Ministry of Education, Research, Youth and Sport, Romania

National Authority for Scientific Research

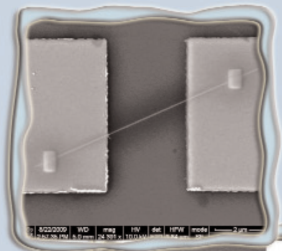
IMT-Bucharest

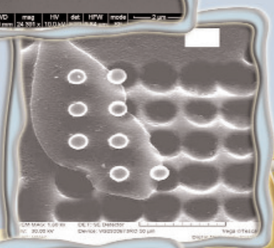
SCIENTIFIC REPORT 2009

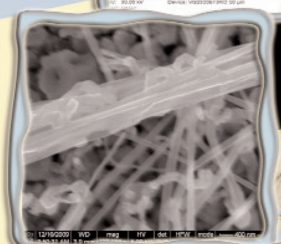
National Institute for R&D in Microtechnologies

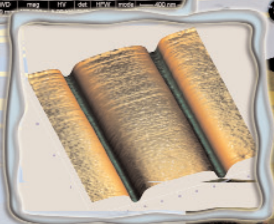
From micro- to nanotechnologies

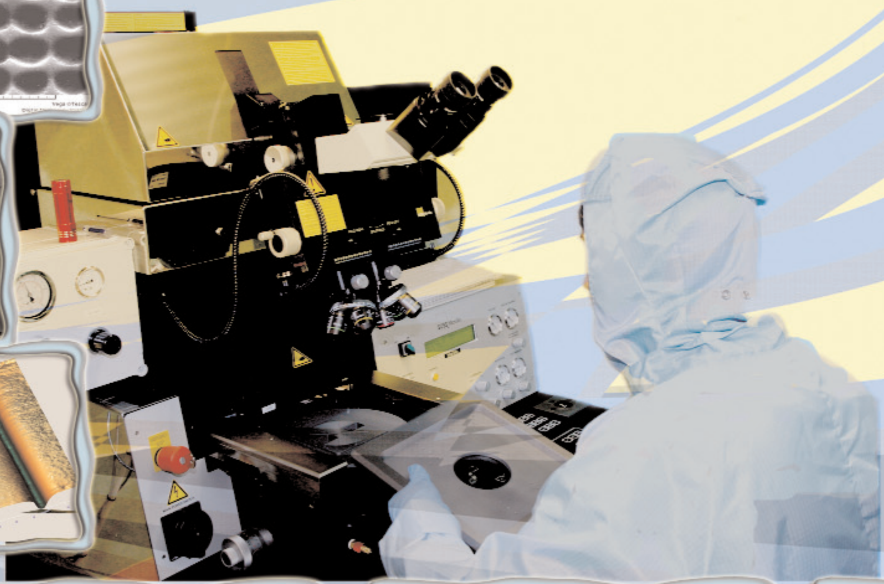
and micro-bio-nanotechnologies











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

National Institute for Research and Development in Microtechnologies

IMT-Bucharest

SCIENTIFIC REPORT 2009

Experimental infrastructure

Research and technological development

Design: IMT - Bucharest

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About IMT

The present organization originates in the Centre of Nanotechnology (founded in September 1991), then becoming the Institute for Microtechnologies (IMT) by a decision of the Romanian Government, in July 1993. To our knowledge it was the first institute with this profile from Central and Eastern Europe. The present National Institute for Research and Development in Microtechnologies (IMT - Bucharest) was set up at the end of 1996 from IMT merging with the former ICCE (Research Institute for Electronic Components, working in semiconductor electronics).

The field of activity of the National Institute for Research and Development in Microtechnologies (or simply IMT) corresponds today to micro-nano-biotechnologies. IMT is coordinated by the Ministry of Education, Research and Innovation, through the National Authority for Scientific Research. However, IMT acts basically as an autonomous, non-profit research company. As far as the participation to national and European projects is concerned, IMT is assimilated to a public research institution.

IMT became visible at the national level, especially by coordinating various projects financed from the National Programme MATNANTECH (New Materials, Micro and Nanotechnologies) (2001-2006), and then from CEEX (since 2005) and PN II (since 2007). Between 2003 and 2009 IMT was involved in approximately European 20 projects in FP6 and FP7, as well as in other European projects from ENIAC, Eureka, Leonardo, ERA-NET etc.. IMT houses a European Centre of Excellence financed by the EC (2008-2011) the first one after Romania became an EU member. This is called MIMOMEMS and acts in RF and Opto MEMS. In December 2009, the European Associated Laboratory (LEA) was inaugurated, with IMT – Bucharest, LAAS/CNRS Toulouse and FORTH, Heraklion. This LEA is acting in the field of RF MEMS/NEMS.

About the present report

The Scientific Report 2009 starts with the basic figures about IMT in 2009 and continues with the organizational chart and the Board of Directors The personnel figures are rather stable in the last years, with no significant brain-drain. In financial terms, the volume of activity of IMT in 2009 experienced a decrease, following the continuous increase taking place during the previous four years (2005-2008). The volume of investments from various sources during the 2006-2009 period is about 7 millions of euro.

The second part of this report is devoted to basic infrastructures (clean room areas) and equipments. IMT displays a broad range of resources for micro- and nanotechnologies, from simulation and design computer techniques, to characterization tools, fabrication equipments (including a mask shop), and testing equipments (including a reliability laboratory). We are underlying the fact that research for biomedical applications is sustained by specific equipments and by techniques dealing with biological materials or bio-compatible materials.

The third part is the core of this report and it is devoted to the presentations delivered by IMT laboratories for research and development (R&D). These research groups, rather stable during the relatively short history of IMT, are presenting their assets, as well as the results of the on-going projects (including international ones) during 2009.

The last part of the report contains the list of main scientific publications.

Other information about IMT

Apart from scientific research and technological development, IMT is active in technology transfer and innovation, as well as in education and training. Since 2005, IMT includes an autonomous Centre for Technology Transfer in Microengineering (CTT-Baneasa), and in June 2006, a Science and Technology Park for Micro- and Nanotechnologies (MINATECH-RO) was set-up by a consortium with just two partners: IMT (housing most of the park area), and University "Politehnica" of Bucharest. The facilities provided to companies in the park include rooms for working points, priority of access to scientific and technological services provided by IMT, as well as the possibility to install their own equipments in the technological area of IMT. The last possibility is to be implemented now and opens the way for an exchange of services with IMT, including cooperation in a small-scale production. CTT-Baneasa is pursuing the technology transfer and innovation, by promoting the development of a "cluster" of organizations either providing or using the knowledge and the technologies in the domain. The same centre is providing services to the Science and Technology Park.

IMT is open for educational activities in cooperation with universities: undergraduate, M.Sc. and Ph.D. studies, and also for "hands-on training". IMT was active in a Marie Curie training by research network and also in Leonardo programme. Since October 2009, IMT is covering fully a number of disciplines in the new M.Sc. Courses organized by the University "Politehnica" of Bucharest (PUB). In November 2009, IMT also cooperated with PUB in organizing a Eurotraining course on "Nanotechnology for Electronics".

IMT is organizing the Annual Conference for Semiconductors (CAS), an IEEE event (CAS 2009 was the 32nd edition), now largely devoted to micro- and nanotechnologies. IMT is also organizing within the Romanian Academy the "National Seminar for Nano-science and Nanotechnologies" (the 8th edition - in 2009). The institute is co-editing (in English): "Romanian Journal for Information Science and Technology" (since 2008, in the ISI Thomson database), a publication of the Romanian Academy; the series of volumes "Micro- and Nanoengineering", in the Publishing House of the Romanian Academy (15 volumes until 2009).

Prof. Dan Dascalu
CEO and President of the Board

Prof. *Dan Dascalu* was the founder and the director of the Centre for Microtechnology (1991), the Institute of Microtechnology (1993), the National Institute for Research and Development in Microtechnologies (IMT-Bucharest). Dan Dascalu is also professor at the "Politehnica" University of Bucharest (PUB), Department of Electronics and Telecommunications and 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, respectively) as well as of many technical papers published in scientific periodicals or conference proceedings.

Prof. 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). He is a member of the Consultative Board for R&D and President of the Commission for "New Materials, Micro- and Nanotechnologies".

Human resources, funding sources, investments.

Fig.1 (a, b, c) provides information about the number and distribution of researchers active in IMT in 2009 (70 persons). More then one third of them are senior researchers (Fig. 1.a). 69% of them have the Ph.D. degree or are Ph.D. students (Fig. 1.b). The average age is slightly above 40 years (Fig. 1.c).

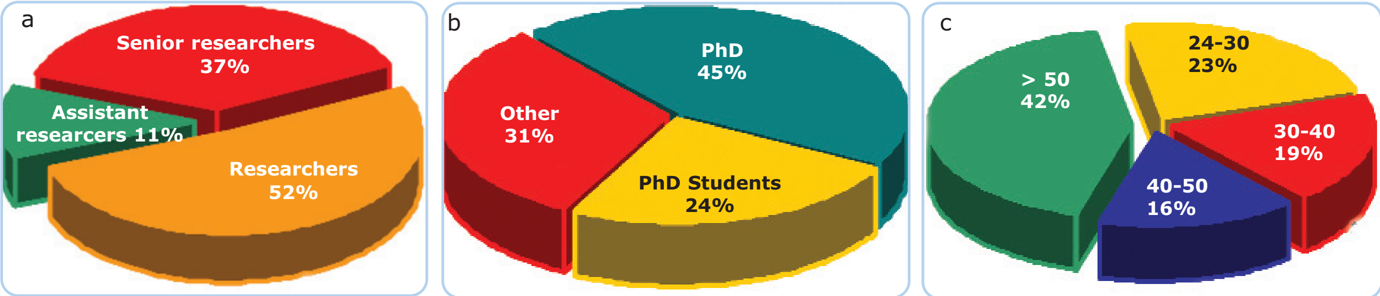


Fig 1 - Researchers active in IMT (74)

Fig.2 gives information about the total number of specialists active in IMT in 2008 (108 people): researchers and specialists providing technical services. Their background is shown in Fig.2. The male (59) - female (49) number is relatively balanced. The number (and age distribution) of specialized IMT personnel temporarily working abroad (21) is shown in Fig. 3 in comparison with the personnel active in the institute (108).

Fig 2 - Background of researchers and specialists providing technical services (108)

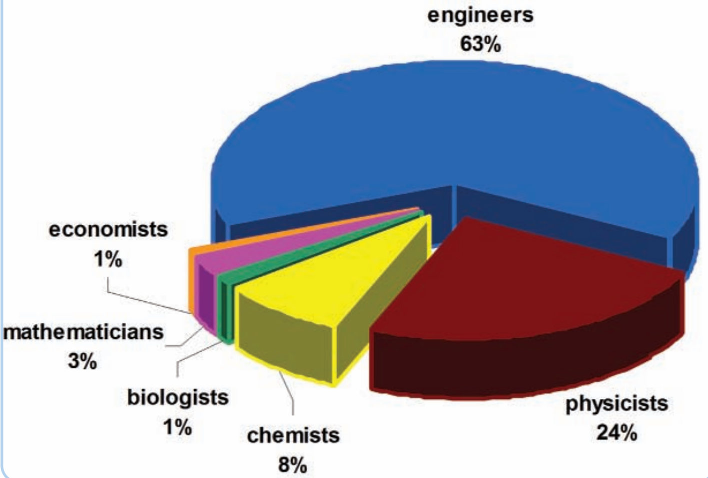
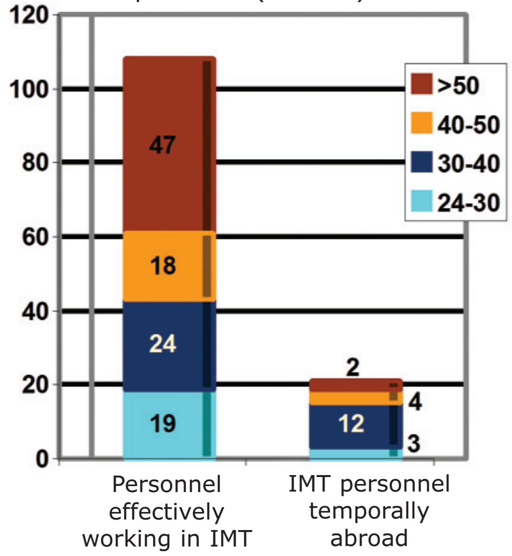


Fig 3 - Age distribution of specialised personnel (108+21)



Funding sources.

Fig. 4.a shows the funding sources in 2009, excluding investments from various contracts. In 2009, the majority of total funding (49%) comes from national R&D programmes (competitive funding, through open calls) and only 24% is provided by core funding (public money available to national institutes for R&D, since 2003).

Fig.4.b displays the evolution along the last six years (b). The decrease in 2009 in comparison with 2008 (approximately 6 millions in comparison with 8 millions of euro) follows a sustained and substantial annual increase from 2004 to 2008.

Fig 4a -Funding sources (EUR), 2009

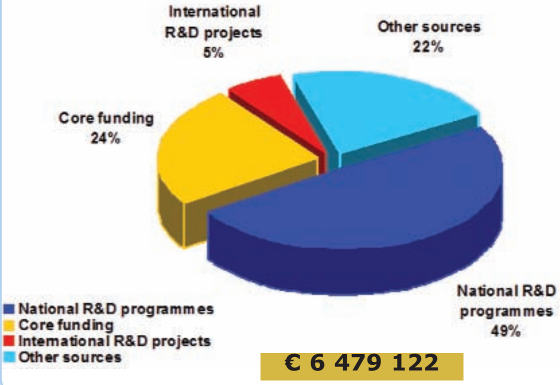
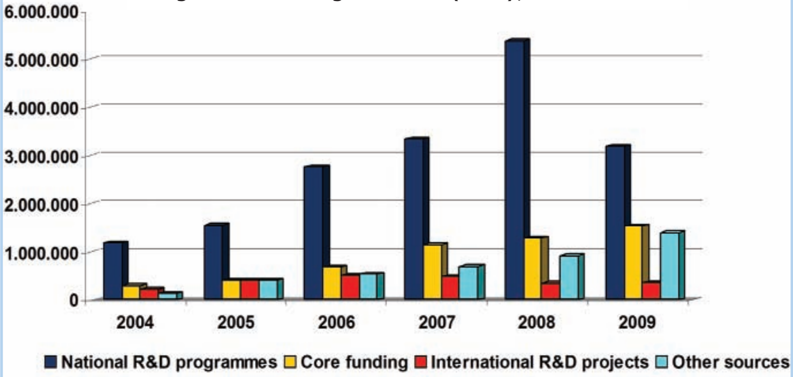


Fig 4b - Funding sources (EUR), 2004-2009



Investments: dynamics and structure.

The dynamics of investments during the previous four years of existence of IMT as a national institute (2004-2008) is even more spectacular (Fig. 5).

The direct investments from central funding (from the public budget) have been in general comparatively low or even negligible, with the exception of 2006 and 2007.
However, the investments in equipments in the last four years (2006-2007) has been about 7 millions of euro, especially due to a large proportion by funding from R&D projects financed from the national programmes, including infrastructure projects and an European REGPOT project as well. Fig. 6 shows the structure of investments.

Fig 5 - Evolution of IMT investments (EUR), 2005-2009

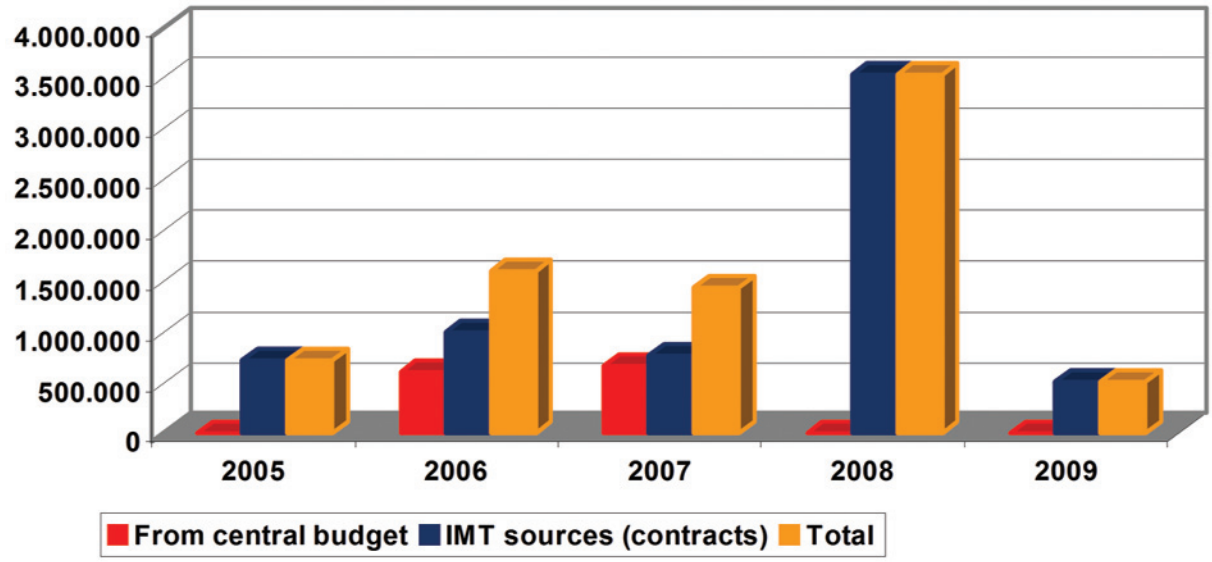


Fig 6a - IMT investments, per category 2005-2008

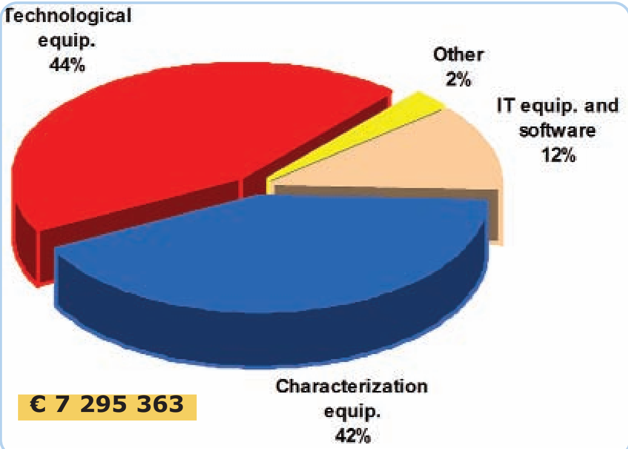
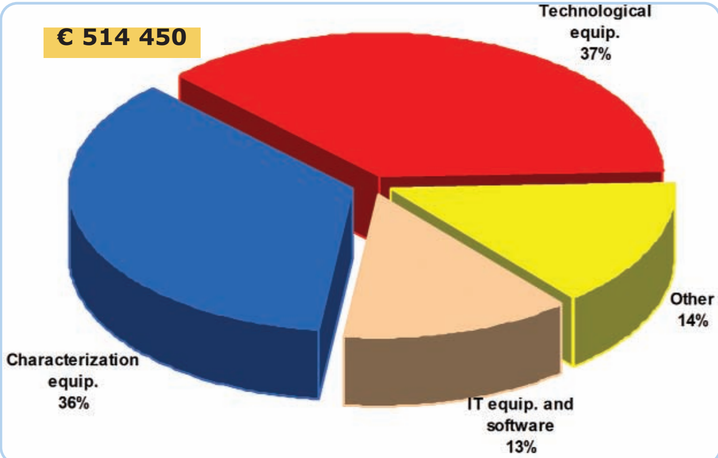
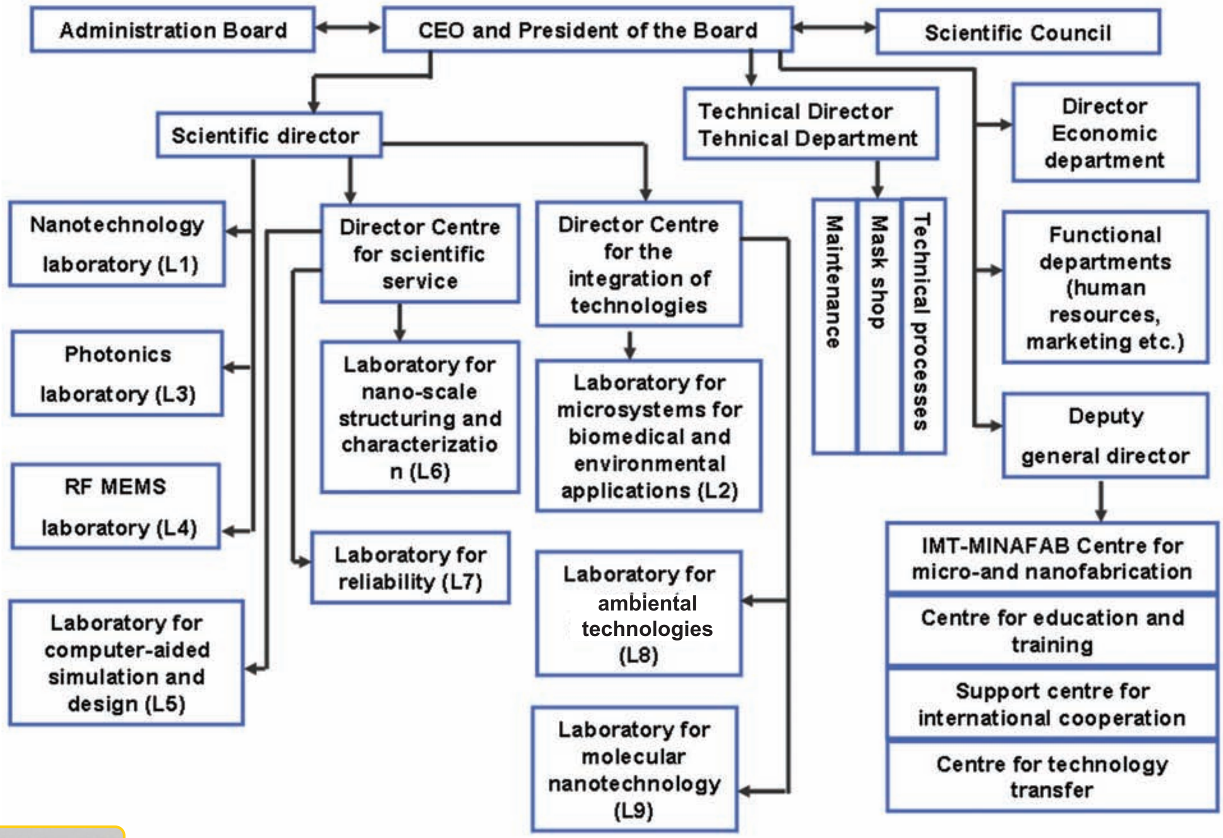


Fig 6b - IMT investments, per category 2009



Organizational chart



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- Bucharest (National Institute for Research and Development in Microtechnologies). She is Scientific Director starting with 2009. Her main scientific interests include design, and technological processes (nanolitography) for microelectronic devices, integrated optics, microsensors and microsystems.

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. Currently he is Director of Centre for Research and Technologies Integration. He has published 159 scientific papers: 86 in journals (76 ISI papers) si 73 communications at various national and international conferences. The papers are dedicated to the following areas: nanoelectronics, microwaves, MEMS, optoelectronics. He is co-author of several books.

Radu Cristian Popa graduated in 1989 the "Politehnica" University of Bucharest, Department of Electronics and Telecommunications. In 1998 he received his PhD at the Department of Quantum Engineering and Systems Science, University of Tokyo. 1989-1992 he was with IIRUC-Bucharest, specializing in computer architectures. Afterwards, he obtained the position of assistant professor in the Department of Electrical Engineering, Polytechnic University of Bucharest and participated in the scientific collaboration contracts with Electricité de France, Paris. 1998-2003, Radu Popa was Senior Researcher with Science Solutions International Laboratory, Inc., Tokyo, where he was in charge with, or participated in competitive research contracts for various Japanese corporations, companies and universities. 2003-2006, he was first scientific associate at the University of Tuebingen and became Director of Development at Neurostar GmbH, Germany.

He is currently with IMT-Bucharest, leads the Molecular Nanotechnology Lab., which belongs to the Center for Nanotechnology and he is Director of Centre for Scientific Services. He studies techniques and solutions for the identification of DNA nucleotide sequences.

Marin Nicolae received the M.Sc (1972) in Electronics and Telecommunications from "Politehnica" University of Bucharest, Romania and in 1998 PhD in Electronics and Telecommunications, from the same university.

He has extensive background in manufacturing/design semiconductor devices, characterization, electrical circuit simulation, debugging, evaluation and product monitoring.

He is Technical Director starting with September 2009.

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

Infrastructure: IMT-MINAFAB

General. This part of the Scientific Report 2009 provides information about the clean room spaces available at the end of 2009, as well as about the equipments available at the time of printing this report (july 2010). The majority of the equipments listed below are new, purchased through the investments taking place recently (approximativelly 6.5 million euro in 2006-2008).

The main achievement is the set-up of to two new clean room areas (operational since September 2009), as follows:

Clean room facilities, class 1,000 (200 sqm). The present clean room (class 100 to class 1000) contains a mask shop with a DWL 66 (1 μm resolution), RIE, vacuum deposition system (E-Beam and sputtering), double-face alignment, deep pen nanolithography, etc. A new clean room (to be operational soon) will contain LPCVD, PECVD, APCVD, RTP equipments, etc.).

General images from clean room

Characterization area, class 100,000 (220 sqm): The characterization area (class 100,000) is equipped with SEM/EBL, nanoengineering workstation (Raith e_Line), FEG-SEM, SPM (AFM, STM etc.), nanoindenter, X-ray difractometer, Raman Spectrometer, SNOM, WLI, electrochemical impedance spectrometer, fluorescence, phosphorescence and lifetime spectrometer, nanoplotter and nanoscanner for microarrays, etc.

The facilities are presented in more detail on the next few pages. Basic experimental and CAD facilities are covering the whole chain from simulation and design to mask fabrication, technological processes, characterization, and testing (including reliability). Therefore, *IMT has the opportunity to provide complex services to both companies and universities*. This was leading to the idea of the centre of services, IMT-MINAFAB, to be fully developed in 2009.

IMT-MINAFAB
IMT Centre for MIcro and NAnoFABrication

A new infrastructure initiated in 2008, **IMT-MINAFAB**, should be seen as **an interface** which will be created by IMT - Bucharest in order to fully exploit its tangible and intangible assets in micro- and nanotechnologies (clean-room facility, equipments, human resources, partners and clients). The so-called "fabrication centre" will be in fact a *complex technological platform* including also CAD tools, characterization equipments, a mask shop, a reliability lab. The fabrication itself, whenever necessary, is accompanied by specific testing and design, as shown in the following examples: *(i) the COVENTOR software package for modeling and simulation of microsystems provides design verification, as well as the direct input data for mask fabrication; (ii) the on-wafer RF testing allows immediate testing of experimental RF components; (iii) the nano-plotter and microarray scanner (NanoBioLab, in cleanroom environment) allow on-chip controlled deposition of biological molecules etc.*

The term "fabrication" in this context means "physical realization" and not necessarily production. In some cases, the equipments can be used for both research and "small-scale production".

