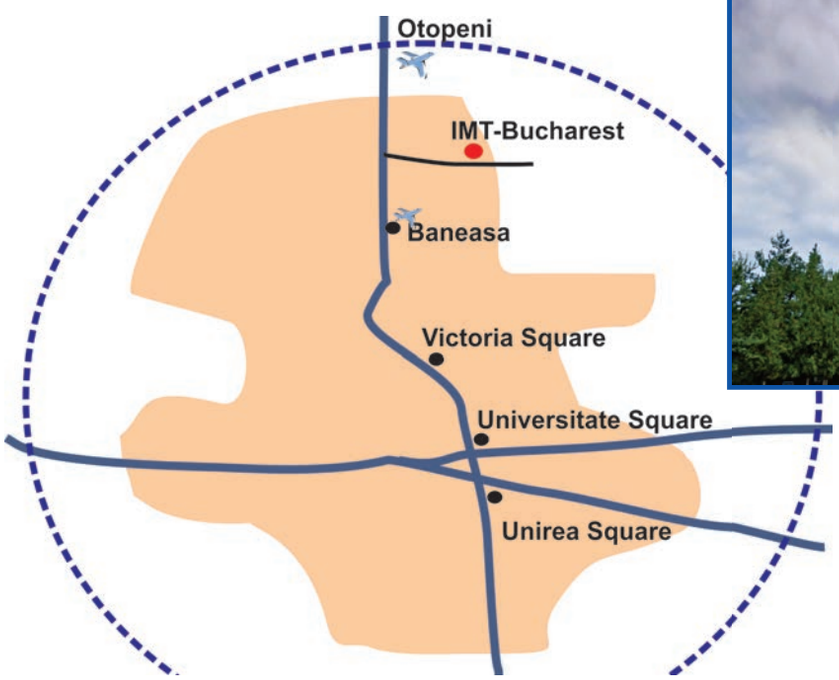

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