IMT policy related to MINAFAB. A strategic target for IMT-MINAFAB is to initiate at the national level a *network of complementary facilities in micro- and nanotechnologies*. Such a network was planned to be set-up in 2009 starting from the links established between IMT and other RTD institutes in the so-called "technological networks" (financed between 2005 and 2008), as well as in common research projects. IMT intends to exchange services with such partners and mostly elaborate a joint offer of services to third parties. Partnerships with external organizations are also extremely important. Existing partners are LAAS/CNRS, Toulouse, France, and FORTH, Heraklion, Greece, the interaction being financed by twinning activities within the MIMOMEMS centre of excellence.

As far as the industrial clients are concerned, IMT is promoting cooperation in two ways: first, using MINATECH-RO, *the science and technology park for micro- and nanotechnologies* (whereby, for example, companies can place their own equipment in the technological area); secondly, by facilitating the interaction with other companies and research groups through the *network for knowledge and technology transfer* with more than 60 partners (the information is exchanged through the *Centre for technology transfer in micro-engineering*, part of IMT). Partnership with important foreign companies should be promoted, whenever possible.

Details of the types of services provided by the centre. *Internally*, IMT-MINAFAB achieves the grouping - in a *unique* experimental centre - of the resources acquired and exploited by the IMT RDT laboratories, and enables their optimal usage by *all* IMT researchers. The "centre" is optimizing the use of the support infrastructure and the maintenance; it also deals with cost evaluation, standardization of processes, know-how management and other supporting activities. Secondly, as an interface to the "*external world*" of partners and users, the MINAFAB centre ensures a *fast and flexible* interaction with partners and clients, fully exploiting the RD potential based on the existing knowledge, and the emerging opportunities.

The basic categories of services are:

• *Partnership in RTD activities, sharing the IP resulting from common research (with research centres, universities, companies);*

• *Scientific and technological services, including design, consultancy, training and education (for universities and companies);*

• *Direct access to equipments for "hands-on" activities, after appropriate training (for companies protecting their IP, for postgraduate and postdoctoral students).*

How to access IMT-MINAFAB?

- The potential customers should consult first the extensive information about the equipments and technologies available at: ***www.imt.ro/MINAFAB****. You may also e-mail a request for further details to the person in charge with an certain equipment (the process engineer or the application scientist).*

- If you are ready to order a service, please contact the IMT-MINAFAB executive team, by emailing at: ***minafab@imt.ro****.*

*Inquires could be also made by fax at +40-21 490 82 36 or phone at +40 – 21 490 82 12 ext. 19 (****Dr. Radu Popa****).*

EQUIPMENTS AND EXPERIMENTAL LABORATORIES

On the next pages one may find information about the main equipments available in IMT. In some cases an equipment, or a group of equipments are located in a special room and they are managed by a certain RTD laboratory, part of the organizational structure (page 6). In such a case we are speaking about an "experimental laboratory". The person in charge is usually a researcher, with his/her own research interest and motivation. However, apart from the usual cooperation between labs, the "experimental laboratories" should be accessible (directly or indirectly) to any researcher from IMT. Moreover, the "services" provided by these "experimental labs" should be also available outside IMT. A typical situation is that of experimental labs created by some research laboratories in the characterization area (class 100,000), which has a special support infrastructure for providing demanding operating conditions of delicate equipments. All looks like a "joint venture" of individual research laboratories in an special area provided by the institute.

Another important concept is that of an interdisciplinary group working as a "research centre", due to interactions of two or more research labs. The MIMOMES Centre of Excellence financed by EU provides such an example: it is the result of combined activities of RF MEMS and Photonics laboratories, respectively. The second case corresponds to the so-called "Centre for nanotechnologies", grouping other laboratories. This centre, also mentioned below, is functioning "under the aegis" of the Romanian Academy (this is a "purely scientific" interaction, without administrative or financial consequences).

Monica Simion (monica.simion@imt.ro) working on the Micro Plotter to prepare a protein C reactive microarray slide

A. Experimental laboratories in the characterization area (class 10,000 to 100,000).

Centre of Nanotechnologies an interdisciplinary group, involving a few RTD laboratories, was developed as follows:
Laboratory of nanotechnology (L1) created the following experimental laboratories:

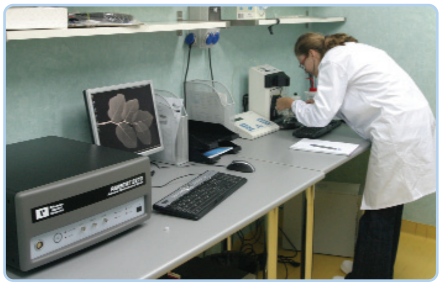
Experimental laboratory for "Microarrays", or NanoBioLab, with the following main equipments:
- Microarray Scanner - GeneTAC UC4 (Genomic Solutions Ltd., UK);
- Micro Plotter - Omni Grid (Genomic Solutions Ltd., United Kingdom);
Project: Integrated Research Network Devoted to Nanobiotechnology for Health (Romanian Nanomedicine Network) RO-NANOMED (2005-2008).

Mihaela Miu (mihaela.miu@imt.ro) investigating the electrocalalytic activity of the gold nanoparticle electrode array with SECM

Experimental laboratory for surface spectroscopy, with:
- **Electrochemical Impedance Spectrometer PARSTAT 2273** (Princeton Applied Research);
- **Scanning electrochemical microscope** (SECM);

Experimental laboratory for X-Rays diffraction, with:
- **X-ray Thin film Diffraction System** (triple axis rotating anode) - SmartLab - 9kW rotating anode, in-plane arm (Rigaku Corporation Japan);

Experimental laboratory for nanoparticles, with:
- **DelsaNano Zeta Potential and Submicron Particle Size Analyzer** - Allegra X-22 (The Beckman Coulter);
- Fluorescence spectrometer;
- Centrifuge - Allegra X-22 (Beckman Coulter);



Teodora Ignat (teodora.ignat@imt.ro) is working for gold electrode cleaning by cyclic voltammetry

Mihai Danila (Mihai.danila@imt.ro) introducing in the sample in the XRD for investigation the Pt nanocystallite orientation and size

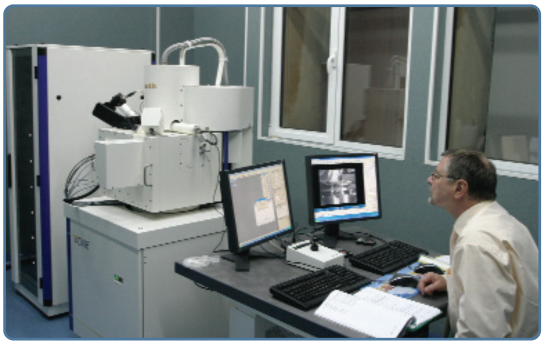
Teodora Ignat (teodora.ignat@imt.ro) investigating a Cy3 labelled DNA sample by fluorescence spectrommetry

Adina Bragaru (Adina.bragaru@imt.ro) working for nanoparticle centrifugation and characterization

Laboratory for nanoscale structuring and characterization (L6), created the following experimental labs:

Experimental laboratory for Electron Beam Lithography (EBL)/ Scanning electron Microscopy Laboratory (SEM), or NanoScaleLab;

- Scanning Electron Microscope SEM - Vega II LMU and Pattern Generator - PG Elphy Plus (TESCAN s.r.o and RAITH GmbH); - A Nanolithography Equipment composed of a SEM and EBL pattern generater which can investigate different samples at nanometric range (SEM resolution 3 nm, smallest geometry line in the range of 30-50 nm) is used for different samples investigations, for direct writing in PMMA of nanometric configurations and for students training in microscopy and nanolitography.



nanoengineering workstation e_Line (RAITH)

Experimental laboratory for e-line nano engineering work station;

- Electron beam lithography and nanoengineering workstation - e_Line (RAITH GmbH);

EBL - Direct writing Electron Beam nanoLithography is an ideal tool for nanotechnology research and is a versatile equipment with specific requirements for interdisciplinary research: options for nanomanipulations; EBID-Electron Beam Induced Deposition; EBIE-Electron Beam Induced Deposition;

Applications: • Nanolithography with under 20 nm resolution; • 3D nanostructures; • CNT based interconnections for next-generation integrated circuits; • CNT based nanodevices; • SAW devices with nanometer interdigitated electrodes; • Optical devices, holograms, micro lenses, gratings; • Development of Nanodevices using E-beam induced deposition and etching; • Development of circuits for communications based on photonic crystals;

FEG-SEM - Nova NanoSEM 630

Experimental laboratory for SEM/FEG (Field Emission Gun);

- **Field Emission Gun Scanning Electron Microscope/FEG-SEM-Nova NanoSEM 630 (FEI)**; The FEI Nova NanoSEM 630 is a high-quality nanoscale research tools for a variety of applications that involve sample characterization, analysis, prototyping, and S/TEM sample preparation. It features a superior low voltage resolution and high surface sensitivity imaging in the range of Ultra high Resolution Field Emission Scanning Electron Microscopes (UhR FE-SEM).

Experimental laboratory for SPM;

- **Scanning Probe Microscope** (AFM, STM, EFM, KPM etc)**-NTEGRA (NT-MDT)**;

Applications: • Surface morphology inspection; • Quantitative measurement of surface features at nanometric level; • Nano-surface texture/ roughness measurement; • High-resolution surface profilometry; • Evaluation and optimization of thin film coatings for various applications (optical, packaging, paintings, wear-resistant etc); • Grain and particle size analysis; • Morphological studies of biological and biocompatible materials;

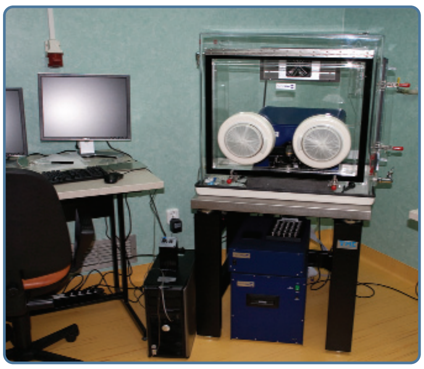
Scanning Probe Microscope SPM-NTEGRA

- **Nano Indenter G200, Agilent Instruments (former MTS Nano-Instruments)**: Instrument for characterizing the mechanical properties of materials at the nano and micro scales, mainly by performing depth-sensing indentation experiments, but also by other modes of testing such as scratch testing etc. Accuracy and repeatability of the measurements are guaranteed by implemented methods according to ISO 14577.

Technical specifications: • Displacement resolution: 0.01 nm; • Load resolution: 50 nN; • Maximum load: 500 mN; • Max indentation depth: 500 μm; • Position accuracy: 1 μm;

Applications: Studies of mechanical properties of materials on small scales or near surfaces with high spatial resolution. The measurable properties include hardness, elastic modulus, nano-scratch critical loads, stress-strain data. The provided information is useful for developing and/or optimizing application specific materials and processes and also could be used as input data for running simulations of the material behavior by finite-element analysis.

Nano Indenter G200



Laboratory for computer simulation and design (L5) has an experimental lab belonging to the "Centre for nanotechnologies" placed in the class 1,000 clean room

Dip pen nanolithography Laboratory;

- **Dip Pen Nanolithography Writer - NSCRIPTOR** (NanoInk, Inc.);

System allows patterning in nanometric range and is direct writing method that can use molecular and biomolecular "inks" on a variety of substrates. It can selectively place molecules at specific places.

Applications: surface functionalization (with direct liaison to proteomics, DNA recognition, virus identification); deposition materials onto semiconductor substrates for electronic industry; photolithographic masks correction; molecular electronics; realization of master stamps for NIL; novel nano- devices;

EQUIPMENTS AND EXPERIMENTAL LABORATORIES

MIMOMEMS - EU Excellence Centre (grouping the RF MEMS lab and the Photonics lab) created from the following experimental laboratories:

- **Scanning Near-field Optical Microscope** (SNOM) - Witec alpha 300S (WITEC GmbH, Germany);
- **High Resolution Raman Spectrometery** - LabRAM HR 800 (HORRIBA Jobin Yvon);
- **White Light Interferometer (WLI)** - Photomap 3D Standard 2006 (FOGALE NANOTECH, FRANCE);

Scanning Near-field Optical Microscope (SNOM)

- **Witec alpha 300S (WITEC GmbH, Germany)**; It allows the optical characterization of various samples (nanostructures, biological samples, polymers) with a resolution of 50-90 nm in visible spectral range with the possibility of extension in the infrared spectral range.

Working in the collection or photon scanning tunneling microscope (PSTM) mode the alpha 300S SNOM allows the imaging of propagating optical field in various metalic and dielectric waveguides providing a powerful method to caracterize and investigate nanophotonics and nanoplasmonic structures and devices.

Contact person: Dr. Cristian Kusko, E-mail: **cristian.kusko@imt.ro;**

High Resolution Raman Spectrometery

- **LabRAM HR 800 (HORRIBA Jobin Yvon)**;

Application for the analysis of solids, liquids and solutions:

• chemical identification, characterization of molecular structures;
• to determine the composition and phase (crystalline/amorphous) of composites materials;
• environmental stress on a sample and crystal quality and composition of alloy semiconductors; • nature of oxides on compound semiconductors;
• polymers characterizations and polimer nanocomposites;
• chemical and biological detection using SERS technique;
• micro/nano structures characterization (micro/nanorods, carbon nanotubes), self assembled molecule (SAM) on functionalized substrate and other.

Contact person: Dr. Munizer Purica, E-mail: **munizer.purica@imt.ro;**

"On wafer" microwave characterization up to 110 GHz (MIMOMEMS and "Capacities" program SIMMCA)

• Recently in the microwave laboratory the existing 65 GHz set-up for on wafer S parameter measurements (the Anritsu VNA and the Karl Suss probe station) has been upgraded to 110 GHz.
• A frequency generator up to 110 GHz (from Agilent Technologies).
• A spectrum analyzer up to 110 GHz (from Anritsu).

The Fig.1 presents the recently upgraded to 110GHz set-up for "on wafer" S parameters measurements; in Fig. 2 there are presented the frequency generator up to 110 GHz and the Spectrum Analyzer up to 110 GHz .

Applications:

• Characterization of microwave and milimeter wave circuits in the 0.5 – 110 GHz frequency range;
• "On wafer" S parameters measurements for microwave and millimeter wave devices and circuits;
• Characterization of microwave devices based on carbon nanotubes (CNT) and graphene;

Contact person: Dr. Alexandru Muller, E-mail: **alexandru.muller@imt.ro; mircea.dragoman@imt.ro**


1


2

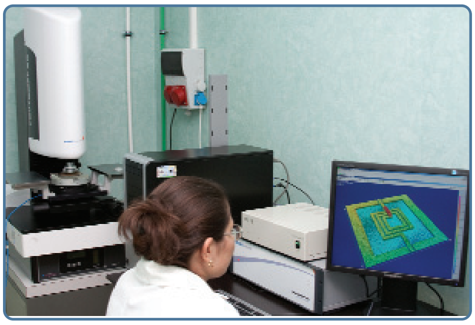
Upgraded to 110GHz set-up for "on wafer" S parameters measurements (left), Generator up to 110 GHz and the Spectrum Analyzer up to 110 GHz (top).

White Light Interferometer (WLI) - Photomap 3D Standard 2006 (FOGALE NANOTECH, FRANCE) ("Capacities" program (SIMMCA));

Optical profiler allows measuring the surface topography of different materials (such as metals, plastics, semiconductors, biological materials etc). The photo below presents the WLI equipment (Photomap 3D, microscope, electronic module) and as a result of the characterization a 3D topography of a MEMS device.

Applications: • Characterization of residual stress for different thin film deposition layers;
• Measurements for thickness of transparent layers (plastics, glasses or varnish) with known refraction indices;
• Conceived not only for statistical surface roughness measurements but also for high precision measurement of mechanical or chemical micromachining;
• Can be used for MEMS dynamic measurements;

Contact person: Dr. Alina Cismaru
E-mail: alina.cismaru@imt.ro; dan.vasilache@imt.ro



White Light Interferometer (WLI) - Photomap 3D Standard 2006 (FOGALE NANOTECH, France);

B. Main technological equipments in the clean room class 1,000


1


2

Dry etching: - Reactive Ion Etching (RIE) Etchlab 220, SENTECH Instruments GmbH (img 1);

Lithography: - Double Side Mask Aligner MA6/BA 6 (Suss MicroTec); for alignment/exposure nanolithography and nanoimprint: double face exposure alignment, UV, nanoprint 4”-6” (img 2).

- Spinner; Spinner SUS MICROTEK;

Masks: - Pattern generator DWL 66fs Laser Lithography System (Heidelberg Instruments Mikrotechnik GmbH); Writing facility on mask (with dimensions ranging between 2,5” and 6”) and on plates (with the diameter up to 3”). Resolution: minimum feature size 1μm for lines, not complex geometry (img 3).


3

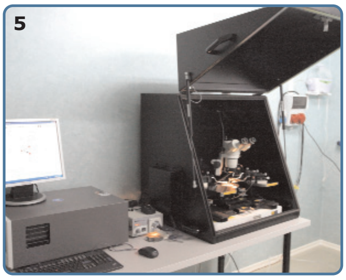

4

Thin film deposition: - Electron Beam Evaporation an DC sputtering system AUTO 500 (BOC Edwards, img 4);

Note: A few CVD equipments will be installed in a new clean room (class 10,000) in the second semester of 2009. These include: ***LPCVD - LC100*** *(AnnealSys-France);* ***PECVD - LPX-CVD*** (STS, UK); ***PCVD-PYROX*** *(TEMPRESS);* **RTP- Rapid Thermal Processing** ***system for Silicon, Compound Semiconductors, Photonics and MEMS processes AS-One 100*** *(ANNEALSYS,France)* -available soon.

Applications: •Implant annealing; •Contact Alloying; •Rapid Thermal Oxidation (RTO); •Rapid Thermal Nitridation (RTN); •Diffusion from spin-on dopants; •Densification and crystallization; •Glass reflow; •Silicidation(etc);

Substrate types: •Silicon wafers; •Compound semiconductor wafers; •Poly silicon wafers for solar cells; •Glass substrates; •Graphite and silicon carbide susceptors (etc);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C. Other equipments available in IMT-Bucharest

Characterization equipments: - **Spectroscopic ellipsometer - SE 800 XUV**
- UV-VIS-NIR Spectrophotometer, SPECORD M42;
- FTIR Spectrometer, Tensor 27 from Bruker Opticks;
- UV-Vis Spectrometer AvaSpec-2048 TEC (Thermo-electric Cooled Fiber Optic Spectrometer);
- Semiconductor Characterization System with Manual Probe Station-4200 SCS/C/Keithley, EP6/ Suss; MicroTec (Keithley; Suss MicroTec, img 5)**;**

Performs electrical measurements for a wide range of applications from materials research and nanostructures development to I-V characterization of nanoelectronic devices. System 4200-SCS configured with the 4200-PA Remote Preamplifiers, offers exceptional low current measurement capability with a resolution of 0.1 fA and 5 mV.

The Reliability Laboratory, L7, has an experimental laboratory for reliability testing of microelectronic components, microsensors, MEMS and nanostructures, containing equipment for:

Electrical characterization at various temperatures:

- **Electrical measurements** - 4200SCS (Keithley): C-V units 3532-50, DMM 2700-7700 and 2002; 6211-2182; Stimuli: Voltage CC<100V, Current CC<1A; Impulses: analogical signal 30V, <40MHz; Measurements: Voltage 0,5μV, Current 1fA;
- **Temperature conditioning** for electrical measurement TP04300A-8C3-11 Thermo Stream (Temptronic): Temperature: -80 .+225°C; Transition time: up 7sec, down 20sec; Temperature control +/-0,1°C;

Testing at unique and combined stresses:

- **Combined testing** at temperature and low pressure – VO 400 (Memmert): Capacity: 49 l; Temperature: 20...200°C; Pressure: 10...1100 mbar;
- **Thermal cycling** TSE-11-A (Espec Europe), Compact type (air-to-air), Two chambers: low temperature (-60...0°C) and high temperature (+60…200°C)
- **Combined tests at temperature, humidity, pressure and electrical bias** EFS 211M (Espec Europe): Highly Accelerated Stress Test (HAST), Capacity: 18 l, Temperature: 105...142°C, Humidity: 75% …100% RH, Pressure: 0.02…0.196 Mpa;
- **Damp heat–Climatic chamber** CH 160 (Angelantoni), Temperature: -70 ...+180°C; Speed 5°C/min, Relative humdity: 20…95 %, between +10°C…+80°C;
- **Combined tests at temperature and electrical bias** – Three climatic chambers UFB 400 (Memmert), Capacity: 53l; Temperature: 20...220°C; Rack N6711A (Agilent), with modules N6741B, N6743B, N6746B and N6773A, two sources E3648A and E3649.

Also, the Reliability Laboratory offers **other reliability servicies**, such as:

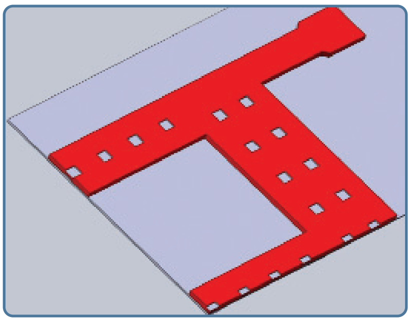
- **Training courses on: Quality&Reliability** assurance for semiconductor devices; Reliability accelerated testing for MEMS; Failure analysis at accelerated testing; Characterisation of microelectronic devices and MEMS;
- **Consultance/technical assistence** about: Reliability analysis for all families of semiconductor devices; Elaborating standards and other documents for various types of electronic components; Qualification of semiconductor devices.

From left to right: Equipment for combined testing at temperature and low pressure VO400 (Memmert), Equipment for thermal cycling TSE-11-A (Espec Europe) and Equipment for Highly Accelerated Stress Test (HAST) – EFS 211M (Espec Europe).

Contact person: **Dr. Marius Bazu**, marius.bazu@imt.ro

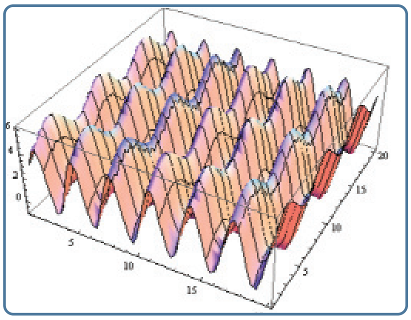
EQUIPMENTS AND EXPERIMENTAL LABORATORIES

Computer technique for simulation and design:

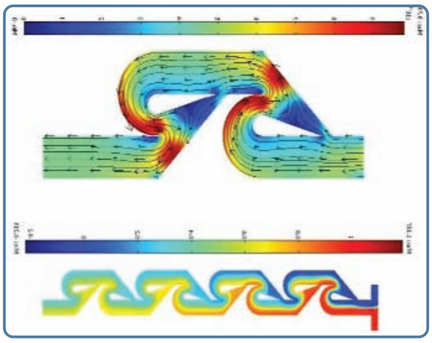


Design of a RF switch - Solidworks

- ***COVENTOR 2008.2:*** suite of software tools dedicated to microsystems design and analysis. It contains design modules, as Architect and Designer, and simulation tools for MEMS analysis type (electrical, thermal, mechanical, piezoelectric, electrostatic, coupled-field analysis) and microfluidic analysis type (general flows, electrokinetics, chemical reactions, two-phase flow, coupled fluid – structure interaction).
- **MATLAB 7**- Mathematical software with a high performance language specialized for technical calculations, data acquisition, data analysis and visualization: Optimization Toolbox; Extended Symbolic Math Toolbox; Partial Differential Equation Toolbox; Genetic Algorithm and Direct Search Toolbox; Statistics Toolbox; Neural Network Toolbox; Curve Fitting Toolbox; Spline Toolbox; Signal Processing Toolbox; Image Processing Toolbox; Simulink.
- **ANSYS** Multiphysics 11.0- Structural, thermal, acoustic, electromagnetic and coupled field analyses, CFD
- **COMSOL** Multiphysics 3.3 and 3.4 (enabling parallel computation): simulation software, multiphysics modelling dedicated to phenomena and processes from physics, engineering and chemistry;
- **Solidworks Office Premium 2008** - 3D CAD software: design tool for 2D and 3D complex geometries, export CAD files to other simulation software tools;
- **Mathematica 7:** Mathematical software for technical and scientific data processing: numeric and symbolic calculus; suitable for solving linear and non-linear differential equations, computational geometry, statistics, 2D and 3D



3D Plot of a trigonometric function Matematica 7



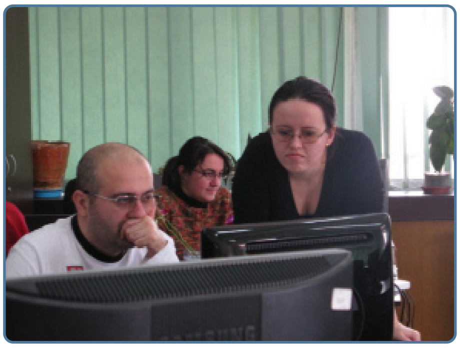
COMSOL Simulation of a Tesla micromixer
National Project Computer aided design for microfluidic components

Graphics

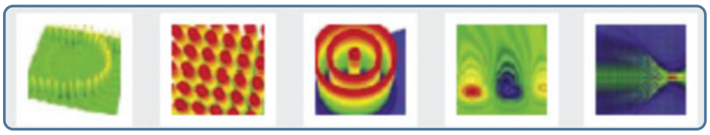
- **Origin PRO 8**: data analysis and graphing workspace, analysis tools for statistics, 3D fitting, image processing and signal processing
- **Visual Studio 2008** Pro Programming tool for RAD and IDE.
- **Dual IBM 3750 Server** with 8 quad-core Intel Xeon MP 2.93 GHz processors, 196 GByte RAM and 1 TByte HDD + 876 GByte external storage;

Services: We offer simulation, consulting and training services in micro and nano domains; Application areas: microsensors, microfluidics, MEMS/NEMS, MOEMS, RF MEMS

- *Computer Aided Design using: COVENTOR 2008 and ANSYS;*
- *Mask Design, Process Editor, 3D building and mesh;*
- *Modeling for technological processes/ optimizations;*
- *Special features: particularized use (macro or subroutine) creation; special geometrical modeling (AFM images reconstruction in CAD format, surfaces generated in accordance with mathematical expression, etc);*
- *Computer Aided Engineering and Analysis (using FEM, FVM, BEM tools);*
- *Microfluidics analysis (thermo)dynamics, electrokinetics, diffusion, fluid mixing and separation in microcomponents;*
- *Electro-thermo-mechanical and piezoelectric analysis (steady state and transient);*
- *Coupled field simulations: thermo-mechanical simulations; electro-mechanical simulations; multiphysics, fluid-solid interaction;*
- *Consultancy regarding design and simulation optimization;*
- *Training in COVENTOR and ANSYS;*



Software for Photonic devices:



- **Opti FDTD 8.1** - design and simulation of advanced passive and nonlinear photonic devices;
- **Opti-HS** – design and simulation of active devices based on semiconductor heterostructures;
- **OptiBPM 9.0-** design of complex optical waveguides, which perform guiding, coupling, switching, splitting, multiplexing and demultiplexing of optical signals in photonic devices;
- **OptiGrating**- design software for modelling integrated and fiber optical devices that incorporate optical gratings;
- **LaserMod** - analysis of optoelectronic devices by performing electrical and optical analysis of III-V and other semiconductor materials;
- **Home made software based on C++** language for analysis of the reflection/transmission of the multiple layer systems. The software allows the analysis of 20 layers 3Lit – design of 3D micro-optical elements;

- Mission
- Main areas of expertise
- International participation
- Research Team
- Awards

Mission: Nanomaterials and nanostructures: design, modelling/simulation and technological experiments.

Main areas of expertise: The research activities carried on in Laboratory of Nanotechnology can be divided into four areas which are:

The main research direction in *Functional nanomaterials area* is study of nanostructured silicon based or composite materials, from preparation to surface functionalisation and integration in complex systems.

The *Nanobiosystems* area focuses on development of various technologies to study and solve biological issues. Biomolecular patterns in microarrays, integration of sensing elements onto biochips for study of bioreactions, and implantation of active device elements in cells to study cellular biochemistry are examples of research activities being carried out.

The *Nanophotonics* area is represented by two directions, porous silicon with emission in the visible spectrum for microparticles visualisation in vitro and for optical biosensors and metallic nanoparticles (Au, Ag) on silicon substrates for SERS/ SEIRS applications.

The *Bio-Micro- Electromechanical Systems* (Bio-MEMS) area focuses on the design, modelling/simulation and fabrication of new complex devices on silicon/polymers for applications in many interdisciplinary areas; recently new results in biochips, or microfluidic systems as laboratory-on-a-chip with applications in biomedicine and environmental monitoring as well as in the development of new fuel cell devices as clean energy sources were obtained.

International participation

- *Development of sustainable solutions for nanotechnology-based products based on hazard characterization and LCA – NanoSustain*, **FP7** Collaborative Project, 2009-2012;
- *A "system-in-a-microfluidic package" approach for focused diagnostic DNA microchips - DNASIP*, **MNT-ERA** Project, 2008-2010.
- *Nanostructural carbonaceous films for cold emitters – NANOCAFE*, **MNT-ERA** Project, 2009-2011;
- *Development of plasmonic biosensors based on metals – silicon nanoassemblies*, **Brancusi Bilateral** Project (Institute for NanoSciences Paris), 2009-2010.

Research team *has multidisciplinary expertise* with background in physics, chemistry, computers and specializations in pharmacy and bio-chemistry and is composed by 4 senior researchers and 5 PhD students

Award: **Gold Medail**, **Bruxelles INNOVA 2009** - *Technology for Silicon Micro-device for DNA Identification by Polymerase Chain Reaction* – M. Simion, I. Kleps, A. Angelescu, T. Neghina, M.Miu, A. Bragaru, F. Craciunoiu, (IMT-Bucharest), E. Condac (UB, Faculty of Biology)

Irina Kleps, Florea Craciunoiu, Mihaela Miu, Mihai Danila, Monica Simion , Adina Bragaru, Andrei Avram, Marioara Avram, Teodora Ignat, Lucia Cortojan

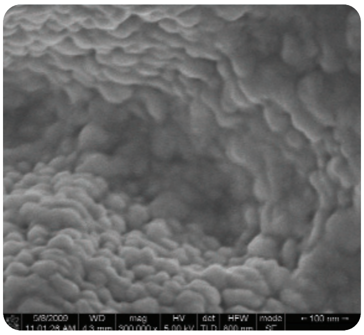
Laboratory Head - Dr. Irina Kleps (irina.kleps@imt.ro)

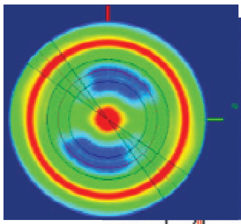
She obtained her MSc. in Chemistry Engineering, in 1973, and the PhD in chemistry in 1998 at Politehnica University of Bucharest. Her competence domains are: nanomaterials, nanostructures, nanotechnology, new materials and technological development for MEMS/NEMS, bio-medical devices, protein microarray. Dr. Kleps participated in several European projects: INCO-COPERNICUS SBLED (1998-2001), EMERGE (guest experiments at IMM, Germany) Metallics (2000-2003), PHANTOMS (Network of Excellence on Nanoelectronics) (2001-2004), NANOFUN-POLY (2004-2008). She was involved as expert for project evaluation in the EC-FP5 (IST; Growth, Improving programmes), FP6, FP7 (NMP and Marie Curie) and MATNANTECH, CEEX and PN2 national programs. Other activities: Golden medal (2001, 2007, 2008) Salon International des Inventions-Geneve; Chapter Electrochemical Nanoelectrodes, in Encyclopedia of Nanoscience and Nanotechnology; Co-editor of the Nanoscience and Nanoengineering (2002), Advances in Micro and NanoEngineering (2004), Convergence of Micro-nano-Biotehnologies (2006), Progress in nanoscience and nanotechnologies (2007), Series in Micro and Nanoengineering, (Romanian Academy). More than 150 papers published in international journals/conferences, 90 technical reports, and 6 Romanian patents. Dr. Kleps retired from 1st of March, 2010, but is still cooperating with IMT on certain projects.

STUDY OF SILICON-PROTEIN TYPE BIOHYBRIDE NANOSTRUCTURED SURFACES WITH APPLICATIONS IN BIO(NANO)SENZING

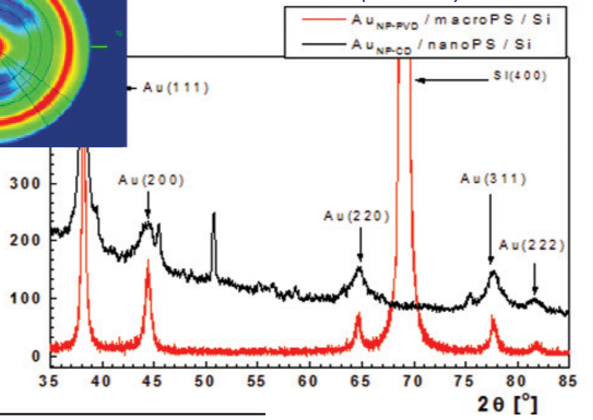
The aim of this project is to realise and characterise Si(111)- and Si(100) - protein interfaces, for application in biomolecule detection. We have demonstrated that different morphologies of porous silicon (PS) as-prepared or coated with gold nanoparticles have an important role in biomolecule detection, due to its large internal surface combined with specific optical properties, being in the same time sensing element/support for immobilization of sensing biomolecules as well as transducer for biochemical interactions.

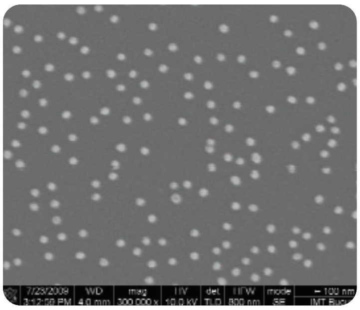
Financed by the National University Research Council (2007- 2010). Coordinator: Dr. Irina Kleps, irina.kleps@imt.ro



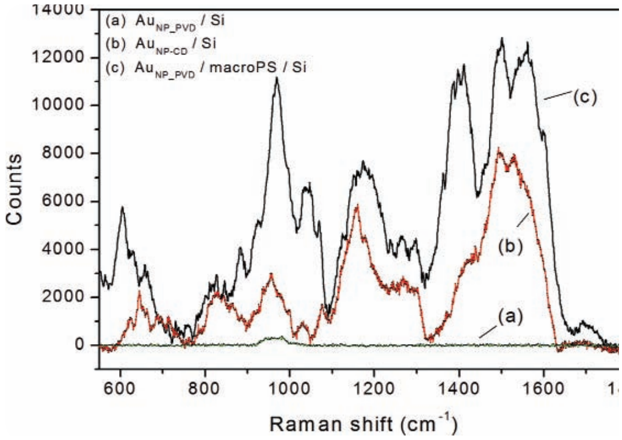


Microstructural characterisation of AuNP-PVD on macroPS and AuNP-CD on nanoPS (10nm medium pore size)



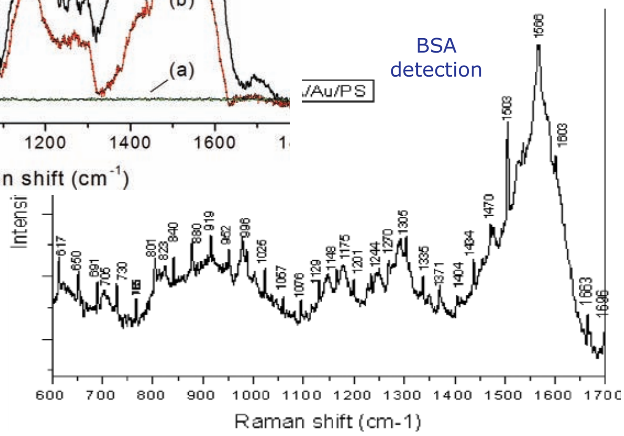


SEM images of Au - nanoparticles and nano-structurated thin film - on PS substrate for biodetection



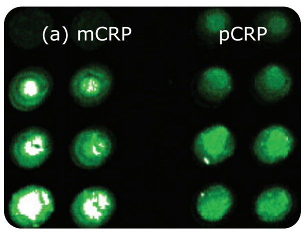
Thus PS constitutes an appropriate substrate for very sensitive SERS biosensors. RAMAN signal of 11-mercaptoundecanoic acid was investigated on Au/macroporous silicon.

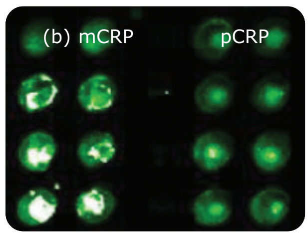
BSA detection

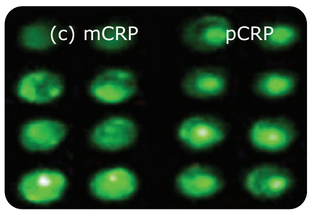


MULTI ALERGEN BIOCHIP REALISED BY MICROARRAY TECHNOLOGY (MAMA)

The aim of this work is to fabricate diferent types of nanostructured porous silicon surfaces and test their ability to efficiently immobilise in an active form the C-reactive protein and the monoclonal and polyclonal anti-human CRP antibodies, in comparison with functionalised glass slides. We have tested two types of nanostructured porous silicon (PS) surfaces with pore size 5-7nm and 15-20nm as potential substrates for proteins immobilization. The microarrayed PS surfaces with proteins and antibodies provide a low surface background and high immobilization efficiency.







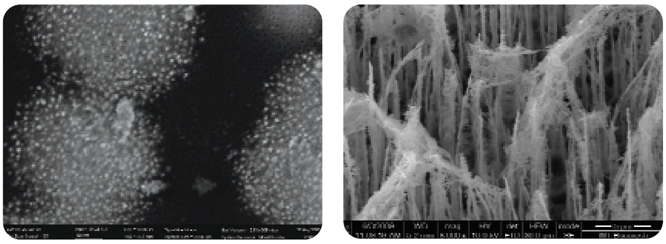
Scanned image with immobilized fluorescent antibodies on the two PS surfaces and commercial aldehyde funtionalised glass slides. a) PS Sample 1; b) PS Sample 2; (c) ALD-glass slides

Taking in consideration the good results obtained in the case of porous silicon treated with dehydrogenated water and knowing the optimal printing parameters, the next step was to use the protein in different concentrations in order to improve the right dilution necessarry to print the allergens, to determine the minimum limit of the detection and the scanning parameters. These results are very encouraging to consider preparation of CRP antibody microarrays onto silicon surfaces useful for diagnostic purposes. Further studies concerning improvement of silicon surface wettability and development of hydrophobic polymers and gel silicon-based substrates are under way.

PNCDI Program (2007- 2010); Coordinator: IMT Bucharest, Dr. Irina Kleps, Irina.kleps@imt.ro
Partners: "Carol Davila" University of Medicine and Pharmacy- Bucharest; Bucharest University, Faculty of Chemistry, Telemedica SA and DDS Diagnostic SRL;

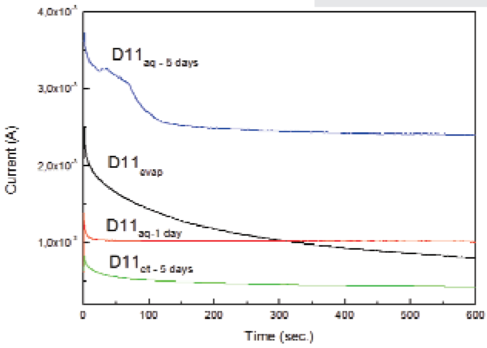
STUDY OF MEMBRANE - ELECTRO-CATALYST NANOCOMPOSITE ASSEMBLIES ON SILICON FOR FUEL CELL APPLICATION

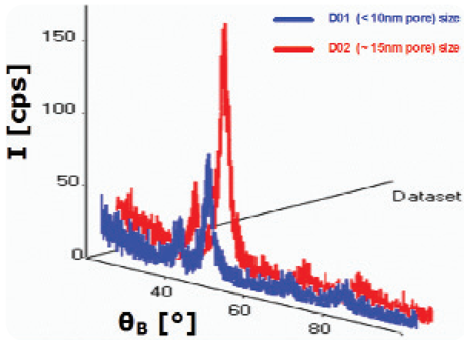
The scope of this project is fabrication of a nanocomposite electrocatalytic proton exchange membrane based on silicon.
The silicon substrate has been subjected to an electrochemical porosification process for nanostructuration an impregnation with Nafion protonic solution has been realised to achieve the specific characteristics for protonic conduction. The enhancement of platinum catalytic function has been obtained by deposition of a metallic nanoparticle array conform to the figure:



The in plane diffraction spectra of samples with different diameters of pores validate the hypothesis that Pt has crystallized mainly inside the pores not on the sample surface and confirm the (111) predominant texture of particles representing an advantage for envisaged applications in fuel cell complex devices.

The electrochemical tests reveal that improving of Pt nanostructuration down to discrete nanoparticles with 2-3 nm in size, dispersed on and inside of porous nanoSi matrix, an enhancement of the electrocatalytic efficiency is obtained. The stability of Pt nanoparticles dispersed in nanoSi matrix implies that most CO adsorbed species could be oxidised and removed from nanoPt catalyst, due to the vicinity of Si fibrils and their active surface sites.

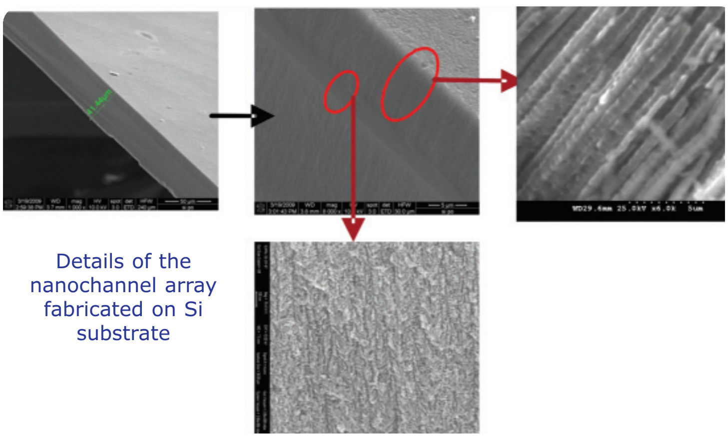




Financed by the National University Research Council (PNII-ID 2007- 2010)
Coordinator: IMT Bucharest, Dr. Mihaela Miu, mihaela.miu@imt.ro
Partners: University of Bucharest, Faculty of Physics and Petroleum- Gas University of Ploiesti;

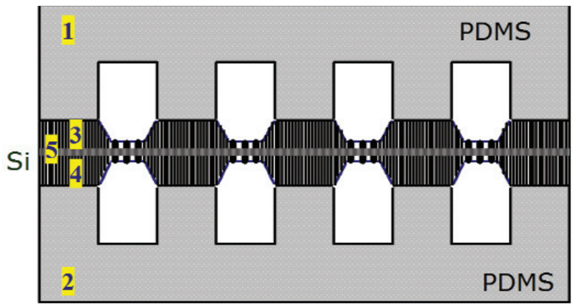
MINIATURISED POWER SOURCE FOR PORTABLE ELECTRONICS REALISED BY 3D ASSEMBLING OF COMPLEX HYBRID MICRO- AND NANOSYSTEMS (MINASEP)

The scope of research is development of an integrated fuel cell hybrid system, as a 3D assembly, using specific processes from MEMS technology – miniaturised direct methanol fuel cell (micro-DMFC). The advantages of these types of micro-FC are determined mainly because of its potential for direct utilization of methanol, which is a low-cost, renewable liquid fuel, without the need for reforming; in addition, the operation takes place at ambient temperatures, with high energy density and lower ecologically harmless CO_2 emissions.
3D device architecture at the micrometer-scale has been designed in order to increase the total area of reactive surfaces per unit volume without increasing the footprint area.



Details of the nanochannel array fabricated on Si substrate

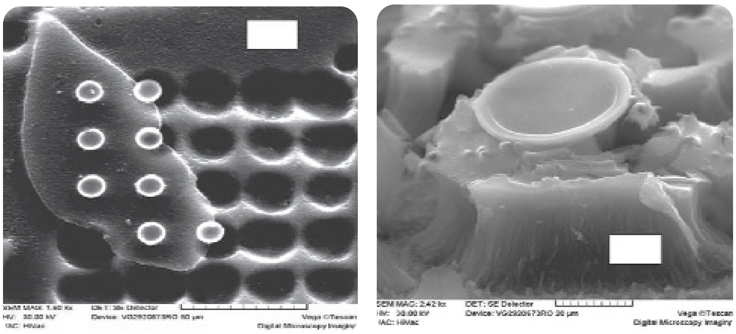
3 new types of nanostructured composite membrane for proton exchange (PEM) are comparatively studied using different matrices:
• nanostructured silicon; • preformed SiO_2/Si_3N_4 membrane;
• carbon nanotube array (CNA) all filed with protonic polymer.



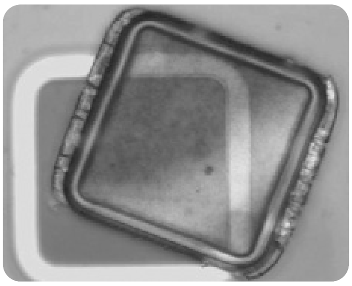
The main elements of proposed device are:
(1, 2) PDMS / Si microfluidic systems for fuel supply to the anodic compartment, and also to prevent the excess water accumulation and cathode flooding;
(3, 4) macroporous Si micro- nanochannel array for fluid microcapillary flow and gas removal respectively;
(5) nanostructured hybrid proton exchange membrane (PEM)

PNCDI Program (2007- 2010). Coordinator: IMT Bucharest, Dr. Mihaela Miu, mihaela.miu@imt.ro
Partners: University of Bucharest, Faculty of Physics and Petroleum- Gas University of Ploiesti;

SILICON BASED MULTIFUNCTIONAL NANOPARTICLES FOR CANCER THERAPY (NANOSIC)



SEM images of nanostructured Si microparticles: (a) n-epi/p+ Si process and (b) n-diffusion in p+ Si process



Optical image of a Si microparticle of 7 μm×7 μm obtained by porosification process using Si_3N_4 layer as mask.

The aim of this project is to optimise the experimental conditions for nanostructured Si particles fabrication, and to find the best methods for attaching on its surface cytotoxic molecules of therapeutic interest.

Micro- and nanofabrication methods were experimented in order to prepare silicon microparticles with sizes between 2 and 10 microns on x/y/z axis with nanoporous structure (10-50 nm):

(i) taking into account the selective porosification of Si as function of type and level of doping:

(ii) Si porosification in using $Si3N_4/SiO_2$ (200 nm/50 nm) or Au/Cr (200 nm/50 nm) as masking layer:

(iii) Si multilayer structure obtained by periodically varying the current density between 50 mA/cm^2 and 12.5 mA/cm^2, subsequently subjected to simple ultrasonation treatment leading to a cleavage phenomenon when a is applied.

The method of staining the Golgi complex in living cells with fluorescent ceramides was used as preliminary biological tests to investigate Si microparticles containing different drug molecules. B16 F10 mouse melanoma cells were cultured in RPMI 1640 medium supplemented with 10% fetal calf serum. Morphological changes and viability in cells attached to the devices were visualized by fluorescence microscopy, following NBD-C6 ceramide labeling.

Coordinator: IMT Bucharest, Dr. Irina Kleps, irina.kleps@imt.ro
Partners: INSB Bucharest and IOB Bucharest;

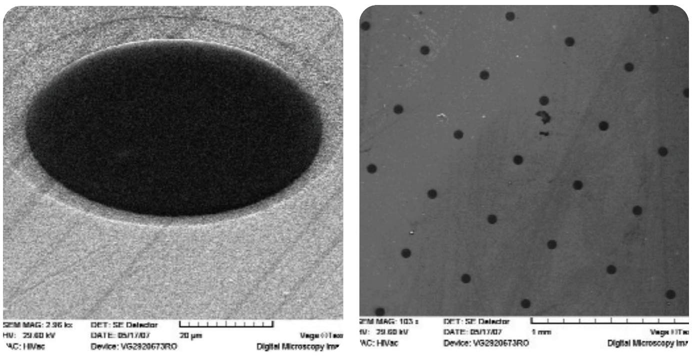
DEVELOPMENT OF THE CONCEPTUAL MODEL OF A LAB-ON-A-CHIP SYSTEM FOR CONTINUOUS PARTICLES SEPARATION THROUGH MAGNETOPHORESIS AND DIELECTROPHORESIS

The fundamental research dedicated to the investigation of the most advanced aspects regarding: (1) interactions in supramolecular biological systems; (2) revealing new interactions; (3) solving the mechanisms which can trigger the behavior of biophysical systems; (4) thorough investigation of the structures and hemodynamic processes; (5) developing new concepts regarding electrophoresis, dielectrophoresis and magnetophoresis phenomena; (6) innovative applications for the realization of a lab-on-a-chip for sorting, manipulating and counting biocells. a very small microfluidic device capable of sorting biological cells depending on their size and properties, and also capable of performing some preliminary results can be priceless in hematological laboratories for sorting, manipulating and analyzing bioparticles.

The main objectives of this project are: (1) molecular dynamic studies regarding the electrophoresis, dielectrophoresis and magnetophoretic migration regimes; (2) thermo-electromagnetic modeling and complex structural analysis studies; (3) formulation of self-consistent theories in order to describe nano-biosystems while interacting with the electromagnetic field; (4) numerical simulations using specialized software, which will be adapted in order to optimize the convergence of the solutions with the best possible results; (5) development of the advanced concept of lab-on-a-chip- for dielectrophoretic and magnetophoretic biocells sorting

PNII-IDEI Project (2009- 2011); Coordinator: IMT-Bucharest, Dr. Marioara Avram, marioara.avram@imt.ro;

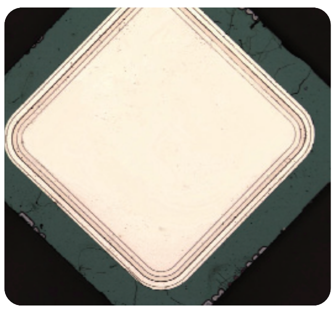
SENSOR DIODES ON DIAMOND AND SIC WITH APPLICATIONS IN CEMENT INDUSTRY (DIASENZOR)



Schottky diodes structures fabricated on diamond

SiC and diamond are the most promising materials for power devices, because their dielectric breakdown field is ten times greater than that of silicon, they can be used at high temperatures, because they have a high thermal conductivity. The SiC and diamond devices reduce power loss and equipment size.

We have developed the technology of fabrication sensors on SiC and diamond based on high power Schottky diodes. The fabrication process of the diamond and SiC devices were implemented on the silicon processing facilities.



Schottky diodes structures fabricated on silicon carbide

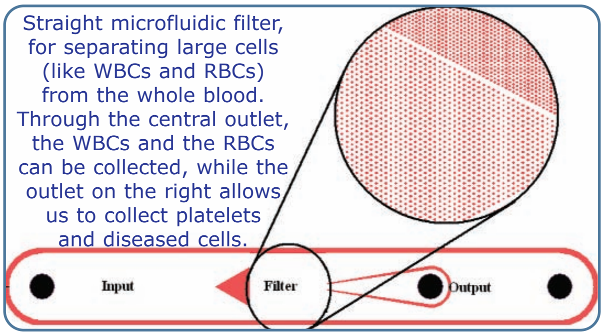
PNCDI Program (2007- 2010); **Coordinator:** Politehnica University of Bucharest, Prof. Dr. Brezeanu Gheorghe; **Partners:** IMT Bucharest, Dr. Marioara Avram, Marioara.avram@imt.ro; METAV SA, CEPROCEM, CARPAT-CEMENT;

MICROFLUIDIC BIOCHIP FOR RHEOLOGICAL CHARACTERIZATION OF NON-NEWTONIAN BIOLOGICAL FLUIDS WITH APPLICATIONS IN MEDICAL DIAGNOSIS AND TREATMENT (MELANOCHIP)

Within this project, we want to create efficient and accurate analysis instruments necessary for medical diagnosis and development of new therapies for thrombosis and malignant diseases (basal cell carcinomas and malignant melanoma), pathologies in which modifications in the flow of biological fluids appear.

The results obtained within the project have direct applicability in the medical area, in the detection of the pathogens implicated in thrombosis, malignant pathology, histopathological aspects and etiopathogeny data, as well as therapeutic decision. The biochip realized in this project will impose itself in clinical laboratory research by its importance and complexity of the delivered information for fast indication of the diagnosis and therapy to be followed.

Curved microfluidic filter, for cell separation depending on size and weight.

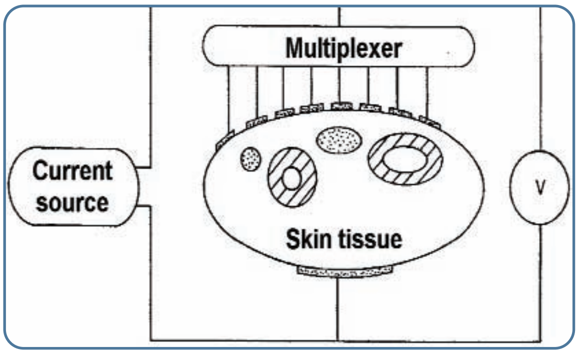


Straight microfluidic filter, for separating large cells (like WBCs and RBCs) from the whole blood. Through the central outlet, the WBCs and the RBCs can be collected, while the outlet on the right allows us to collect platelets and diseased cells.

PNII Project 12-094/2008; Coordinator: IMT-Bucharest, Dr. Marioara Avram, marioara.avram@imt.ro;
Partners: "Politehnica" University of Bucharest, "Transilvania" University of Brasov, ICPE - CA; Universitary Hospital

MICRO- ELECTRO- MECHANICAL SYSTEM WITH APPLICATIONS IN RECONSTRUCTIVE MICRO-SURGERY OF PERIPHERAL NERVES (RECONECT)

The proposed intelligent microsystem can be used to: immobilize the peripheral nerves inside microchannels; investigate the interactions in supramolecular systems; reveal some new interactions and solve the mechanisms through which these interactions can trigger the behavior of peripheral nerve fascicles (on the molecular level). The microsystem is a combination between a microfluidic system and a microelectronic-bionic one. With the help of the microsystem realized during this project we will be able to conduct studies closer to the truth about the peripheral nerve and it's capacity of regeneration and reconstruction. Also, we will be able to study what is happening to the section heads of the nerve and the segment added to rebuild the nerve's continuity and we will be able to study the physiological function and it's physiopathology. Thus, we will be able to predict, by comparison with the modern state of the art reconstruction techniques, the future of reconstructive microsurgery for any of these components.



Device scheme. Multiplexer is connected to the electrodes in contact with epithelial tissue. Elsewhere on the skin and attach reference electrode. The device is powered from a power source and a voltmeter to measure the potential difference of each electrode with reference electrode.

In this project we want to develop a technique able to identify the exact position of each type of nervous fiber at the nerve's head. In order to determine the fiber nerve types we will use the variation of the rest potential, the variation of the activity potential, the variation of the velocity of the nervous impulse and also the electrical capacity of the membrane, the transmembrane currents and the ion channel currents. The rest potential can be directly measured with the help of microelectrodes, or indirectly by using ionized fluorescent substances (for example the tiocianate).

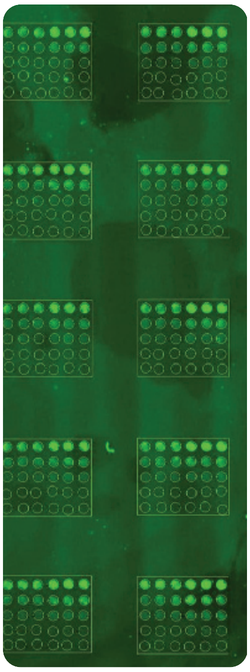
PNII Project 72-160/2008; Coordinator: IMT-Bucharest, Dr. Marioara Avram, marioara.avram@imt.ro;
Partners: "Politehnica" University of Bucharest, "Transilvania" University of Brasov, Universitary Hospital**.**

A "SYSTEM-IN-A-MICROFLUIDIC PACKAGE" APPROACH FOR FOCUSED DIAGNOSTIC DNA MICROCHIPS (DNASIP)

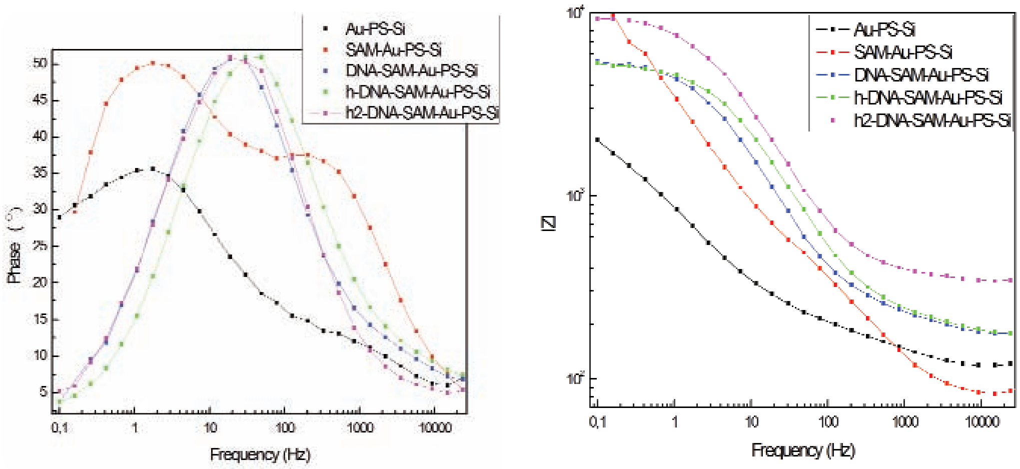
Deoxyribonucleic acid (DNA) is the most important bio molecule from every living organism (plant, animal, human, unicellular organism) witch had an essential role in storing and the determination of hereditary characteristics. The identification of mutation is important because many compounds bind and interact with DNA and causing changes to the structure of DNA and the base sequences, leading to perturbations in DNA replication and cancer. This work is focused on the study of interaction between DNA molecules and silicon/porous silicon system The remarkable advantages of this material include its huge surface to volume ratio, its high chemical reactivity at room temperature and potential compatibility with silicon integration technologies.

The 25-mer pre-syntehetised oligonucleitides probe were purchased from Integrated DNA Technologies and have the following seqvences Probe: 5' – AAC CAG GAT ATC CGC TCA CAA TTC – 3' – complementary strand :5' – GGA ATT GTG AGC GGA TAT CCT FFT T – 3'. Detection of DNA had three important technological steps: (i) DNA immobilization, (ii) blocking remaining active bonding, (iii) DNA target hybridization.

The DNA interaction with a nanostructurated Au-PS substrate was study from two points of view: a) microarray based detection base on fluorescent ssDNA label; b) impedance spectroscopy as label-free detection scheme.



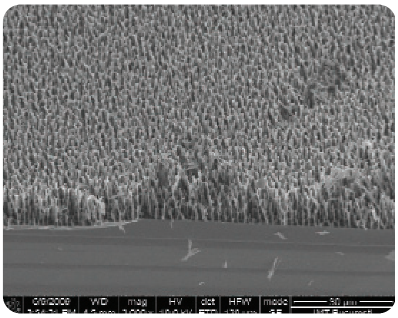
Scanned image with immobilized Cy3 labeled DNA on PS



DNA hybridisation detect by electrochemical impedance measurements. Bode (a, b) and Nyquist (c) plots for: Au/PS; thiols/Au/PS; DNA imobilized and hybridized evolution

MNT-ERA Program (2008 – 2010); Coordinator: IMT Bucharest, Monica Simion monica.simion@imt.ro
Partners: Genetic Lab SRL, Université catholique de Louvain, University of Liège, Coris BioConcept

NANOSTRUCTURAL CARBONACEOUS FILMS FOR COLD EMITTERS –NANOCAFE



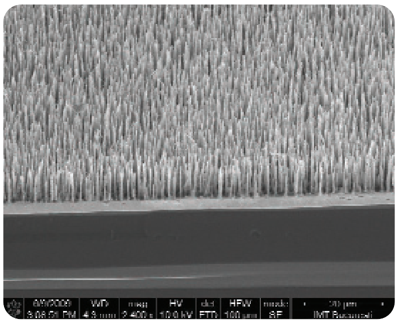
Cross section in a silicon porous layer performed on Si - (111) wafer

The goal of the project is preparation of a new type of cold cathode based on nanocomposite material that is nanostructural carbonaceous film and design of prototype device based on the cathode. This film consists of composite nanostructural material built of carbon nanotubes, carbonaceous and metal nanocrystals. The film based cold electron sources will be designed as a new type of cold electron emitters. The substrate for nanostructural carbonaceous films is porous silicon, this material assuring high level of active surface and a good adherence of the carbonaceous material.

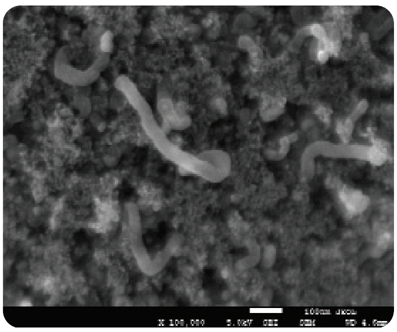
Three types of PS substrates (nano-, meso- and macro-porous) were prepared by selective anodization of the <111> and <100> orientation Si wafers.

On these substrates polish partners performed carbonaceous films deposition processes.

The films obtained were investigated both in Romania and in Poland in order to choose the best kind of substrate for the high efficiency cold emitters. Finally – will be designed a prototype of a new cold cathode that shall be tested design a prototype of a new cold cathode that shall be used in bright displays of new type.



Cross section in a silicon porous layer performed on Si - (100) wafer



Various nanostructured carbonaceous (including nanotubes) deposited on PS substrates.

MNT-ERA Program (2008 – 2010); Coordinator: IMT Bucharest, Florea Craciunoiu florea.craciunoiu@imt.ro
Partners: Industrial Institute of Electronics Warsaw, Kielce University of Technology and Institute of Microelectronics and Optoelectronics Warsaw

SERVICES OFFER AND CONSULTANCE ACTIVITIES:

(i) X-RAY DIFFRACTION CHARACTERISATION

- Investigation of crystal structure (HR RSM, HR RC);
- film thickness, density, roughness;
- characterization of the ultra thin film (XRD);
- particle/ pore size analysis (reflection SAXS, transmission SAXS);
- phase identification, crystal structure (powder/thin film/poly/ mono/ crystall, trace, small area/quantity);

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

(ii) MICROARRAY BIOCHIPS

- Development of technologies (controlled deposition of biologic material) and devices (microarray biosensors) for biological material investigation and detection (proteins, DNA, enzymes) on various substrates (silicon, glass, polymers) with applications in medical diagnosis;
- Fundamental research for study of biomolecular recognition reaction;

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

(iii) ELECTRICAL/ELECTROCHEMICAL CHARACTERISATION

Material characterization; Fundamental studies of physico-chemical phenomena at bio-hybrid interfaces with applications in areas:

- *Microelectronics:* development of new processes and materials with improved electrical properties;
- *Energy:* development of new fuel cell devices as clean energy sources; development of solar cells with improved parameters;
- *Biomedicine:* development of electrochemical immunosensor devices for clinical diagnostics; implant biocompatibility studies;
- *Environmental* quality control: Detection of compounds/toxins/pathogens for water, food;

Contact: Dr. Mihaela Miu, mihaela.miu@imt.ro

(iv) NANOPARTICLE CHARACTERISATION

- Determination of the submicron particle size by measuring the rate of fluctuations in laser light intensity scattered by particles as they diffuse through a fluid, for size analysis measurements and/or electrophoretic light scattering (ELS);
- Zeta Potential analysis of the functional surfaces;

Contact: Chem. Adina Bragaru, adina.bragaru@imt.ro

(v) MICRO- AND NANOSTRUCTURED SILICON FABRICATION

- Fabrication of morphological controlled porous silicon (PS) (multi)layers / membranes (2-500 mm thickness) on Si wafers with different characteristics;
- Fabrication of Si nanowire arrays;
- Fabrication of Si nanostructured microparticles (2-10 μm with pore/fibrils diameters of 10-50 nm).

Contact: Florea Craciunoiu, florea.craciunoiu@imt.ro

(vi) REACTIVE ION ETCHING TECHNOLOGIES

Reactive Ion Etching manual loading, capable of processing wafers up to 6”, four process gases: CF_4, SF_6, O_2 and Ar, maximum RF power 600W, equipped with a fore pump and a turbo molecular pump capable of reaching pressures in the reaction chamber down to 10^{-6} mbar. Typical applications for the basic configuration are:

- the etching of dielectrics (SiO_2, Si_3N_4),
- semiconductors (Si),
- polymers and metals (Au, Pt, Ti, Ni).

Contact: Phys. Andrei Avram, andrei.avram@imt.ro

INSTRUMENTS AND EQUIPMENTS

Laboratory of Nanotechnology has contributed to the development of new experimental and characterisation laboratories in the IMT-MINAFAB:

(i) **NanoBioLab** equipped with Plotter microarray (GeneMachines OmniGrid Micro) and Scanner microarray (GeneTAC UC4);
(ii) **Laboratory for Spectroscopic/Microscopic analyses** of interface electroactivities equipped with Electrochemical Impedance Spectrometer PARSTAT 2273 – Princeton Applied Research; Scanning Electrochemical Microscop (SECM);
(iii) **Laboratory for X-ray Diffraction** equipped with Rigaku SmartLab X-ray thin film difraction system;
(iv) **Laboratory for Nanoparticles** equipped with DelsaNano Zeta Potential and Submicron Particle Size Analyzer, Fluorescence Spectrometer.

Other available facilities are: AMMT wet etching system with software for 4’ silicon wafers, potentiostat MC and etching power supply; Fluorescence set-up for LEICA DMLM with images acquisition and measurement system; computers for simulation; instruments and software for electrical characterisation of nanostructures.

L3:Laboratory of micro/nano photonics

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

The Laboratory of Micro/Nano Photonics is recognized at national level, and funded between 2001 and 2004, as a
Centre of Excellence in Micro and Nano-Photonics.

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

Main areas of expertise

- **modeling and simulation** of micro and nano photonic structures; development af simulation tools
- **new materials** for micro/nano opto-electro-mechanical systems integration (e.g. compound semiconductors, functional polymer, hybrid organic-inorganic nano-compozites and glasses), and related fabrication processes (including mixed technologies);
- **passive and active** micro-nano-photonic structures,
- **hybrid or monolithic integrated photonic circuits and MOEMS** (including heterogeneous platforms) for optical communications, interconnects and optical signal processing;
- **micro-optics** - design and fabrication based on replication techniques
- **plasmonics**
- optical and electrical **characterization** of materials and devices

European Projects

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

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

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

Specific facilities:

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

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

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

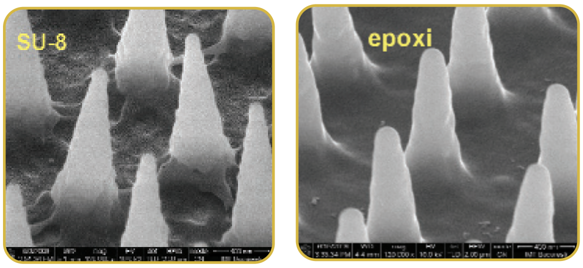
Dr. Dana Cristea obtained the MSc in Electronics (1982) and PhD in Optoelectronics and Materials for Electronics from "Politehnica" University, Bucharest, Romania. From 1982 until 1994 she was a research scientist in the Department of Optoelectronics and Sensors from the Research & Development Institute for Electronic Components, Bucharest, Romania.

Since 1994 she has been a senior researcher in the National Institute for R&D in Microtechnologies (IMT- Bucharest), Romania, head of Laboratory of Micro/Nanophotonics since 1997 and head of Department for Multidisciplinary Research betwen 2002 and 2008; since 1990 she has also Associate Professor at "Politehnica" University, Bucharest, Faculty of Electronics. Her main research activities are in the fields of optoelectronics and photonic integrated circuits, optical MEMS for communications, chemo and bio-sensors with optical read-out. She has been more than 80 publications in international scientific journals and conference proceedings. She is also a reviewer in Romanian and international scientific journals and evaluator of European projects (FP6, FP7). She is project manager for national and European projects.

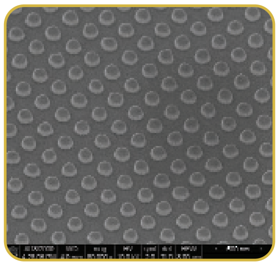
Replication techniques for micro and nano-optical components

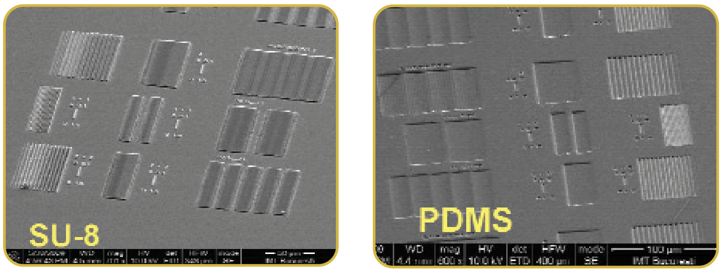
This technique is versatile, inexpensive and can transfer patterns into functional materials and onto a number of surfaces. Replica molding was used to replicate:

- micro-optical components with different feature size (dots, rectangular structures, pillars, optical resonators);
- components for micro-fluidic applications;
- to generate nano-components in polymers with 30-100 nm resolution.

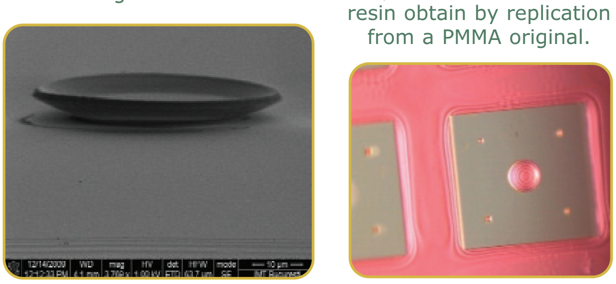


Antireflective layer in epoxy resin – replica (positive copy) of a SU-8 original


Lens-shape structures (ϕ~150 nm) in epoxy resin obtain by replication from a PMMA original.



Multi-level holograms replicated in PDMS (left image) using an SU-8 original

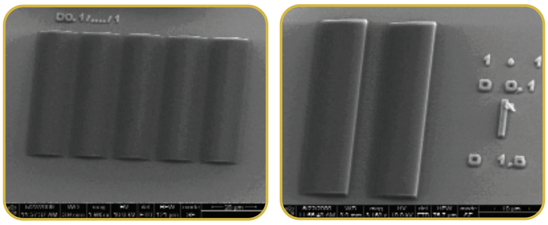

SEM and optic images of the optical resonator

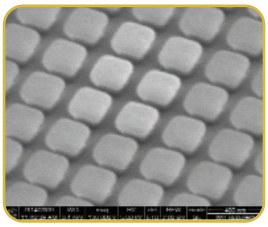
PN II Project (2007-2010), "Development of soft lithography techniques for micro and nano-photonics" - **LISOFT**
Coordinator: IMT Bucharest, **Project manager:** Paula Obreja (paulao@imt.ro)

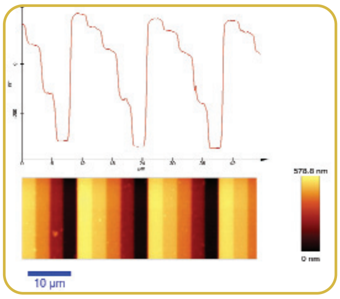
Techniques for fabrication of 3D polymeric or metallic nanostructures with application in photonics

The techniques combine the following processes: 3D electron beam lithography in a multi-layer resist, metal deposition and lift-off, replica molding. Diffractive optical elements with different shapes (prism, dots, lines) with feature size in the range 100 nm - 150 mm were obtained for antireflection coatings for solar cells, microlenses for photodetectors, holograms

A. Polymeric and metallic 3 D micro nanostructures with application in photonics: antireflective (AR) layers, photonic crystals, plasmonics, sub-micron diffractive optics


Different shape multi-level DOEs fabricated by grey tone EBL in SU-8: a) dose = 0.1...1x6 μC/cm²; b) dose=zero...1.5x6 μC/cm2 (16 levels)

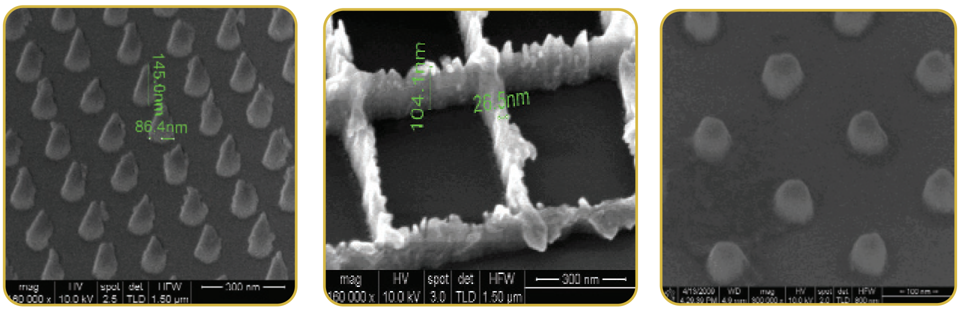

SEM images of T-shape structures obtained in PMMA950k/495k systems



Profile of a 5-level structure in PMMA 35K (AFM- contact mode).

B. Metallic structures as masters for replication

Photodetector with selective spectral response was fabricated by integration of a multilayer structure with controlled optical properties with a silicon PIN photodiode with an active area of 0.6mm^2 fabricated by silicon planar technology. Multilayer structure consists in semitransparent metallic films and dielectric layer with controlled thickness.



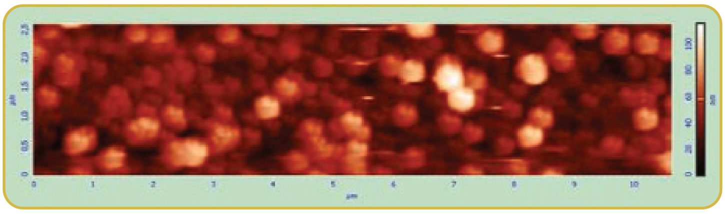
Metallic masters for a) AR layers; b) grating for biosensors; photonic crystals.

European Project (FP7-Capacities) MIMOMEMS, contract No. 202897- cooperation with Cooperation with FORTH Herakion, Greece (metal deposition)

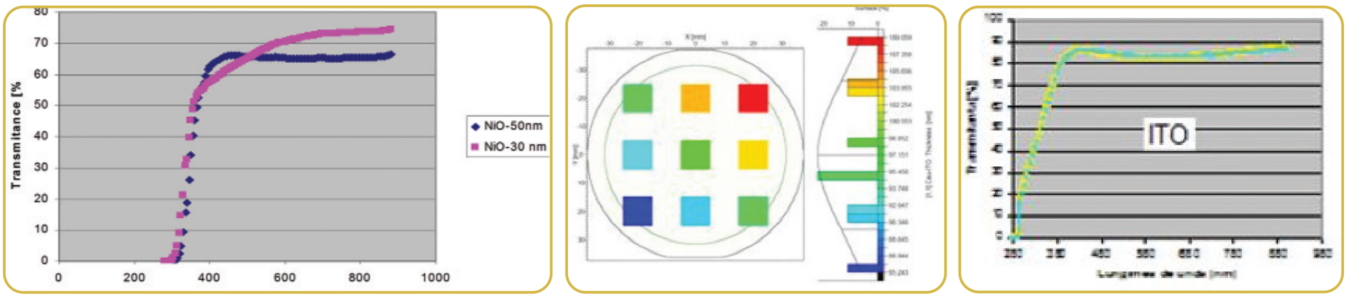
IMT core program Convert- project PN 09 29 02 05- cooperation with Microphysical characterization laboratory (EBL, SEM).

Transparent conductive oxide (TCO) thin layers for transparent electronic and optoelectronic devices

• **ITO** by DC sputtering and **NiO** by thermal oxidation of Ni layers deposited by vacuum thermal evaporation on unheated transparent substrates and on polished silicon wafers. NiO layers with thickness in the range 30-80 nm with a transmittance >60% have been obtained at 450 – 500 ºC for 20-45 min. Optical and electrical characteristics have been determined by the pair of parameters, oxidation temperature and oxidation time.

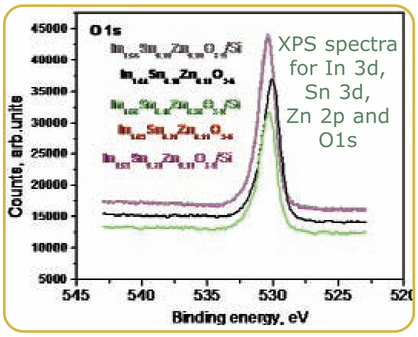


Morphology of NiO layer by AFM



Transmittance of oxidic layers obtained : a) – NiO: c) ITO; b) uniformity of ITO layer

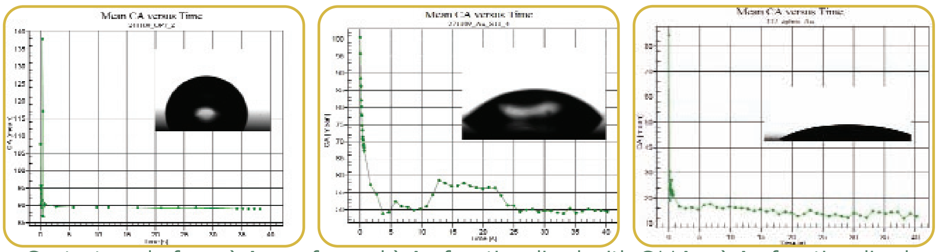
• **Oxides in the system In_2-(x+y)SnxZnyO$_3$-δ(ISZ)** that by rigorous control of x and y can be obtained layers of n or p type and by the control of δ-oxygen vacancies the conductivity can be monitorised. $In_{1.64}Sn_{0.16}Zn_{0.2}0O_{3-\delta}$ layers of p type and $In_{1.64}Sn_{0.20}Zn_{0.16O3-\delta}$ of n type have been prepared. The achieved layers have 159-300 nm thickness, more than 85% transmittance and resistances in the range 200-1000 Ω.



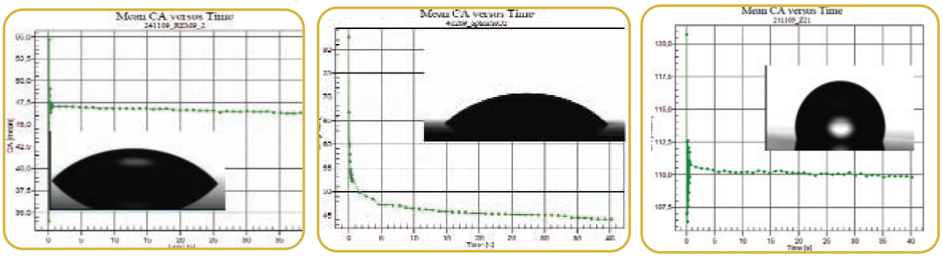
Co-operation with "A.I. Cuza" University of Iasi in ELOTRANSP project.

PN II project, contract no: 12128/2008, "Development of processes and devices based on oxidic and polymeric thin layers for transparent Electronics and Optoelectronics. (ELOTRANSP)"; **Co-ordinator:** IMT-Bucharest
Project manager: Dr. Munizer Purica (munizer.purica@imt.ro)

Control of hydrophobic/hydrophilic behaviour of surfaces



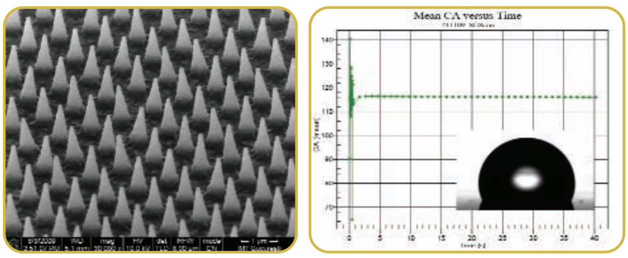
Contact angle for: a) Au surfaces; b) Au functionalized with C11A; c) Au functionalized with APTMS.



Contact angle for: a) SiO_2; b) SiO_2 functionalized with APTMS; c) functionalized with trichlorsilane

Recently, the need for tuning the wetting properties of the surfaces has been increasing, for applications in micro/nanotechnologies (e.g. replication, nanoimprint), Lab-on-a-Chip diagnostics and microfluidics. We increased the hidrophilicity of Au and polymer surfaces (Au, SiO_2, PDMS, SU-8) by functionalization with APTMS or plasma treatment. Hydrophobic and superhydrophobic surfaces were obtained by silanization or nanostructuring.

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

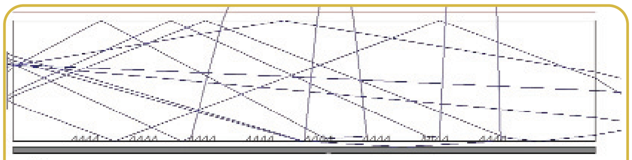


Super-hydrophobic SU-8 surface obtained by nanostructuring; a) SEM images; b0contact angle measurement

PDMS hydrophilization by plasma treating and contact angle measurements: a) PDMS sample- untreated: contact angle contact 112º , b) PDMS treated in SF6 (P=10Pa, Prf=50W, t=10min, SF6=100sccm)- contact angle 105º c) PDMS treated in SF6 (Prf 200W) +O_2)- contact angle 97° d) treatment in SF6 (Prf 250W) +O^{2-} contact angle 85°.

Flexible Patterning of Complex Micro Structures using Adaptive Embossing Technology

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

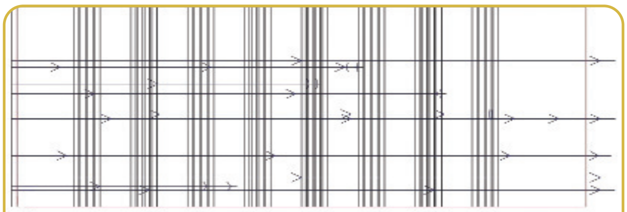


Calculations of the power out coupled from the waveguide; power remaining in the waveguide. Cross section view of a waveguide with scattering elements embossed on its lower surface and a random distribution of rays interacting with the scatterers.

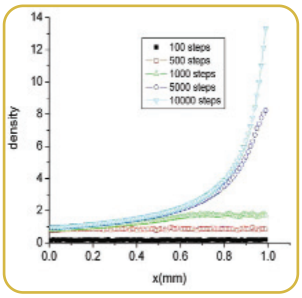
■ Development of a Mathematical Model for optimization of the embossing process of diffractive optical elements

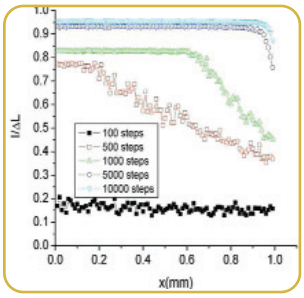
A mathematical model describing the interaction of the optical radiation with scattering elements embossed on the lower surface of a transparent waveguide has been proposed. The interaction of an incident optical field I0 with a scattering element results in a field coupled out of the waveguide with intensity kI0 and a remaining field propagating inside the waveguide with intensity (1- k)I0, where k is a coefficient depending on the geometrical parameters of the scattering element. This model has been proposed for the case in which the projections of the incident rays on the waveguide surfaces are parallel with the propagation direction z.

The implementation of this case has been analyzed. Based on this model, a method of determining the value of the outcoupling coefficient from the radiance measurements of a set of test structures has been proposed. In addition, an equation describing the distribution of scatterers giving a uniform radiance (luminance in photometric units) has been found. The validity of this model has been verified by performing the ray tracing simulations using the commercial software Zemax. In addition, for optimizing the distribution of scattering elements in order to obtain a uniform radiance (luminance) an objective function has been defined. The proposed mathematical model is the basis for an optimization algorithm using the simulated annealing or Metropolis algorithm.



Top view of the waveguide showing the collimated beams in the (x-z) plane

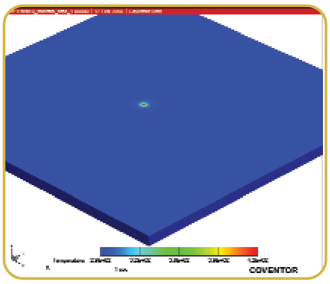




The evolution of the scatterers density (left) and of the irradiance as the system relaxes according to the Metropolis algorithm and the objective function approaches zero.

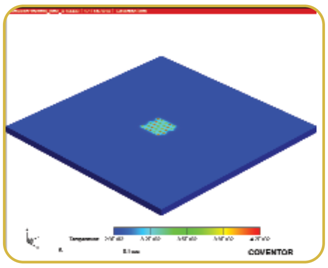
Contact persons: Dr. Cristian Kusko (cristian.kusko@imt.ro), Dr. Mihai Kusko (mihai.kusko@imt.ro)

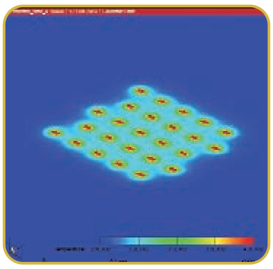
■ Thermal transient analysis of the embossing step-FlexPaet



Temperatures in K degree in the substrate after embossing at 1s just one structure in the tool

1. Parametric study with Coventor 2008 software tool (initial tool temperature = 150°C and rise in the thermal conductivity of the substrate limited to 1 W/m/K) The substrate used for embossing is of PMMA and the tool/indent of Ni and it has 25 pixels (structures). We performed thermal transient simulations in order to observe the temperatures reached in the substrate after embossing.



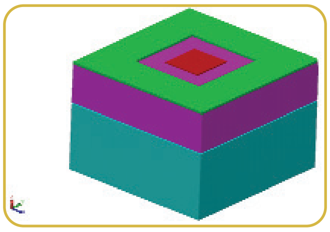


Simulation results: Temperatures in the substrate after embossing at 0.1s and detail

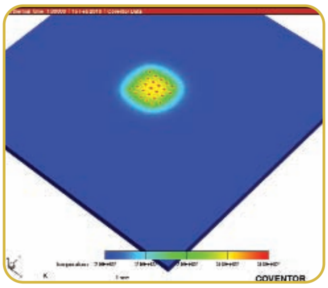
2. **Parametric study** with CoventorWare 2008 software tool –using a thermal flux.

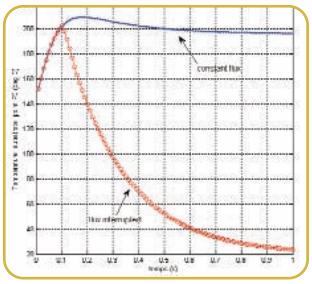
In order to describe the Ni-Shim heating/cooling effect we imposed a thermal flux at the top surface of the ceramic layer 4x4mm (we considered Al_2O_3) and a cooling at the surrounding zone with water at 20°C. The initial tool temperature was set to150°C and rise in the thermal conductivity of the substrate limited to 1 W/m/K).

A cooling effect is predicted only when the heating flux is interrupted during embossing (in this case at 0.1 s)



The 3D model used in simulations with CoventorWare with the ceramic (Al_2O_3) layer and cooling zone (water), Ni layer and PMMA layer





Temperatures in the substrate at 1s when we apply a heating flux on the top of ceramic: heating flux = 120 W/cm², interrupted at 0.1 s

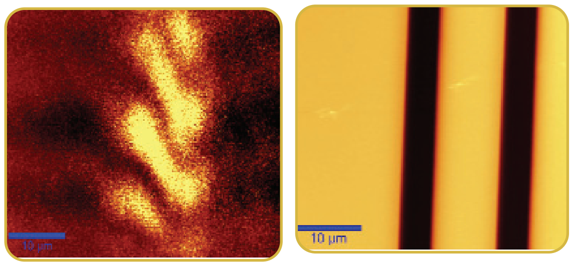
Cooperation with Simulation, Modelling and Computer Aided Design Laboratory**.**
Contact person: Rodica Voicu (rodica.voicu@imt.ro)

European projects

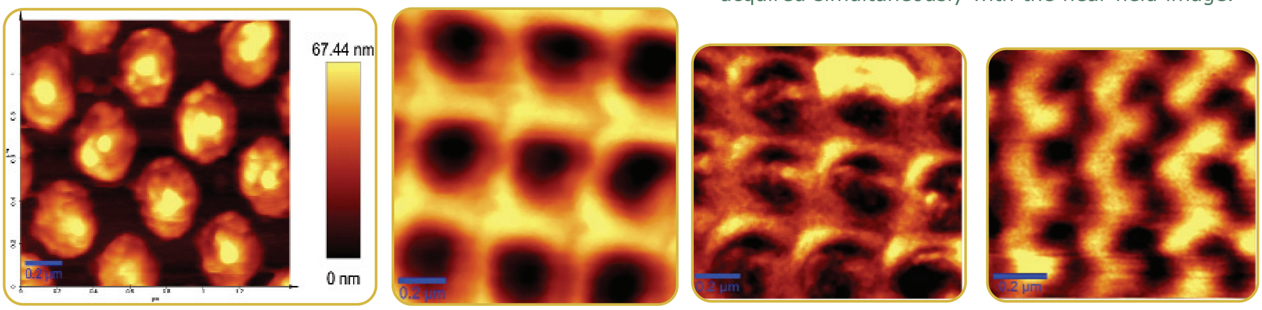
Photonics and plasmonics studies using near field optical microscopy.

The scanning near field optical microscope allows the characterization of light interaction with dielectric and metallic structures. The metallic structures are periodic arrays of gold disks obtained by nanolitography and lift-off and they exhibit plasmon excitations. They are characterized by SNOM in transmission, reflection and collection modes. The experimental results are compared with FDTD simulations.

For dielectric wave-guides characterization, the SNOM has been used in the photon scanning tunnelling microscopy mode. The light is launched in the waveguide through end – fire coupling and the evanescent field is collected with SNOM probe giving the optical field configuration in the waveguide



a) SNOM image of the evanescent field in a multi-mode PMMA waveguide b) AFM scan of the waveguide acquired simultaneously with the near field image.



Topography image – AFM (a) and SNOM images in the transmission (b), reflection (c), and collection (d) mode of a periodic array of 200 nm diameter gold disks on a glass substrate (obtained by EBL and lift – off)

Contact person Dr. Cristian Kusko
European Project (FP7-Capacities) European Centre of Excellence in Microwave, Millimetre Wave and Optical Devices, based on Micro-Electro-Mechanical Systems for Advanced Communication Systems and Sensors" (MIMOMEMS), contract No. 202897
Coordinator: Dr. Alexandru Muller (Lab. Micromachined Structures, Microwave Circuits and Devices)
Vice-coordinator: Dr. Dana Cristea (Lab. Micro-nano Photonics)

SERVICES OFFER:

Modelling, simulation, CAD

- modelling, simulation CAD for active and passive micro/nano-photonic devices and micro-optics.
- concept & design studies, development of new tools (customized) especially for "linking" different commercial software to offer a coupled simulation (opto-electro-mechanical analysis)for optical MEMS and sensors

Characterization

- Analysis and characterization of the nanometric thin films and multilayered structures from different materials –dielectrics, conductive oxides, polymers, semiconductors: measuring the index of refraction (n) and the extinction coefficient (k) for a single layer permits one to determine the material composition and modeling of optical performance.
- Testing the optical properties of samples for the ability to reflect or transmit light by spectrophotometric measurements-transmistance, absorbance spectra [$T(\lambda)$,$A(\lambda)$], surface reflectivity of the texturized and porosified layers.
- Raman spectroscopy for physical and chemical material analysis of solids, liquids and solutions for chemical identification, characterization of molecular structures; composition and phase (crystalline/amorphous) of composites materials (compound semiconductors, oxidic semiconductors); polymers characterizations and polimer nanocomposites; chemical and biological detection using SERS technique; micro/nano structures characterization (micro/nanorods).
- Near field optical microscopy: transmission, reflection, collection, fluorescence
- Confocal microscopy: transmission, reflection, fluorescence, can be upgraded with a Raman spectrometer;
- Atomic force microscopy: contact and AC – Mode

L4: Laboratory of micromachined structures, microwave circuits and devices

The laboratory is one of the promoters of the RF - MEMS topics in Europe. It has coordinated the FP4 **MEMSWAVE** project (one of the first EU project in RFMEMS) nominated in 2002 for the Decartes Prize. It has participated in the FP6 network of excellence **"AMICOM"** (2004 -2007) with new and original results obtained in cooperation with key players in the European research in this topic (LAAS-CNRS Toulouse, VTT Helsinki, FORTH Heraklion). The laboratory is now involved in the **MEMS 4 MMIC** FP7 Strep. The laboratory is coordinating (together with the microphotonics Lab) the FP7 "European Centre of Excellence in Microwave, Millimetre Wave and Optical Devices, based on Micro-Electro-Mechanical Systems for Advanced Communication Systems and Sensors"-**MIMOMEMS**. Since 2009 the laboratory is member of **LEA "Smart MEMS/NEMS Associated Lab"** togheder with LAAS-CNRS Toulouse and FORTH Heraklion.

- Mission
- Main areas of expertise
- International projects
- International bilateral cooperation
- National projects
- Research Team
- Specific facilities

Mission: scientific research and technological development of micromachined microwave and millimetre wave devices and circuits. The new RF MEMS technologies (including the "membrane supported circuits technologies") represent a solution to manufacture high performance microwave and millimeter wave devices and circuits devoted to the emerging communication systems and sensors. Lately the laboratotry has also stared the research to develop acoustic devices using micromachining and nano-processing of wide band gap semiconductors (GaN/Si, AlN/Si) and experimental devices based on Carbon nanotubes and graphene.

Main area expertise:
- Development of a new generation of circuits devoted to the millimeter wave communications based on the semiconductor (Si, GaAs, GaN) micromachining and nanoprocessing materials;
- Acoustic devices (FBARs and SAWs) based on micromachining and nanoprocessing of wide band gap semiconductors (AlN , GaN)
- Microwave devices based on carbon nanotubes;
- Microwave devices using CRLH materials (metamaterials)

International projects - FP7 "**MIMOMEMS**" - REGPOT (regional potential) action, IMT coordinator, (2008-2011);
MEMS 4 MMIC Strep (2008-2011) - IMT member.
Related to FP7 projects:
MEMIS ERA-NET Project, IMT Member.
SE2A, ENIAC (2009-2011) – IMT member

International bilateral cooperations: The laboratory has a bilateral intergovermental cooperation with University of Pretoria, South Africa on a "60 GHz radio frontend"

National projects: In the PN II programme, the laboratory has 6 projects (5 Partnership and 1 Capacities) as coordinator and one as partner. The laboratory had finished three CEEX projects as coordinator, two CEEX projects as partners and four projects in the MINASIST+.

Research team: has multidisciplinary expertise in physics and electronics of microsystems and is composed of 8 senior researchers (6 with PhD in physics, electronics, microwave and chemistry), 3 PostDoc researcers, 1 PhD student, 1 master student.

Specific facilities: Computers and software for EM simulations (IE3D, Fidelity from ZELAND and CST Studio Suite software packages); "On wafer" S parameter measurement system in the 0.1 -110 GHz range: (Microwave VNA from Anristu and probe station PM5 from Suss Microtec) Specrum Analyser from Anristuup to 110GHz; Frequency Syntesizer from Agilent up to 110GHz; Optical profiler WLI (Photomap 3D from Fogale); Keithley Semiconductor characterization system 4200 SCS; Measurement accessories.

Ioana Petrini, Mircea Dragoman, Dan Neculoiu, Cristina Buiculescu, Alexandru Muller, Alina Cismaru, Alexandra Stefanescu, Mihaela Carp, Emil Pavelescu, Gheorghe Sajin, Cornel Anton, Andrei Muller

Laboratory Head — Dr. Alexandru Muller (alexandru.muller@imt.ro)

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

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

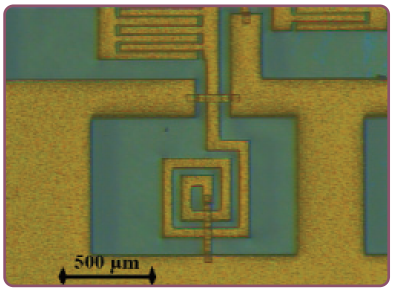
Dr. Müller is the coordinator of the European project FP7 REGPOT (2008 – 2011) "European Centre of Excellence in Microwave, Millimetre Wave and Optical Devices, based on Micro-Electro-Mechanical Systems for Advanced Communication Systems and Sensors" - Project No 202897. Dr. Müller has coordinated the ***European Project FP 4 MEMSWAVE (1998-2001)***. He is member of Micromechanics Europe Workshop and MEMSWAVE workshop steering committees. He is member of IEEE and EuMA. Dr Muller is member of PhD Jury in Politechnica Univ. Bucharest and Univ. Paul Sabatier/LAAS Toulouse. Co-editor of the Micro and Nanoengineering Series (Romanian Academy). He had invited papers at important European conferences. He has more than 150 contributions in books and international journals/conferences.

Dr. Müller is finalist of the Descartes Prize competition 2002 of the European Community with the MEMSWAVE Project, Romanian Academy Prize "Tudor Tanasescu" second prize for the MATNANTECH project, SIRMEMS (at CONRO 2003)

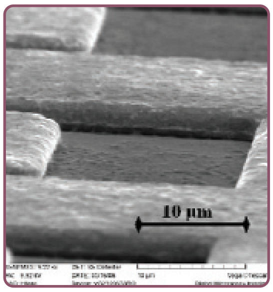
New reconfigurable micromachined filters dedicated to reconfigurable frontends for mobile communication systems 3G and „beyond" 3G" which endure the DCS 1800MHz and WLAN 5.2 GHz standards- – design and manufacturing

The filters are realized with two levels of micromachining (air bridges of the membrane supported spiral inductors). The structure is suspended on a dielectric membrane of 1.5 μm thick $SiO_2/Si_3N_4/SiO_2$. S parameters measurements between 1-8 GHz have been performed. A good agreement between measurements and simulations has been obtained. Measured losses are 1.8 dB above the simulated ones.

Achievements: design, electromagnetic simulation and optimization of band pass filter model, technological fabrication of reconfigurable filters with resistive switches in "on-DOWN" and "off-UP" states, S parameters measurements.



Detail of the reconfigurable filter: optical photo of a spiral inductor on membrane



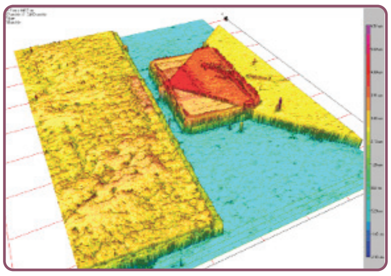
SEM photo of the interdigital capacitor (detail)

PNII Partnership Project "Advanced circuits for microwave, millimeter wave and photonics based on MEMS technologies MIMFOMEMS" (2007-2010)
Co-ordinator, IMT-Bucharest, Project Manager: Dr. A Müller (alexandru.muller@imt.ro)
Partners: National R&D Institute for Material Physics, "Politehnica" Univ. Bucharest, Institute of the Macromolecular Chemistry "Petru Poni" Iasi, SITEX 45 Bucharest

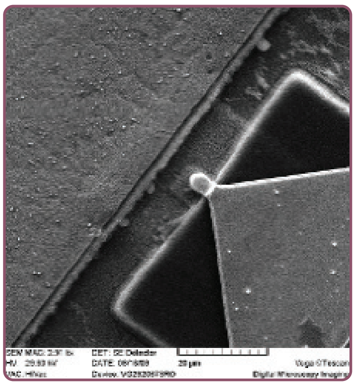
Substratless integrable Schottky structures

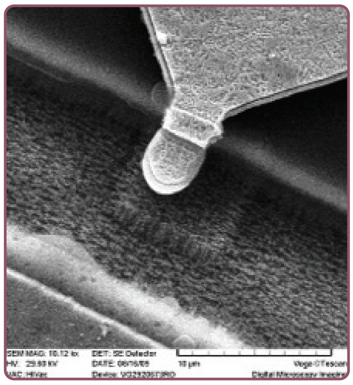
In order to fabricate the Schottky diodes on thin semiconductor membranes (suspended in air), a very complex technological flow is used – mesa areas for the Schottky and ohmic contacts, metallization, membranes. The substrate used is GaAs because, unlike Silicon it allows monolithic integration of micromachined passive circuits with the active ones.

Achievements: fabrication and characterization of substratless Schottky diodes



Analysis of white light interferometry topography through the realized diode structures





SEM photos of the diode structures realized on GaAs substrate and detail with the Schottky contact area

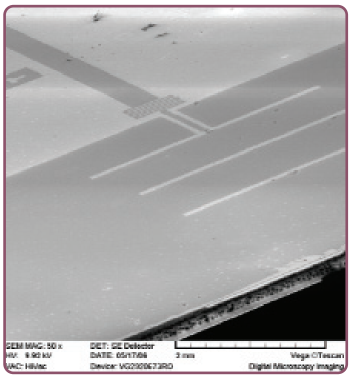
PN II Partnership Project "Advanced circuits for microwave, millimeter wave and photonics based on MEMS technologies MIMFOMEMS" (2007-2010)
Co-ordinator, IMT-Bucharest, Project Manager: Dr. A Müller (alexandru.muller@imt.ro)
Partners: National R&D Institute for Material Physics, "Politehnica" Univ. Bucharest, Institute of the Macromolecular Chemistry "Petru Poni" Iasi, SITEX 45 Bucharest

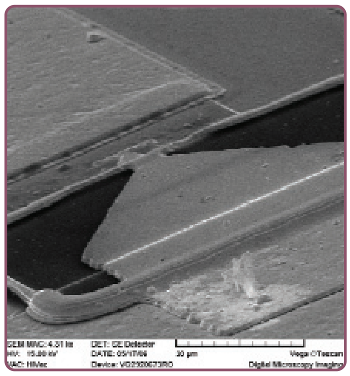
Design and fabrication of monolithic integrated micromachined receiver test structures on the GaAs membrane on 60GHz to be used as MMID TAG

The structure was simulated with IE3D Zeland software. The Yagi-Uda antenna monolithically integrated with the Schottky diode is suspended on the micromachined membrane and the band pass filter is on the bulk region..

Achivements: design and fabrication of monolithic integrated micromachined receiver test structures on GaAs membrane.

PN II Partnership Project "Advanced circuits for microwave, millimeter wave and photonics based on MEMS technologies MIMFOMEMS" (2007-2010)
Co-ordinator, IMT-Bucharest, Project Manager: Dr. A Müller (alexandru.muller@imt.ro)
Partners: National R&D Institute for Material Physics, "Politehnica" Univ. Bucharest, Institute of the Macromolecular Chemistry "Petru Poni" Iasi, SITEX 45 Bucharest





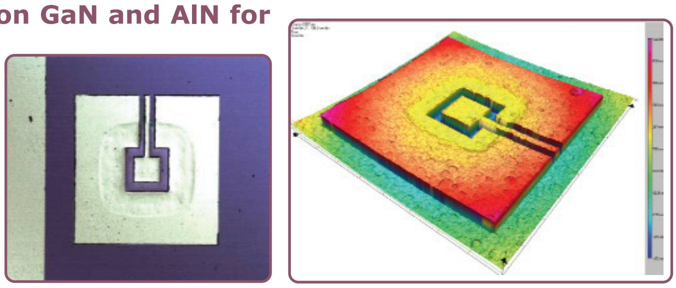
Optical photo of a FBAR structure manufactured on thin GaN membrane and its white light interferometric analysis

Micromachined FBAR structures manufactured on GaN and AlN for applications in the GHz frequency range – technological experiments

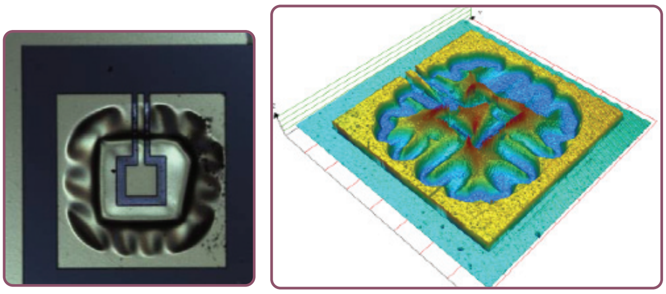
GaN and AlN piezoelectric layers can be a solution for manufacturing of FBAR resonators with very high resonance frequencies. The use of advanced micromachining techniques and very thin membranes, allows the increase of the resonance frequency of FBAR structures processed on these WGB materials, in the GHz range.

Achievements: FBAR structures obtained on GaN and AlN thin membranes with Mo and MoAu electrodes.

PN II Partnership Project "SAW and FBAR type resonators dedicated to applications in communications for 2-6 GHz, based on micro&nanomachining of wide band semiconductors (GaN and AlN) – GIGASABAR" (2008-2011).
Co-ordinator, IMT-Bucharest, Project Manager: Dr. A Müller (alexandru.muller@imt.ro)
Partners: National R&D Institute for Material Physics, "Politehnica" Univ. Bucharest, "Ovidius"University Constanta, SITEX 45 Bucharest

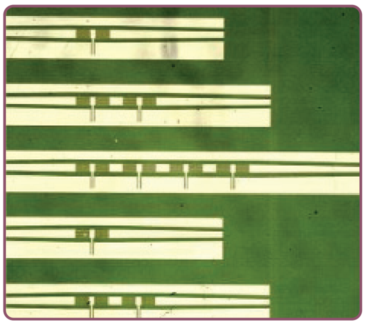


Optical photo of a FBAR structure manufactured on thin GaN membrane and its white light interferometric analysis

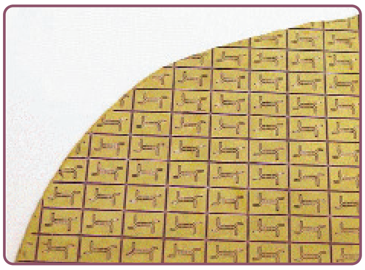


Optical photo of a FBAR structure manufactured on thin AlN membrane and its WLI analysis

Metamaterial mm-wave CRLH filters and directional coupers



Silicon wafer with directional CRLH couplers structures



Silicon wafer supporting 1, 2 and 4 sections CRLH band-pass filters

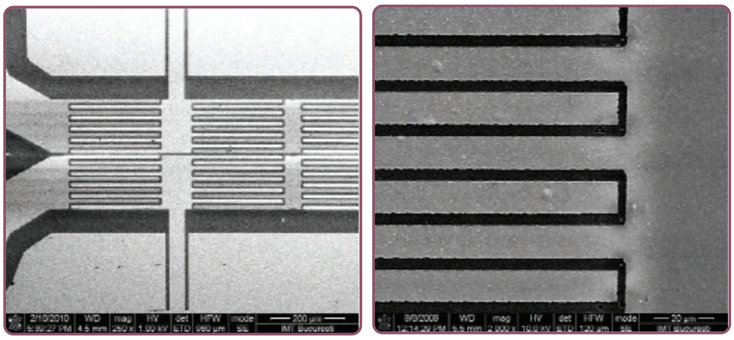
The metamaterials in microwave circuitry are artificial transmission lines (TLs) with both right-handed (RH) amd left-handed (LH) behavior. This dual frequency characteristic of the Composite Right/Left Handed (CRLH) cell has been exploited in the development of directional couplers and filters in mm-wave frequency range. Combined with other metamaterial devices and circuits it allows development of a new and different kind of microwave and mm-wave circuitry.

The measured S parameter of the BPF values show a return loss S_{11}<-15 dB in a frequency range of 45 GHz – 55.5 GHz. The losses in the same frequency range are around 6–7 dB.

The directional coupler have reduced geometrical size and measured electrical parameters demonstrate a working frequency between 23 GHz – 33 GHz, low return losses and a better than 30 dB isolation.

PN II Partnership Project 11-010: Millimeter wave devices on metamaterials microprocessed by laser ablation – METALASER. **Project manager: dr.ing Gheorghe Ioan Sajin**-(gheorghe.sajin@imt.ro);
Partners: INCDIE ICPE CA Bucharest; „Politehnica" University Bucharest, INCD-FLPR Bucharest.

CRLH structures in millimeter wave frequency range fabricated by laser ablation



SEM image of CRLH cells processed by laser ablation (a) and detail of an interdigital capacitor (b)

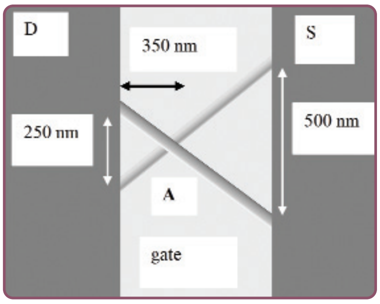
In mm-wave frequency domain, the dimmensions of the devices metallic lines and the spaces are less than 3μm, close to the limits of the standard photolithography capabilities. The laser ablation developed in collaboration with the NILPRP is a valuable alternative to process CRLH mm-wave structures. Thin metallic films deposited on silicon are precisely processed by tightly focused femtosecond laser. Using this technique, the fabrication of mm-wave filters, couplers and antennas were demonstrated.

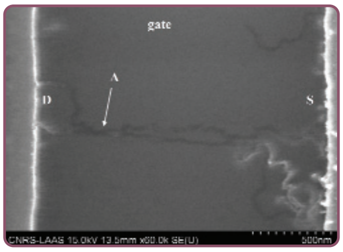
PN II Project 11-030: Advanced femtosecond laser system for metamaterials and photonic crystals nanostructuring – FEMAT. **Partnership** with NILPRP Bucharest. **Scientific manager for IMT: dr.ing Gheorghe Ioan Sajin**

Nanoelectronics based carbon nanotubes

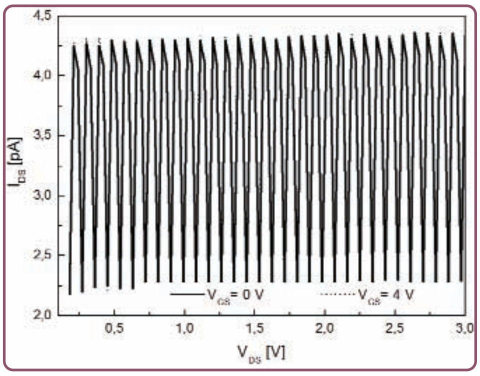
The design of test structures for CNT characterization, experiments regarding CNT manipulation of CNT and DC characterization technological implementation of the microwave test structures were succesflly performed

Achievements: the interconnection single and two CNT resulting in a FET transistor:





A FET-like configuration based two CNT.



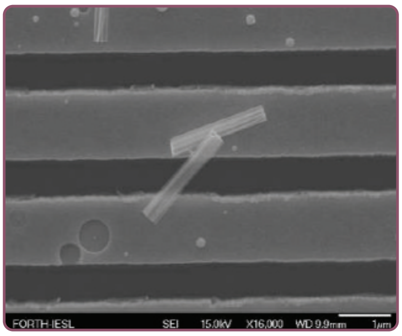
IV characteristics for A FET-like configuration based two CNT

PN II Partnership Project "Nanoelectronic devices for high frequencies based on carbon nanostructures for communications and environment monitoring" (2007-2010) **Co-ordinator, IMT-Bucharest, Project Manager:** Dr. M. Dragoman(mircea.dragoman@imt.ro)
Partners: National R&D Institute for Material Physics, "Politehnica" Univ. Bucharest, SITEX 45 Bucharest

Sensing DNA using carbon nanotubes

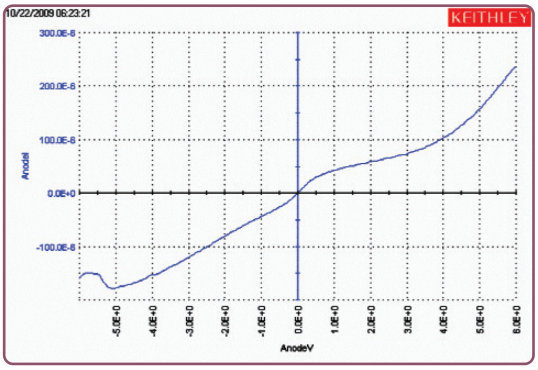
The aims of the research of the were to identify the solutions to functionalize CNT with DNA and design of the test structures for detection of CNTs functionalized with DNA.

Achievements: The realisation and characterisation of GaN nanowires (dielectric permitivitty similar to DNA which is also a widebandgap semiconductor) network deposited on the IDT electrodes



SEM photo of GaN nanowires network deposited on the IDT electrodes.

I-V dependence of the GaN nanowire network at room temperature.



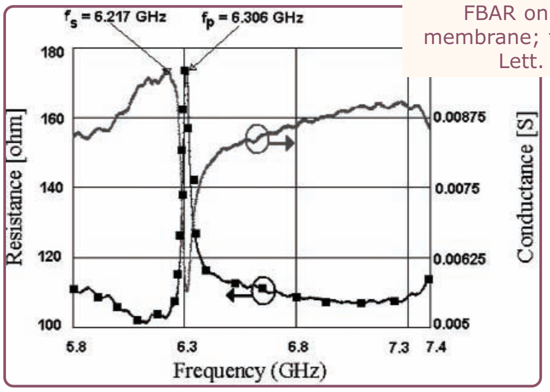
PN II Partnership Project (2008-2011) „Biosensors based on carbon nanotubes for the real-time detection of nucleic acids with oncogenic potential"
Co-ordinator, IMT-Bucharest, Project Manager: Dr. M. Dragoman(mircea.dragoman@imt.ro)
Partners: Institute of Oncology, National R&D Institute for Material Physics, "Politehnica" Univ. Bucharest

L4 - FP7 projects

MIMOMEMS - "European Centre of Excellence in Microwave, Millimetre Wave and Optical Devices, based on Micro-Electro-Mechanical Systems for Advanced Communication Systems and Sensors", project No 202897 financed (2008-2011) through the "Regional potential" part (REGPOT call 2007-1) of the European Framework Pogramme (FP7), starting date May 2008 (**www.imt.ro/mimomems**)

Co-ordinator: Dr. Alexandru Muller, alexandru@muller@imt.ro

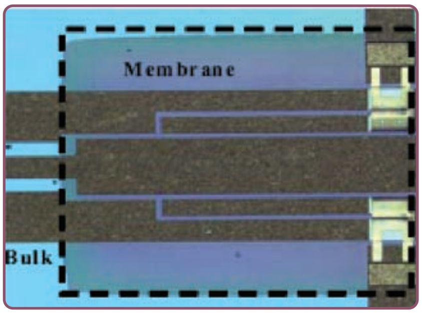
The overall aim of the MIMOMEMS project is to bring the research activity in Radio-Frequency (RF) and Optical-MEMS at the National Institute for R&D in Microtechnologies (IMT-Bucharest) to the highest European level and create a European Centre of Excellence in **M**icrowave, **M**illimetre **W**ave and **O**ptical Devices, based on **M**icro-**E**lectro-**M**echanical **S**ystems (MEMS) for Advanced Communication Systems and Sensors.



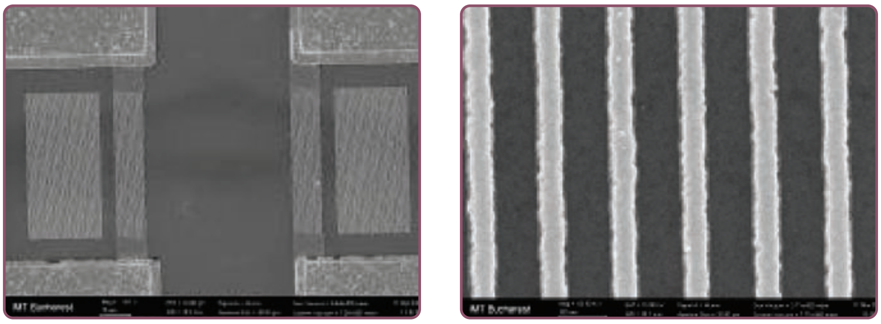
FBAR on 0.54μm GaN/Si membrane; fr= 6.3 GHz; El Dev Lett. 2009, p 799

Results obtained for the objectives of the MIMOMES project

- "Exchange of know-how and experience". This activity is performed **by twinning with two research centres: LAAS-CNRS** in Toulouse and **FORTH-IESL-MRG** in Heraklion.

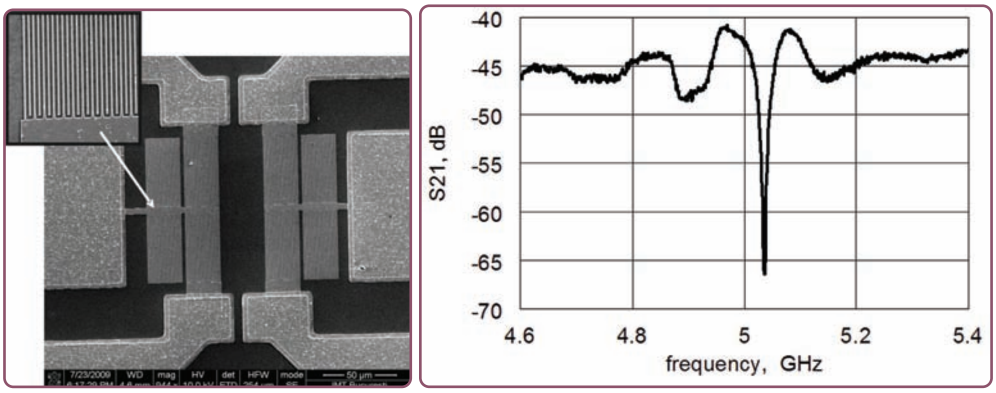


60 GHz reconfigurable filter; MME 2009



SAW on GaN/Si; fr= 7 GHz manufactured by nanolithography

The millimeter wave characterization equipment up to 110 GHz



SAW on AlN/Si; fr= 5.03 GHz; Electronics Lett, 2009, p1196

The frequency synthesizer up to 110 GHz

-"Recruitment of incoming experienced researchers" allows IMT to hire 3 researchers:

Dr Emil Pavelescu, PhD in Science and Technology at Tampere University
Dr. Mihaela Carp, PhD in Electrical & Electronic Engineering Nanyang Technological University, Singapore
Dr. Alexandra Stefanescu, PhD in Electric Engineering at Polytechnica Univ, Bucharest.

-"Acquisition, development or upgrading of research equipment" 50% of the total funding of the project is dedicated to this objective

• Upgrade to 110GHz the 1-65 GHz set-up for "on wafer" characterization: Acquisition finished in December 2008 was installed in April 2009
• Frequency synthesiser up to 65GHz-110 GHz installed in April 2009
• Au plating facility for semiconductor wafers will be purchased in 2010

In the same time a spectrum analyser working up to 110 GHz was purchased using the national 'Capacities' program founds.

- "Organisation of workshops and conferences" will support knowledge transfer at national and international levels through organisation of scientific international sessions and seminars:
The MIMOMEMS project has organized a Strategic Workshop in MEMS for applications in microwave & optical devices, Oct'09. The workshop took place in Sinaia, Romania, on 11 October 2009 with the preparation started early in May 2009. The agenda of the workshop with links to the presentation of each speaker is on the web page of the project *http://www.imt.ro/mimomems/ws_agenda.php*. The speakers in the strategic workshop represented a diverse range of organizations from pure research, development and testing to practical industrial applications and volume production with activities in the field of RF and Optical-MEMS.

- "Dissemination and promotional activities" will consist in publication of research results in peer reviewed journal and presentation at international conferences (Project web page; Promotional article in the Romanian Journal "Market Watch", Parliament magazine)

- "Proposal in FP7"
Connected to the MIMOMEMS project numerous proposals for the FP7 and connected program were submitted: 4 IP, 1 SA, 3 STREP in Call FP 7-ICT-2009, one wining proposal in MNT-ERA Net and one wining proposal in ENIAC-JU.

- "Publications"
• **3 ISI papers in Electronic Letters, Electron Device Lett., Microelectronics Journal**.
• **8 papers in international conferences proceedings: Asia Pacific Microwave Conf, EMRS, NATO Workshop, European Microwave Conference, Memswave, CAS.**

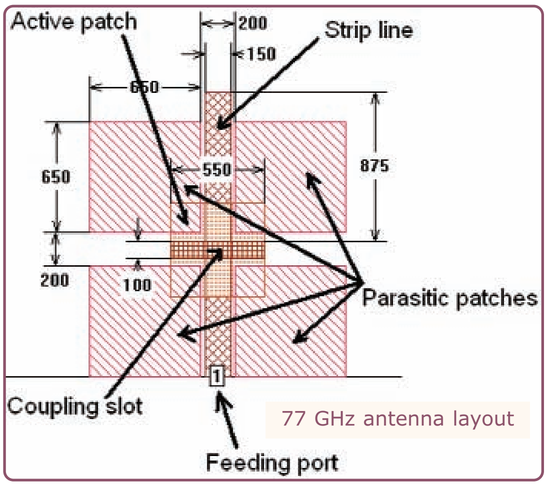
L4 - FP7 projects

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

STREP project financed (2008-2010) through the ICT Challenge 3: Components, Systems and Engineering, Micro/Nanosystems of the FP7.

Coordinator: **R. Baggen, IMST GmbH**. ***Partners:*** *IMST GmbH, Germany, Swedish Defence Research Agency- FOI, Sweden, Technical Research Centre of Finland-VTT, Finland, OMMIC, France, National Institute for research and Development in Microtechnologies-IMT Bucharest, Romania, Institut d'Electronique de Microélectonique et de Nanotechnologie, IEMN, France*.

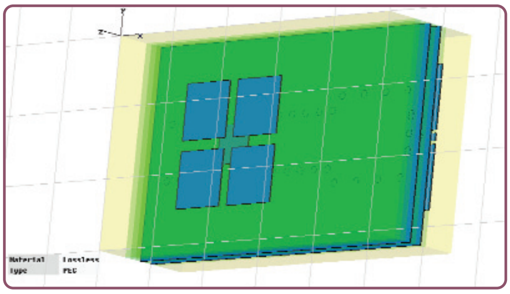
Responsable person for IMT: **Dr Dan Neculoiu, dan.neculoiu@imt.ro**

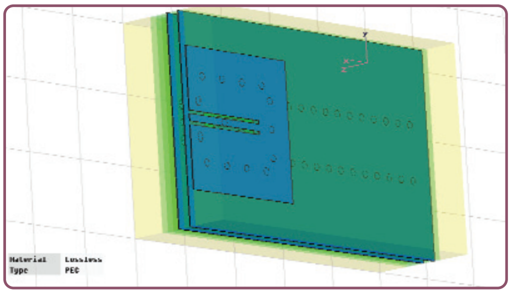


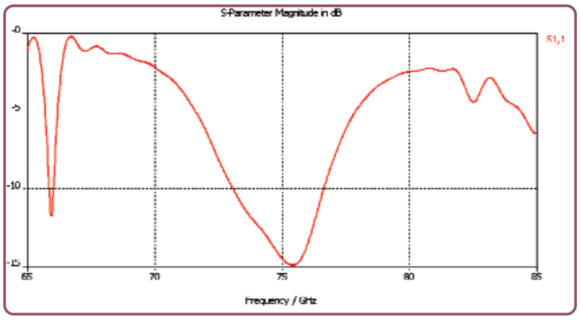
77 GHz antenna layout

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

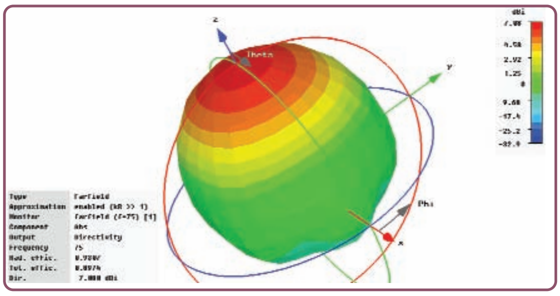
IMT results in 2009 – Electromagnetic Modeling and Design - up to 100 GHz for RFMEMS & LTCC technologies.


77 GHz antenna simulation (LTCC technology)


LTCC special VIA transition between the substrates



Reflection parametervs frequency



Radiation pattern for the 77GHz antenna (LTTC technology)

ENIAC Project SE2A (2009-2011): “Nanoelectronics for Safe, Fuel Efficient and Environment Friendly Automotive Solutions - SE2A”

Coordinator: NXP Semiconductors Netherlands BV. 20 partners from 7 countries; 4 SMEs, 2 Universities, 11 Institutes, 3 LSEs; Budget 21 MEuro.

Responsable person for IMT: **Dr Alexandru Muller, alexandru.muller@imt.ro**

IMT Bucharest is involved, together with FORTH Heraklion in the design, manufacturing and characterization of a 77 GHz radar sensor for automotive ground speed detection. This type of sensor will have as end- user Volvo from Sweden. This topic is important because classical methods for car speed measurements have a low precision if on a road conditions are not normal (mud, snow, dirt, dust) especially at low speed (v<60 km/h). The ground speed sensor proposed by us is based on System in a Package (SiP) transceiver using GaAs MMIC technologies and GaAs micromachining.

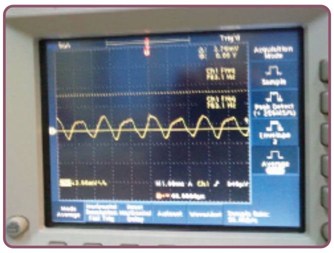


Photo of the experimental set-up and detail


The experimental setup and detailed sensor characterization (radiation pattern, frequency response, sensitivity)

The proof of concept was done with existing antennas and membrane supported monolithic integrated direct (video-type) receiver modules based on GaAs micromachining for 38 GHz.

L5: Simulation, Modelling and Computer Aided Design Laboratory

- Mission
- Main areas of expertise
- Research Team
- Specific facilities
- International networks
- Services

Mission: research, simulation and modeling activities oriented to collaborative research projects, education (short courses, hands on training, seminars, workshops), services (offering access to hardware and software tools) and consulting (design/optimization) in the field of micro-nano-bio/info technologies. The lab plays a key role in supporting the research activities of other laboratories of IMT- Bucharest

Main areas of expertise: **design, development and optimization of MEMS/MOEMS** components and devices (switches, cantilevers, bridges, membranes, microgrippers); mechanical, thermal, electrical and electrostatic, piezoelectric, fluidic, as well as coupled field (static and transient) analysis; modeling and simulation for multi-physics problems; **design, modelling and simulations of microfluidic components and systems** for biomedical applications and micro-electronic fluidic systems (valves, pumps - with various actuation principle as electrostatic, piezoelectric, pneumatic, electroosmotic- cell reservoirs, microchannels, filters, mixers, heaters, etc.) – the microfluidic analyzes include: fluid dynamics in microstructures (general flow, fluid mixing, thermal analysis); electrokinetic flow (electrophoresis, electroosmosis); electrokinetic with field switching analysis; fluid diffusion; bubble and droplet simulation (transport, merging, splitting); interaction between fluids and mechanical parts; mechanical, electrostatic, piezoelectric analysis for microfluidic actuators-; modelling of optoelectronic devices, neural networks.

Research Team: The team has a multidisciplinary expertise in: mathematics, physics, electronics; 4 PhD, 2 physicists, 1 electrotechnical engineer, 3 PhD students.

Specific facilities:

Soft/hard Tools: • **COVENTOR 2008.2**; • **MATLAB 7**; • **ANSYS Multiphysics 11.0**; • **COMSOL Multiphysics 3.3 and 3.4**; • **Solidworks Office Premium 2008** ; • **Mathematica 7**; • **Origin PRO 8**; • **Visual Studio 2008 Pro**; • **Dual IBM 3750 Server**, 8 quad-core Intel Xeon MP 2.93 GHz processors, 196 GByte RAM and 1 TByte HDD + 876 GByte external storage; • Computer network for training

Characterization equipments: • *Avantes Fiber Optic Spectrometer AvaSpec NIR256-2.2;* • *Fluoreecence spectrometer UV-vis-NIR;* • *Semiconductor Characterization System (4200S/C/Keithely)* with Manual Probe Station (EP6/SüssMicroTec).

International networks and projects:

- **IPMMAN**: **Improvement of industrial Production Integrating Macro, Micro And Nanotechnologies for more flexible and efficient manufacturing,** FP 6 Project (CA, NMP-CT-033205, 2006-2009): Coord. Profactor, Research and Solutions GmbH, Austria.

Contribution to the MINAM Newsletter MNR Future Vision (February 2009 –Conclusions of the IPMMAN Project). IPMMAN project contributed to the strength of different links between the European Manufacturing Industry and research initiatives, contributing to the improvement of competitiveness and sustainability of the European manufacturing community, merging macro-, micro- and nano-tech to foster industrial innovation. Collaborating with other projects (CA MicroSapient and NoE 4M), IPMMAN played an active role and contributed to the: • Establishment of the European Micro and Nanomanufacturing Platform- MINAM.

- **ComEd:** Leonardo da Vinci - **Life Long Learning Development of competences of educational staff by integrating operational tasks into measures of vocational training and further education**" (2008-2010); Coordinator BWAW Thüringen GmbH, Germany, Contract No: DE/08/LLP-LdV/TO/147174 (2008-2010) *Partners:* PROREC GmbH, Germany, Technical University of Kosice, Slovakia, TUK, IMT Bucharest, Instituto de Soldaura e Qualidade Portugal (www.comed-project.eu).

• Transferring the model for integrating operational exploration tasks into vocational training and further education in the context of advancement of abilities and competences of education personnel for/in SME of micro- and nanotechnologies

• Mutual exchange of best practices and generating a common base for practical implementation of vocational education process.

Team from left to right:
Oana Nedelcu; Rodica Voicu; Rodica Plugaru; Raluca Muller; Gabriel Moagar-Poladian; George Boldeiu; Catalin Tibeica; Victor Moagar-Poladian;

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

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. Currently R. Müller is Scientific Director of IMT-Bucharest and 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 University "Valahia Targoviste".

Raluca Muller was coordinator of an important number of national research projects and scientist in charge from IMT-Bucharest in international projects as: FP6 ASSEMIC- Marie Curie Training Network (2004-2007), FP6- PATENT (Modelling and Simulation cluster), Leonardo da Vinci- Microteaching (2005-2007),IPMMAN- CA (2006-2009).

She is author and co-author of more than 80 scientific papers presented at conferences and published in journals (Sensor & Actuators, J. of Micromechanics and Microengineering, Appl.Optics., Journal of Luminescence, Thin Slod Films, etc)

National projects: Capacities

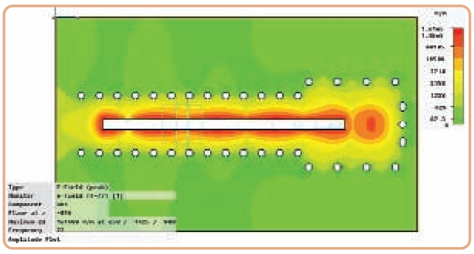
LABORATORY FOR MODELING AND SIMULATION OF MICROSYSTEMS

LAMSYS (2007-2009); Project Type: PN II- Capacities; Contract no.7/2007
Coordinator IMT- Bucharest; Project manager: Mat. Oana Tatiana Nedelcu- (oana.nedelcu@imt.ro)

Design/simulation training room

The aim of the project was the development of the research infrastructure in the field of modeling, simulation and computer aided design for microsystems, improvement of the research capabilities, offering scientific services in a dedicated laboratory, by modernization the existing capabilities.

New facilities: ***Software:*** COVENTORWARE upgrades 2008.010, SolidWorks (design of complex geometries), COMSOL –
Design and Multiphysics simulation of physics-based system, CST Studio Suite-full 3D electromagnetic simulation, Matlab, Mathematica (technical computing software packages), OriginPro8 (tehnical graphics and scientific data processing and interpolation)
Hardware: Computer network, graphic station, multiprocessor workstation; training room for courses and services in MEMS design, modelling and simulation, presentations/dissemination facilities.



Field Distribution in LTCC transition; CST Studio simulation

Services: Optimization solution for increasing performances of MEMS and microfluidic microsystems by virtual optimization: 2D and 3D computer-aided-design, modelling and simulation of lage area of physical phenomena at microscale including coupled effects, results postprocessing (graphics, interpolation, statistics)

- **Microsystems design**: Layout 2D, Process Editor, build 3D models based on silicon technology
- **Modelling and simulation of Micro-Opto-Electro-Mechanical Systems (MOEMS)**: swiches, cantilevers, membranes, resistors etc). Analysis include simulation for mechanical, thermal, electrical, electrostatic, piezoelectric, optical, electromagnetic and coupled field.

Multiprocessor workstation

- **Modelling and simulation of microfluidic components and systems**: micropumps and microvalves with various actuation principles (electrostatic, piezoelectric, pneumatic, electroosmotic), microreservoires, microchannels, micromixers, microfilters. Microfluidic analysis include: fluid dynamics in microstructures (flow under pressure, thermal flow, fluid mixing), electrokinetics, bubble-drop, fluid-structure interaction.
- **Consultancy** in computer-aided-design and microsystem simulation;
- **Assistance and training by research**: hands-on courses, access to computers and software.

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

Courses 2009:

- Eurotraining course: "Nanotechnology for Electronics", November 2009
- Hands-on course "Microsensors", for students of year IV, Faculty of Electronics, Telecommunications and Information Technology, "Politehnica" University of Bucharest
- Hands-on course "Intelligent sensors and microsystems", for master students, Faculty of Electronics, Telecommunications and Information Technology, "Politehnica" University of Bucharest
- Short simulation courses for companies in the frame of the Leonardo da Vinci project: **ComEd** (2008-2010);

Coordinator BWAW Thüringen gGmbH, Germany, Contract Number: DE/08/LLP-LdV/TO/147174.

Students attending the Eurotraining course: "Nanotechnology for Electronics", November 2009

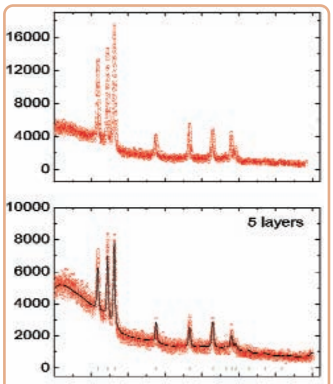
ELECTRONIC NANODEVICES BASED ON OXIDIC MATERIALS

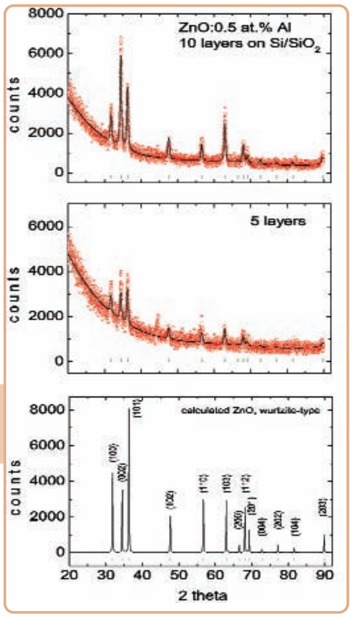
NANOXI Project Type: PNII - Cooperation - Contract Nr. 11-048 (2007-2010), Coordinator IMT- Bucharest; **Project manager:** Dr. Rodica Plugaru (rodica.plugaru@imt.ro); **Partners:** UPB-Bucharest, Institute of Physical Chemistry "I.G. Murgulescu", ICPE-CA, S.C. METAV-Research & Development S.A.

Results: • Experimental study of ultrathin ZnO layers (thickness of 10 layers, 100 nm) doped with Al and Mn in the concentration range (0.5%-10%), for applications in transparent electronics, optoelectronics and as a diluted magnetic semiconductor (DMS) for spintronic devices. Computational modeling of conductivity and magnetism in Al:ZnO, Ti:ZnO and Mn:ZnO disordered systems.

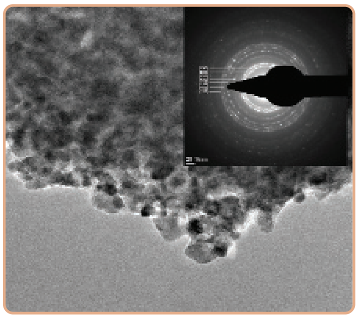
• Investigation of optical transitions in nanostructured ZnO and Al, Mn doped ZnO ultrathin layers by spectroscopic methods. We carried out self consistent calculations in the Local (Spin) Density Approximation (LSDA) using the FPLO band structure code. We investigated the doping effect on the electronic structure of the systems, particularly that in the vicinity of the Fermi level. We established the specific evolution of the density of states created in the doped ZnO and showed the dopant-sensitive nature of such state and the dependence of the dopant concentration.

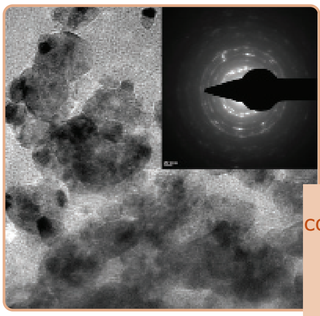
• We achieved complex microstructural-optical characterization by ellipsometry, UV-VIS spectrophotometry, and Raman spectroscopy of undoped and Al doped ultrathin ZnO films in order to optimize the transmission/absorption and the band gap energy.





XRD patterns of ZnO:0.5%Al, 5 layers and 10 layers on Si/SiO2 and glass substrates.





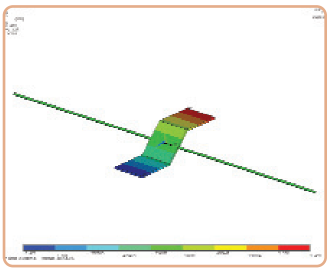
HRTEM images and corresponding SAED patterns of ZnO:0.5%Al 10 layers films grown on Si/SiO2 and glass substrates.

APPLICATIONS OF HIGH TECHNOLOGIES BASED ON MICROSYSTEMS AND NONLINEAR OPTICS FOR MEASUREMENT OF THE ELECTRIC CURRENT PARAMETERS ON THE HIGH VOLTAGE LINES

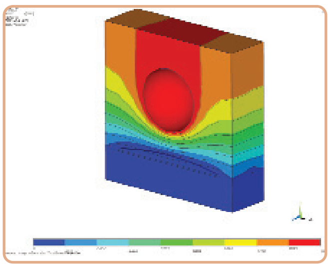
Project Type: PNII - Cooperation 31-021/2007-2010; **Coordinator**: IMT-Bucharest, **Project Manager**: Dr.Gabriel Moagãr-Poladian (gabriel.moagar@imt.ro); Partners: Bucharest University, S.C. SITEX 45 S.R.L.

Results: • As research results we mention the project of an optical focusing system for reading the displacement of microstructures, the project of a benchmark for opto-electic testing of microstructures under high voltage conditions (140 kV cc, 55 kV ac), the project of the space dedicated to the respective benchmark

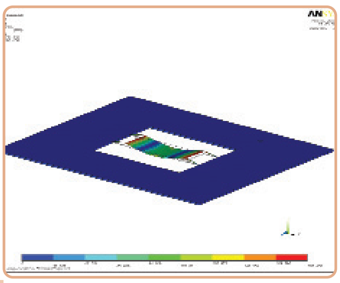
• We have conceived the topography of the electric field sensor and have obtained the simulation results describing its performance. These results are as follows: a) measurement accuracy 0,5 % at 10 kV, being better at higher voltages; b) working electric current frequency: 0 Hz – 400 Hz; c) compensation of accelerations for earthquakes of up to 7 Richter degrees; d) power loss due to the sensor: ~ 1 W.



Displacement map towards parallel plates



Displacement map with thermal expansion/contraction



Electric potential distribution

• Several patents requests were subjected to OSIM during 2009, among which we mention patent request A 00171 / 2009 "Electric field sensor" and A 00687 / 2009 "Procedure for the calibration of the cantilever thermal expansion in thermal dip pen nanolithography".

We have also realized the actual full configuration of a HPC Server (High Pertormance Computing Server), which has 8 Intel Xeon QuadCore processors at 1.92 GHz, 196 GByte RAM, 2,3 TByte HDD. This is presented in the figure below. The server is accessible from the network of IMT to all interested users. Image with the High Performance Computing Server. Realized by the joint efforts of dr. Gabriel Moagãr-Poladian (Project PN II- No 31-021 – half of the structure and operating system) and dr. Oana Tatiana Nedelcu (project Capacities- 7.2007). The choose of the technical specifications are the work of phys. eng. Victor Moagãr-Poladian and eng. George Boldeiu.

NATIONAL PROJECTS

INTEGRATED LABORATORY OF ADVANCED TECHNOLOGIES FOR MICRO AND NANOSYSTEMS

MICRONANOLAB (2007-2009), Project Type: PN II Capacities Contract no.13/2007
Project manager: Dr. Gabriel Moagăr-Poladian (gabriel.moagar@imt.ro)

Visiting the laboratory: the project manager explaining the structure and working principle of the equipments

This new laboratory was successfully audited by the representatives of the National Agency for Scientific Research (ANCS). Some images from the auditing are given below.

Selective Laser Sintering P100 Formiga system (already installed and put into work). It is an equipment that allows realziation of 3D objects made of various types of plastic materials, such as: a) Fine polyamid-biocompatible, Glass-filled fine polyamide, Polystyrene-for lost patterns, Flame-retardant polyamide, Aluminium-filled polyamid. The performance of the system is as follows: a) minimum feature width: 500 microns; b) laser beam positioning accuracy: 50 microns; c) maximum build volume: 200mmx250mm x330mm; d) minimum layer thickness: 100 microns; e) laser beam scanning beam: maximum 5 m/s; f) vertical build speed: minimum 10 mm/hour. Personnel trained for its use (three engineers/ researchers).

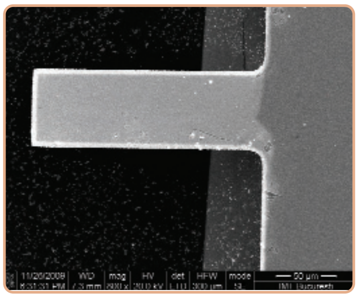
Photo image of the Selective Laser Sintering P100 Formiga system.

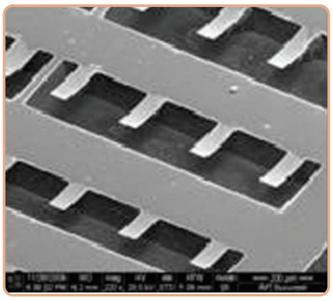
We may realize 3D models of the objects imagined by the customer by using selective laser sintering with the Formiga P100 machine. We offer two services for that purpose: a) CAD (Computer Aided Design) 3D modelling of the objects imagined by customer; b) physical realization of the respective objects for applications in: models realization (for engineering, architecture, education), realization of molds for implants, realization of molds for automotive industry, rubber industry (envelopes for tyres), plastics industry, medicine (prosthetics), museums (copies of sculptures hat are very important), components for construction of industrial machines, glass industry, porcelain industry, realization of fix, mobile or semi-mobile mechanical components for specific applications, including robotics, realization of microfluidics structures and circuits (channels of hundreds of microns diameter, connected in complex 3D geometries) containing pipes, valves, micropumps (at milimetric and centimetric scale), realization of joining elements (screws, etc.) at milimetric scale, realization of customized encapsulations for different type of MEMS, realization of MEMS models for testing their concept and working principle. These objects may be used for illustrative models, functional parts/end products and spare parts.

MEMS sensors and actuators based on micro-cantilevers structures

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

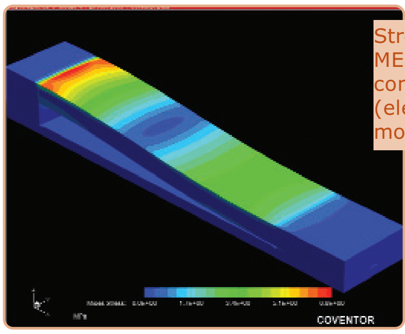
The purpose of the project is the development of new applications of sensors and actuators fabricated using microsystems technologies, MEMS (micro-electro-mechanical systems), based on microcantilever or area of cantilevers. Application domains: environment control, bio-medical, instrumentation.



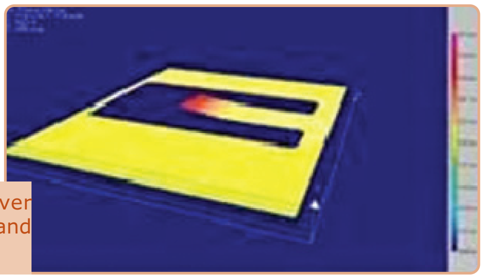


Area of cantilever beams of SiO_2/Cr/Au obtain by front side etching

Preliminary Results:
- design and simulations of a cantilevber MEMS switch- two stage driving, based on a sacrificial layer;
- experimental micromachining of array of cantilevers beams, functionalized with different biolayer;
- microphysical investigation of PZT-Nb ($Pb[(Zr_{0,52}Ti_{0,48})_{0,975}Nb_{0,025}]O_3$) layers, to be used on the top of the cantilevers;

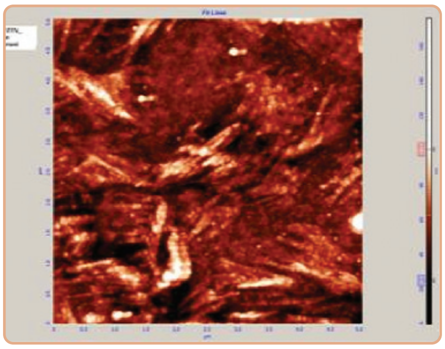
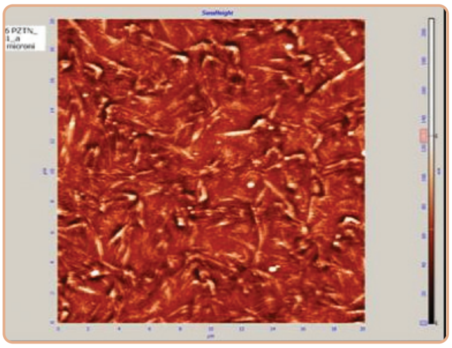
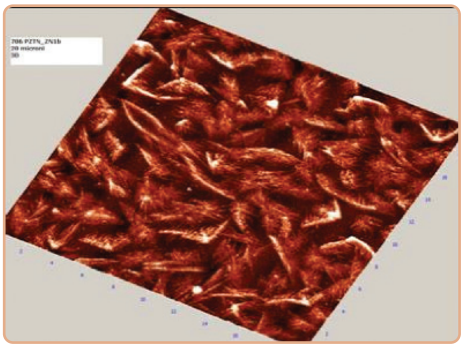


Stress distribution in a cantilever MEMS switch for ON stage, considering 5.5V pull-in voltage (electro-thermal analyse CoSolve module COVENTOR 2008)



WLI characterization of cantilever functionlized with serum albumin and gold particles

MEMS sensors and actuators based on micro-cantilevers structures

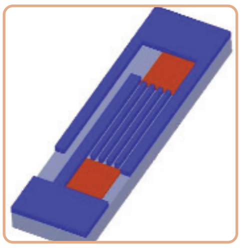
AFM investigation of roughness using SPM Ntegra (NT-MDT) intermittent contact mode of a (PZT-Nb) layer: a) 2D investigation of an area of 5μm x5μm; b) 2D investigationof an area of 20μm x 20μm; c) 3D investigation of an area of 5μm x5

National basic funding projects:

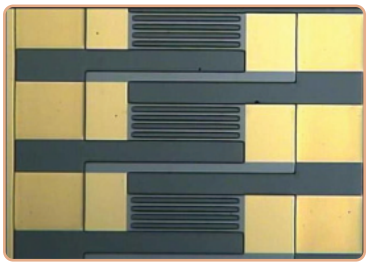
▶ Lab-on-Chip type microfluidic platforms integrated with microelectronics and optoelectronics components (2009-2011); Coordinator PhD St Irina Stanciu

The objective of the project is to develop complex microfluidic Lab-on-Chip platforms integrating elementary microfluidic components, microelectronic components, and optical elements.

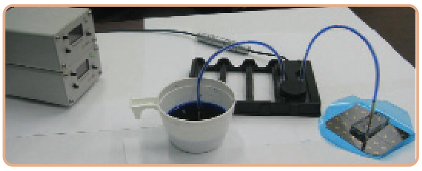
The first results are presented in figures below and mainly consist in design and modeling of an electroosmotic micropump and technological processing of the micropump by deposition of SU-8 on a Si substrate. COMSOL simulations have been made to verify the model, and experiments with fluid flowing through the pump have demonstrated the functionality of the processed device. In order to perform these experiments, a dedicated experimental set-up has been constructed.



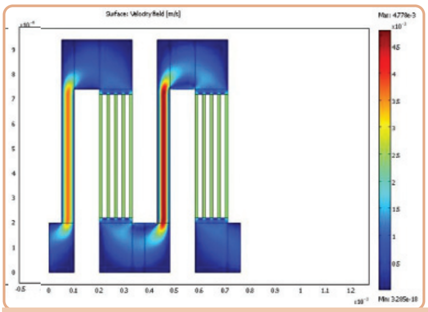
"CoventorWare Designer" Model of the electroosmotic micropump



Optical microscope view of the experimental electroosmotic micropump



Experimental set-up for tests and experiments on the electroosmotic micropumps

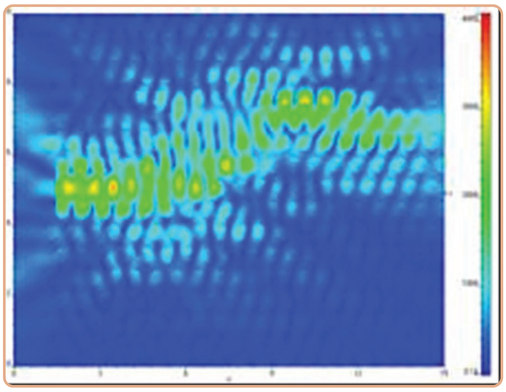


COMSOL simulation for the speed of the fluid through the designed electroosmotic micropump

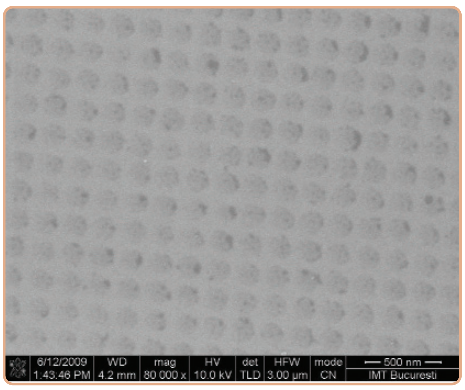
Experiments demonstrating the functionality of the experimental electroosmotic micropump

▶ Fotonic Crystal (PCs) based photonic structures, using EBL technique (2009-2011); Coordinator: Dr. Raluca Muller

The project aim is to develop passive optical devices as: waveguides, splitters, filters, Mach-Zehnder interferometers using 2D PCs, in order to obtain more complicated optical circuits, for communication applications. We investigated two polymeric materials: PMMA and SU8, using Electron Beam Lithography and obtain holes or columns based photonic crystals. The next figures presents preliminary results: simulations and experiments.



Simulation of the electro-magnetic radiation propagation in an optical waveguide, with high angle deviations obtained in a photonic crystal- using FDTD methods (Dr. M. Kusko)



PMMA perforations obtained by EBL, using a Si/SiO$_2$ substrate. The diameters were in the range of 20-400 nm, for a PMMA thickness of 100-200nm (Phys. A. Dinescu)

L6: Microphysical characterization laboratory

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

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

Main areas of expertise: Atomic Force Microscopy (AFM), Scanning Electron Microscopy (SEM), Electron Beam Lithography for nanoscale devices, Optical Microscopy, Electrical characterization of materials and devices.

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

Team from left to right: Adrian Dinescu, Cecilia Codreanu, Loredana Draghiciu, Marian Popescu, Laura Eftime, Mihaela Marinescu, Raluca Gavrila, Alexandru Herghelegiu

Specific facilities: • Scanning Probe Microscope (AFM, STM, EFM, KPM etc) - NTEGRA (NT-MDT).
Features: built-in capacitive sensors, active antivibrational table, could be operated under different environments: air, liquid, controlled gaseous atmosphere, low vacuum (10-2 torr).
Scan range: 100x100x10 μm, noise level, XY: 0,3 nm, Z: 0,06 nm, non-linearity in X, Y with closed-loop sensors < 0.15 %.

• SEM: TESCAN VEGA II LMU-General Purpose Scanning Electron Microscope (resolution: 3 nm @ 30 kV, accelerating voltage 200V-30 kV, electron gun source: tungsten filament, magnification: 13X - 1.000.000X, detectors: SE, BSE, LVSTD)

• FEI Nova NanoSEM 630- Ultra High resolution Field Emission Gun Scanning Electron Microscope - This SEM delivers high resolution surface information and can be widely used in many applications: nanotechnology, materials analysis, semiconductor technology, quality assurance, life sciences.

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

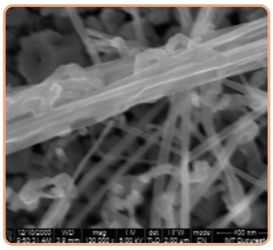
• Raith e_Line - Electron beam lithography dedicated equipment. It is a versatile electron beam lithography system having complied with the specific requirements of interdisciplinary research. Selected options for nanomanipulation, EBID and EBIE expand this system to a versatile nano-engineering workstation. Basic hardware features: thermal assisted field emission gun, cross-over free column with highest beam current density at 2 nm spot size, laser interferometer stage with 100 mm by 100 mm travel range and 20 nm resolution achieved by closed-loop piezo-positioning, minimum line width < 20 nm, stitching accuracy 40 nm, overlay accuracy 40 nm.

• Nano Indenter G200 - Agilent Technologies: Nano-mechanical characterization equipment operating by instrumented indentation and scratch testing. It provides access to various mechanical properties of small-volume samples, such as thin films, but could be equally applied to investigate bulk samples. Max load: 500 mN, load noise floor: 100 nN, max indentation depth: 500 mm, displacement noise floor: 1 nm, position accuracy: 1 mm.

International projects: FP7 ***CATHERINE*** "Carbon nAnotube Technology for High-speed nExt-geneRation nano-InterconNEcts"- STREP- FET proactive (2008-2010), ***Coordinator*** **Consorzio Sapienza Innovazione, Italy.** ***Partners:*** CNIS-Italy, TUD-Netherlands, CIRIMAT-France, USL-Italy, ULV- Lativia, IMT- Bucharest- Romania, FOI- Sweden, INFN-Italy, PHILIPS- Netherlands, Smoltech- Sweden.
IMT-Bucharest: contact person Phys. Adrian Dinescu- (adrian.dinescu@imt.ro)

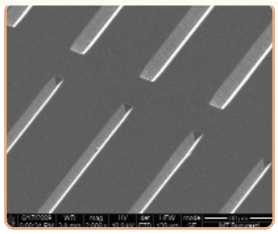
CATHERINE project aims to provide a new unconventional concept for local and chip-level interconnects that will bridge ICT beyond the limits of CMOS technology.

The main goals are: - To develop an innovative cost-effective and reliable technological solution for high-performance next-generation nanointerconnects.
- To develop proof-of-concept nanointerconnects to assess and verify the new proposed solution.



High resolution CNTs imaging

Test fixture for mechanical characterization of CNT



Laboratory Head — Phys. Adrian Dinescu (adrian.dinescu@imt.ro)

He received the M. Sc. (1993) degree in Physics from University of Bucharest. From 1993 -1997 he was Research Scientist at Research Institute for Electronic Components, ICCE Bucharest in the Optoelectronics Laboratory; From 1997 he is **Senior Researcher** at the National Institute for R&D in Microtechnologies (IMT Bucharest) in the ***Microphysical Characterization Laboratory***.

His main scientific interests are focused on patterningat the nanoscale using Electron Beam Lithography and on characterization using Field Emission Scanning Electron Microscopy.

Adrian Dinescu was the leader of several national research projects (Matnantech, Ceres, CEEX) and partner in international projects (CATHERINE FP7, ASSEMIC- Marie Curie Training Network, FP6) and the author more than 15 scientific papers presented at conferences and published in journals.

NATIONAL PROJECTS

A- Projects for infrastructure development

EBL equipment (e-line Ultra High Resolution Electron Beam Lithography and Nanoengineering Workstation)

Functionality enhancement of NANOSCALE-LAB
The Nanoscale structuring and characterization laboratory

The main purpose of the project is to develop the material base of the "**NANOSCALE-LAB**" Laboratory of IMT-Bucharest for structuring and characterization at nanoscale and improve the capacity by offering scientific services. All the facilities purchased under the project have been put into service and became functional. These facilities - a state-of-the art equipment for nanomechanical characterization and several modules which increase the capabilities of the Raith e_Line EBL workstation - were fully integrated in the laboratory infrastructure and enabled us to extend our offer for services.

NANOSERV (2007-2009); Project type: PN II /Capacities no. 9/2007
Coordinator: IMT- Bucharest;
Project manager: Acad. Dan Dascalu (dan.dascalu@imt.ro).

FEG-SEM

NANOSCAN-Developement of topographical and compositional analysis capabilities at nanoscale of Microphysical Characterization Laboratory

The main goal of this project is to complete the equipments of the lab with a state of the art Field Emission Gun Scanning Electron Microscope (FEG-SEM) able to work with low accelerating voltages for true surface imaging: resolution bellow 1.5 nm at 1kV accelerating voltage, in-lens detectors for SE and BSE, true eucentric sample stage, charge compensation system.

NANOSCAN Project type: PN II/Capacities no. 12/2007, (2007-2009). Coordinator: IMT Bucharest; Project manager: Phys. Adrian Dinescu (adrian.dinescu@imt.ro).

Development of Digital Holography Laboratory with equipments for characterization of micro-electro-mechanical systems (μDIGIHOLAB)
Project type: PN II /Capacities, No. 4/2007 (2007-2009)**.**
Coordinator: UPB. (Project manager for IMT Bucharest: Phys. Adrian Dinescu – adrian. dinescu@imt.ro).

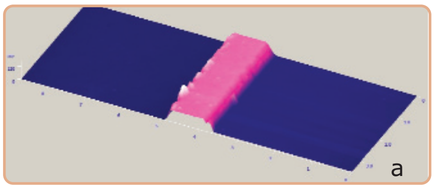
B. Research projects

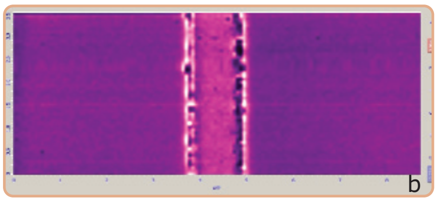
Complementary characterization of surfaces by advanced SPM techniques

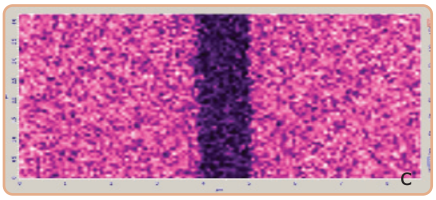
Main goals: Investigating the conceptual and practical implementation issues associated with the application of scanning probe microscopy-based techniques for complementary characterization of materials for micro and nanoelectronics.

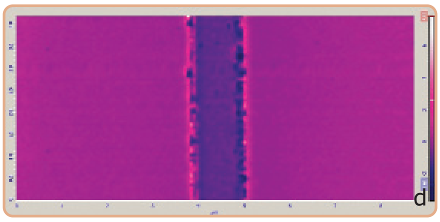
Results: We have tested in practical experiments the capabilities and performances of the Ntegra (NT-MDT) SPM for characterization of local electrical properties of various types of samples and we have identified several key factors that can impact the measurements.

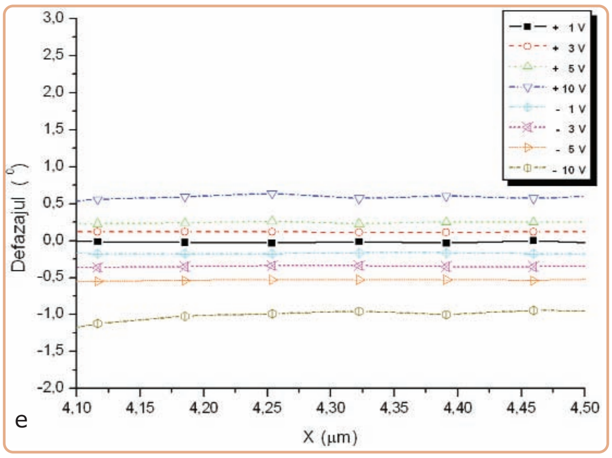
Project Type: National basic funding Project CONVERT +, PN II - (2009-2011);
Project manager: Raluca Gavrila, raluca.gavrila@imt.ro



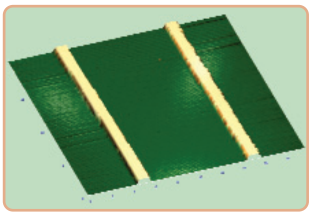


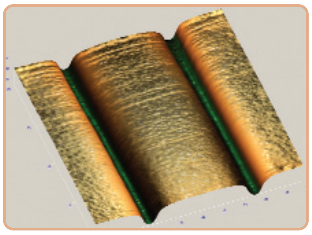






Electrostatic Force Microscopy – Topography (a) and electrostatic field map (b, c, d) for a metallic electrode on SiO2/Si at different bias voltages. The graph in e) displays the contrast in EFM data at more voltage values





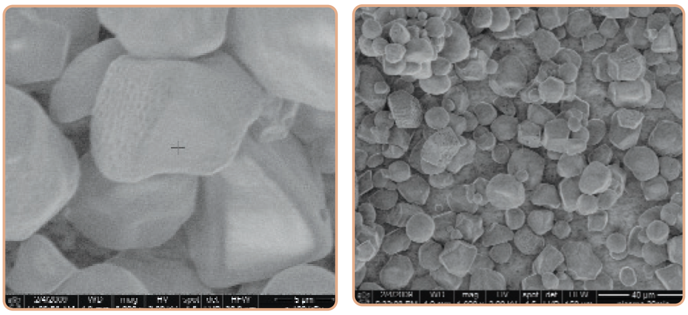
Scanning Kelvin Probe Microscopy Topography (a) and surface potential image (b) for a test sample consisting in parallel interconnected Au tracks on Si

Other research projects:

Modified amidons, obtained by non-conventional technologies, with applications in alimentation industry

AMIR Project Type PNII; No51-007/2007(2007-2010)
Coordinator: INCDFLPR.

IMT-Bucharest: partner; Contact person for IMT:
Phys. Adrian Dinescu (adrian.dinescu@imt.ro)

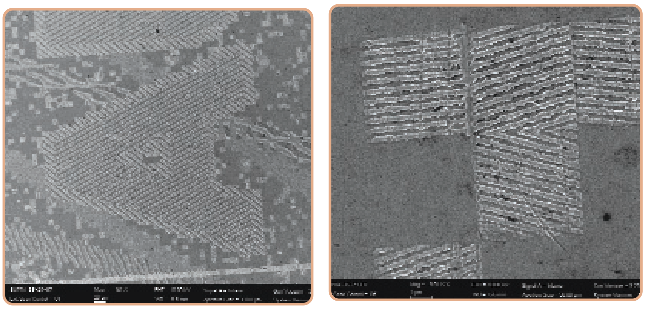


SEM micrographs of amylum grains exposed to high energy electron beams.

Development of a food tracing system dedicated to regional producers

TRASALIM - Project Type: PNII- Innovation, No 121/2007 (2007-2010),
Coordinator: S.C. ZOOM-Soft SRL;

IMT-Bucharest partner; Contact person for IMT:
Phys. Adrian Dinescu, (adrian.dinescu@imt.ro)

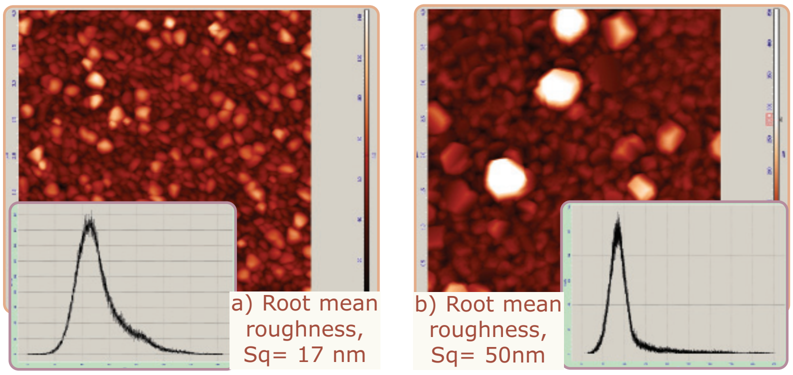


SEM micrographs of authentication stamps used in food industry.

Services offered by the LAB: AFM, SEM, EBL

Mechanical characterization of thin films (Young's Modulus, Hardness)

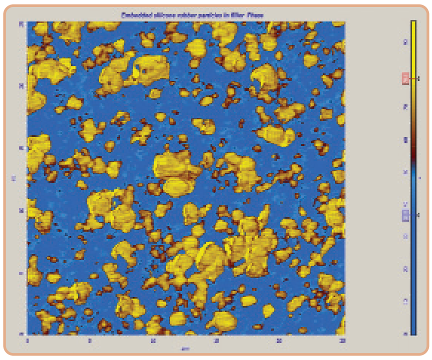
▶ High resolution surface morphology investigations by Atomic Force Microscopy (AFM): 3D surface topography recording and measurement (waviness, roughness, step heights, grains, particles etc);



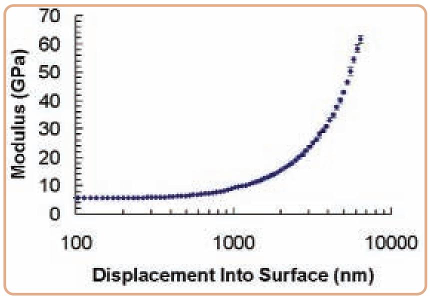
a) Root mean roughness, Sq= 17 nm

b) Root mean roughness, Sq= 50nm

Comparative AFM study of surface morphologies for evaporated (a) and sputtered (b) Al thin films onto Si- 4μm x 4μm scan.

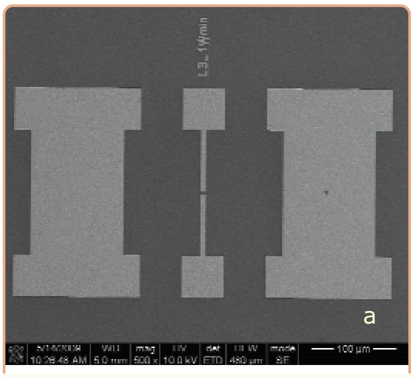


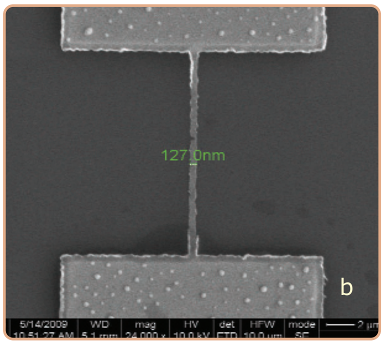
Distribution of embedded silicone rubber particles in filler revealed by AFM - Phase.Imaging

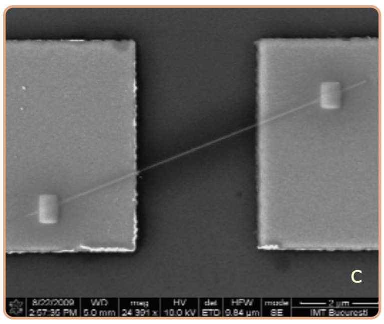


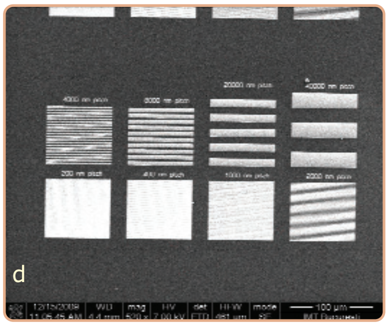
Depth profiling of Young's modulus for a SU8 polymer film deposited on Si

▶ Mechanical characterization;
▶ Nanolitography









Different examples of samples manufactured in IMT using EBL:
a) and b) - Test fixture for electrical characterization of CNts at high frequency;
c) Carbon nanotube fixed in place using EBID (Electron Beam Induced Deposition);
d) Calibration standards for SPM lateral and vertical calibration;

L7: Reliability Laboratory

- Mission
- Main areas of expertise
- Research Team
- Specific facilities
- International networks
- National networks

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

Main areas of expertise:

Reliability building: Reliability building: Design for reliability and testability - design for manufacture, Reliability monitoring & screening of micro and nanostructures, Burn-in and selection, Reliability of components used in harsh environment (nuclear, geology, automotive, aeronautics, etc.);
Reliability assessing: Accelerated testing of micro and nanostructures; Failure analysis & physics, Data processing & Reliability prediction, Behaviour of electronic components in harsh environment, Virtual prototyping;
Standardization: Certification, Qualification and periodic tests, Standards and other specifications.

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

National networks: Contractor of "Micro-biosensors for pesticide detection in environment and food samples", project (2007-2010) in the National Research Programme "PARTNERSHIP".

Specific instruments and equipment:

Reliability Laboratory contains the Laboratory for evaluating the quality of microtechnology products according to EU requirements (LIMIT), provided with modern equipment for:
Environmental testing: Constant mechanical acceleration, Vibration, Storage at temperature, Hermeticity, Mechanical shock;
Testing at combined stresses: Damp heat, Thermal cycling, Pressure + Temperature, Thermal stress + Electrical stress, Electrical stress + Thermal stress + Humidity + Vibrations, Electrical stress + Thermal stress + Pressure, Mechanical ("Tilting") + Thermal stress;
Electrical characterising at various temperatures: Keithley 4200SCS, Temptronic TP04300A-8C3-11 / Thermo Stream.
Thermal analyses: IR microscope.

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

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

Electrical characterization: 4200SCS system (Keithley): Voltage CC<100V, Current CC<1A; Impulses: analogical signal 30V, <40MHz; Measurements: Voltage 0,5 μV, Current 1fA.
Temperature conditioning: Temptronic TP04300A-8C3-11 / Thermo Stream - Temperature variation: from - 80°C to +250°C Transition time: up 7 sec, down 20 sec; Temperature control +/- 0,1°C.

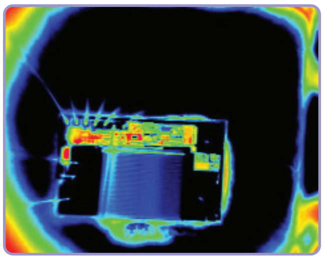
Chamber for Highly Accelerated Stress Test (HAST) - EHS 211M (Espec): Temperature range: +105 ... +142°C, Humidity range: 75%...100% RH, Pressure range: 0.02...0.196

Laboratory Head — Dr. Marius Bazu (marius.bazu@imt.ro)

He received the B.E. and PhD. degrees from the University "Politehnica" Bucharest, Romania. He was involved in device design and semiconductor physics. Recent research interests: methods for building, assessing & predicting the reliability of MEMS. He developed in Romania the accelerated reliability tests, building-in reliability and concurrent engineering approaches. Leader of one European project (Phare/TTQM) on a building-in reliability technology (1997-1999), Member of the Management Board and workpackage leader and of the NoE "Patent-DfMM", FP6/IST (2004-2008).

He is referent of the journals: Sensors, IEEE Transactions on Reliability, IEEE Transactions on Components and Packaging, IEEE Electron Device Letters and Microelectronics Reliability. Recipient of the AGIR (General Association of Romanian Engineers) Award for the year 2000. Chairman/lecturer at international conferences: CIMCA 1999 and 2005 (Vienna, Austria), CAS 1991-2009 (Sinaia, Romania), MIEL 2004 (Nis, Serbia). Author of more than 100 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 two books about the reliability of electronic components, published by Springer Verlag, in 1999 and by Artech House, 2009.

RELIABILITY TESTS AND ANALYSES

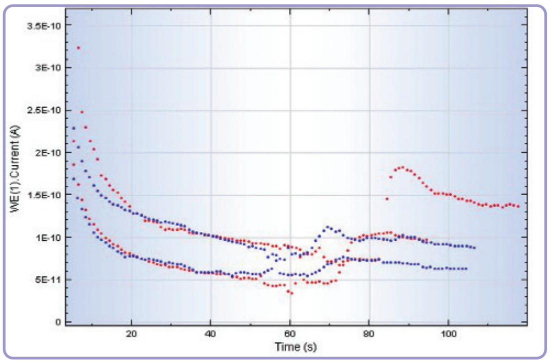


Environmental tests, reliability selections and electrical characterisation at continuous increasing temperatures were executed for Romanian customers, such as SC Baneasa Silicon srl, SC RomQuartz srl and University Politehnica Bucharest, but also for the Turkish company Arcelik. Also, thermal analyses of semiconductor devices with IR microscope were initiated for an international company.

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

Thermal map of a functioning power semiconductor devices, obtained with IR microscope. The colour scale corresponds to the temperature: from blue (the lowest temperature), to red (the highest one).

BIOSENSOR FOR ENVIRONMENTAL MONITORING



Amperometric signals of the biosensors before (red points) and after (blue points) biosensor inhibition.

Biosensors for the detection of the environmental pollutant concentrations were developed.

Achievements:
The biosensors were characterized by measuring the amperometric answer before and after each inhibition. The biosensor sensitivity was greatly improved by immobilising a smaller quantity of enzyme onto microelectrodes; consequently, the inhibitor quantity necessary for obtaining the same inhibition percentage was significantly reduced.

"PARTNERSHIP" project Micro-biosensors for pesticide detection in environment and food sample, (2007-2010).
Contact person Lucian Galateanu (luciang@imt.ro).

SPECIFIC INSTRUMENTS AND EQUIPMENT

Equipments from CAPACITATI project

- ***Thermal cycling*** *TSE-11-A (Espec Europe), Compact type (air-to-air);*
- ***Combined tests at temperature, humidity, pressure and electrical bias*** *EFS 211M (Espec Europe): Highly Accelerated Stress Test (HAST)*

- Combined tests at temperature and electrical bias
Three climatic chambers UFB 400 (Memmert), Rack N6711A (Agilent), with modules N6741B, N6743B, N6746B and N6773A, two sources E3648A and E3649.

Chambers for: -Thermal cycling – TSE-11-A (Espec): High temp. (-65...0^{o}C) and Low temp.(+60…200^{o}C); - Highly accelerated stress test (HAST) - EHS 211M (Espec): Temperature range: +105 ... +142^{o}C, Humidity range: 75%…100% RH, Pressure range: 0.02…0.196 Mpa; - Damp heat - CH 160 (Angelantoni): Temperature range: -70...+180^{o}C; Speed: 5^{o}C / min, Humidity range: 20…95%RH, between +100 C…+80^{o} C

Chamber for testing at temperature + low pressure - VO400 (MEMMERT): 49 l; +20 .. +200°C; 10 .. 1100 mbar

Electrical characterization: 4200SCS system (Keithley, UK): Voltage CC<100V, Current CC<1A; Impulses: analogical signal 30V, <40MHz; Measurements: Voltage 0,5 µV, Current 1 fA.

L2: Laboratory for Microsystems in biomedical and environmental applications

• Mission
• Main expertise
• International Networks
• National Networks
• Research Team

The **Mission** of the laboratory for microsystems in biomedical and environmental applications is research, focused on the development of microsensors (chemo resistive and resonant gas sensors), electrodes for biological sensors, microprobes for recording of electrical activity of cells and tissues, microfluidics and integrated technologies (silicon, polymers, biomaterials), education in the field of micro chemo and biosensors (in cooperation with University "Politehnica" of Bucharest), and services in design, simulation and technology for bio- and chemo-applications.

Main expertise: development of a large area of microsensors (chemoresistive, resonant gas sensors, accelerometers, microarrays, ISFET (Ion Sensitive Field Effect Transistors) sensors, electrodes for biological sensors, microprobes for recording of electrical activity of cells and tissues), in terms of software simulations / modelling, using MEMS–specific CAD software (CoventorWare, CADENCE), technological development and electrical characterisation. Microfluidic platforms simulation and realization including tubes, microfluidic connectors and reservoirs, pumping system and microsensors integration are part of the laboratory expertise.
The team was working in 20 national projects and seven FP6 projects during the last 5 years, both research projects and support actions.

National projects:
- **NEUROSENSE** ("Integrated system for concurrent electrophysiological and chemical recording at neuronal level");
- **IMUNOSENSE** ("Miniaturized immunosensor arrays technology, for herbicide detection");
- **HINAMASENS** – ("Nanostructured hybrid materials for sensors, for therapy and diagnostic usage") – all are national complex projects,.

Current International projects:
- **TOXICHIP** ("Development of a toxin screening multi-parameter on-line biochip system") – FP6 STREP, IST, 2006 – 2009;

Research team:
The Laboratory team includes 12 people, seniors and young researchers with multidisciplinary expertise (microelectronics, physics, chemistry, biology).

Team from left to right: Rodica Iosub; Carmen Moldovan; Ioana Ghinea; Claudia Roman; *second row*: Daniel Necula; Bogdan Firtat; Costin Brasoveanu; Marian Ion;

Laboratory Head - Dr. Carmen Moldovan (carmen.moldovan@imt.ro)

Dr. Carmen MOLDOVAN is the head of the laboratory, and Associated Professor at the Faculty of Electronics and Telecommunications, University "Politehnica" of Bucharest. She graduated on Electronics and Telecommunications and she owns a PhD in Microsensors.

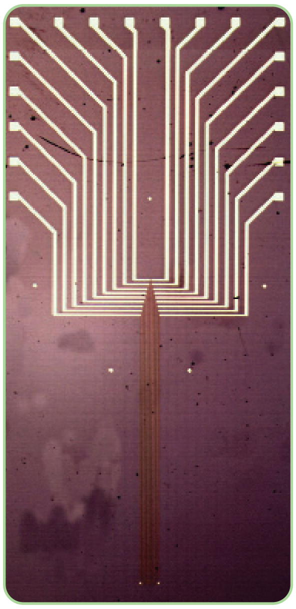
She is responsible from IMT side in the **TOXICHIP** project, STREP (IST), for the development of temperature, pH sensors and O_2 sensor integrated into a microfluidic platform for toxicity detection. She was involved in the **4M** NoE (NMP), working on demonstrators, in Ceramic cluster, having the goal 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 coordinates three national projects in the area of integrated sensors and microfluidic devices for pesticides detection and neural cells monitoring. She is a **member of: IEEE and Science and *NEXUS*** *Steering Committee Member*. The scientific activity is published in more than 65 papers in journals, books and communications in Proceedings.

INTEGRATED PLATFORM FOR CONCURRENT ELECTROPHYSIOLOGICAL AND CHEMICAL RECORDING AT NEURONAL LEVEL

Characterization of electrical and chemical activity of the excitable membranes cells is essential for the functional study of the nerves and brain (neurons) and also for the understanding of the brain control mechanisms. In the same time, at application level, this kind of information is absolutely necessary for the diagnosis and treatment of nervous system diseases. Moreover, the measurement of neurotransmitters' pH level and concentration (for dopamine, acetylcholine, etc.) will be performed in order to evaluate the physiological mechanisms of reaction and regulation.

The general objectives of the project are the following:
• obtain a micro-machined electrode for the extracellular recording (multi-site and single-cell) of electrical activity and for detection of chemical parameters, based on electrochemical principles
• increase the electrode's mechanical resistance using a special technology for deposition (with diamond-like carbon deposited by thermionic vacuum arc technology)
• optimization and standardize the electrode's manufacturing flow
• micro/nanostructuring of recording sites surfaces – structuring is realized in order to increase the electrode's effective surface, which determines a decrease of the equivalent impedance and offers improved immunity to external perturbations of the non-buffered signal
• maximizing the density of recording sites, by reducing the width of conductive layouts deposited at the microelectrode surface in the range of 0.5…5 microns.



Optical photo of the patterned sensors, before etching the microprobe's tip

Intermediary results

1. Sequence of masks for obtaining the integrated microprobe:

• *Mask 1 "Metal"* - metallization mask, for defining the electrodes and temperature and pH sensors
• *Mask 2 "Contact"* – mask opened in the passivation layer for the metal contacts in the pads area and for the probe tip which includes the sensors
• *Mask 3 "Etching"* – mask defining the anisotropic etching area, on the front and bottom of the wafer, in order to release the probe tip

Technology development

In the case of using tetramethylammonium hydroxide $(CH_3)_4NOH$ 25% (TMAH) as anisotropic etching agent, we used as mask material a silicon oxide layer obtained by thermal deposition, covered with silicon oxide densified by CVD.

The typical etching rate for Si<100> using TMAH 25% is approximately 1μm/min at 90°C and approximately 0,6mm/min around 80°C.

2. Software development and interface board acquisition for PC data acquisition

The processing of microsensors' signals for parallel monitoring of electro-physiological activity and chemical environment of neuronal cells is performed with the aid of a portable electronic unit.

The main functions performed by the device are: - generating processing sequences; - effective measurement; - stimuli generation; - data storage; - PC communication; - display control.

The portable electronic unit functioning is designed with the control of a set of programs that assures the execution of the mentioned functions. An associated routine was realized for each function.

Project coordinator: IMT-Bucharest (2007-2010): **Dr. Carmen Moldovan** carmen.moldovan@imt.ro.
Consortium: Victor Babes Institute, Politehnica University, Romelgen, National Institute for Laser, Plasma and Radiation Phys.

SELF- ASSEMBLED MONOLAYERS (SAMS) ON SILICON SUBSTRATE COMPARATIVE WITH POLYMER SUBSTRATE FOR E- COLI O157:H7DETECTION

The work was focused on preparation and characterization of two substrates, silicon and polymer coated with gold, functionalized by mixed self assembled monolayers (SAMs) in order to efficient immobilizing the anti-E O157:H7 polyclonal purified antibody.

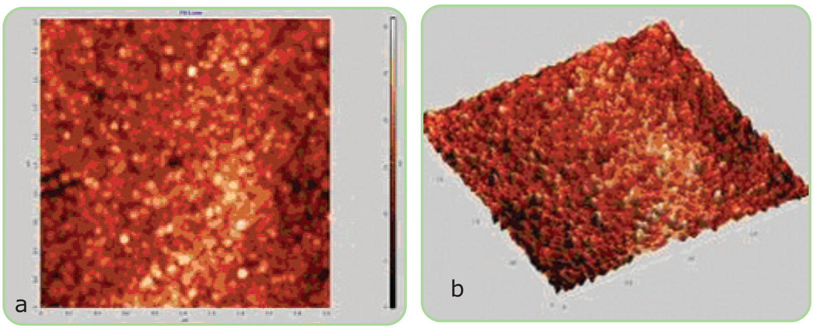


Fig 2. (A), (B) Polymer coated with gold reference three dimensional and two dimensional AFM image (2 μm);

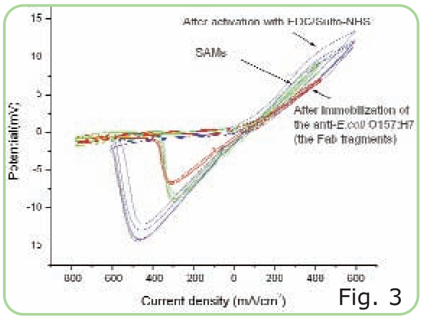
A biosurface functionalized by SAMs (self assembled monolayers) technique has been developed. Immobilisation of goat anti-E.coli O157:H7 antibody was performed by covalently bonding of thiolate mixed self-assembled monolayer (SAMs) realized on two substrates: polymer coated with gold and silicon coated with gold. The F $(ab')_2$ fragments of the antibodies have been used for eliminating nonspecific bindings between the Fc portions of antibodies and the Fc receptor on cells. The properties of the monolayer's and the biofilm formatted with attached antibody molecules were analyzed at each step using infrared spectroscopy (FT-IR ATR), atomic force microscopy (AFM), electron microscopy (SEM) and the cyclic voltammetry (CV).

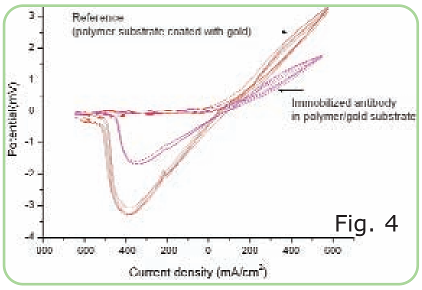
SSELF- ASSEMBLED MONOLAYERS (SAMS) ON SILICON SUBSTRATE COMPARATIVE WITH POLYMER SUBSTRATE FOR E- COLI O157:H7DETECTION

In our study the gold-coated silicon substrates approach yielded the best results. Fig 2 presents AFM images of 3D and 2 D of **Polymer coated with gold** (A and B). It presents also topographic images of the **gold surface** on silicon substrate (C and D) after immersion in thiols (2μm) and topographic images of the gold surface on silicon substrate (E) after immersion in thiols (1μm). Fig 3 presents cyclic voltammetry of the silicon substrate coated with gold (scan rate 25-50mV/s)(A) SAMs after formation of the mixed layer (green curve), after activation with EDC/Sulfo-NHS(blue curve), after immobilization of the antibody in comparison with fig 3 indicating cyclic voltammetry of the polymer substrate coated with gold (scan rate 25-50mV/s) after binding the anti-E.coli O157:H7. Figure 4 shows the results of cyclic voltammetry of the polymer substrate coated with gold (scan rate 25-50mV/s) after binding the anti-E.coli O157:H7

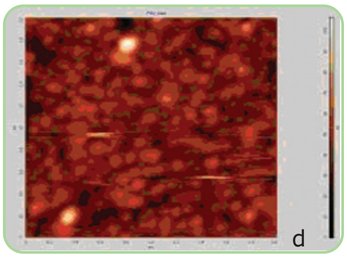
These experimental results revealed the comparison between silicon and polymeric substrates and showed the investigations of each stage of the immobilization process taking into account in the same time the factors that influence the chemistry of the surface and the further interactions in order to realize a sensitive, specific and low cost immunosensor or a microarray for detection of *E.coli* O157:H7.

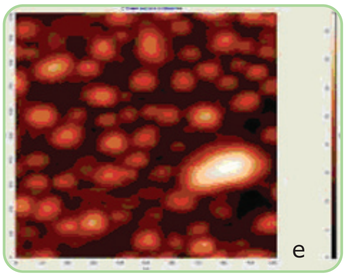
The work was supported by the **IMUNOSENSE** national project, 2007-2010, see the parer number 15 page 48





Cyclic voltammetry Fig 3 The Si substrate coated with Au (scan rate 25-50mV/s)(A) SAMs after formation of the mixed layer (green), after activation with EDC/Sulfo-NHS (blue), after antibody immobilization.
Fig 4. The polymer substrate coated with gold (scan rate 25-50mV/s) after binding the anti-E.coli O157:H7





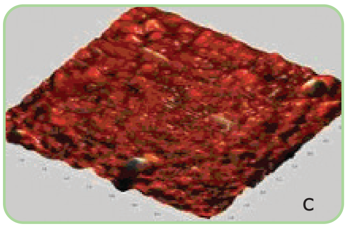


Fig2. (C, D) Topographic images of the Au surface on silicon substrate after immersion in thiols (2μm), (E) Topographic images of the gold surface on silicon substrate after immersion in thiols (1μm)

EUKARYOTE TOXICHIP PLATFORM

ToxiChip, **STREP, http://www.toxichip.org**, Priority 2 -**IST**, Contract Number: 027900, 2006-2009,
Coordinator: PhD. Eric Moore, e-maileric.moore@tyndall.ie; Univ College Cork - National University of Ireland.

IMT provided within the project integrated pH and Oxygen sensors for monitoring of living cells exposed to toxicants. The sensors have been designed, fabricated and measured within IMT. The sensor platform (containing temperature, oxygen and pH sensors) was implemented and characterized. Also, IMT worked on the microfluidic system to integrate the sensors platform. The microfluidic design was aimed at providing independent exhaust in order to avoid cross contamination issues.

The integrated pH sensor *** has been developed and characterized. It is a solid state sensor based on conductive polymers, miniaturized, developed on glass substrate. The sensor measurement is a voltage measurement at zero current. The instrument has the input resistance higher as 1GΩ. The voltage is measured between two electrodes: the active electrode and the reference electrode (Ag/AgCl, KCl 3M). The measurement cell is calibrated individually based on the pair of values (E, pH). The electrode on glass substrate was deposited with a layer of polyaniline conductive emeraldine base form as seen in the SEM. The electrochemical deposited polyaniline has an intrinsic nanowires structure of 100nm diameter (Figure 5).

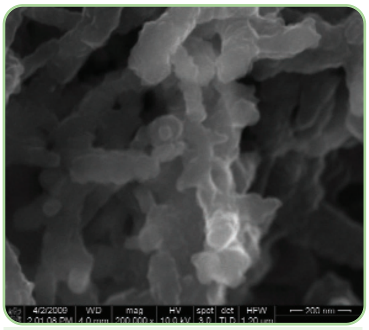


Fig 5. SEM picture of electrochemical deposited polyaniline conductive layer in the form of nanowires

The figure 6 is characterizing the polyaniline forms at pH 4 and pH 7. At pH 4 the predominant polyaniline state is leucoemeraldine. At pH 7 the predominant state is emeraldine. The transformation of the polyaniline from one state into another state is due to the redox reaction taking place at the solution interface. The polyaniline conductive measurements indicated a variation of conductivity depending on the pH environment; the highest conductivity a present in strong acid medium pH of 4 when starting to grow up to pH = 1, which becomes the most conductive form, then the conductivity, remains almost constant. It was expected in a neutral medium, pH = 7÷5 to obtain a less conductive polyaniline to remain constant throughout this interval. Polyaniline variation depends on the pH environment and that way the sensitivity as a pH sensor is demonstrated.

*** See the paper number 9 on page 50.

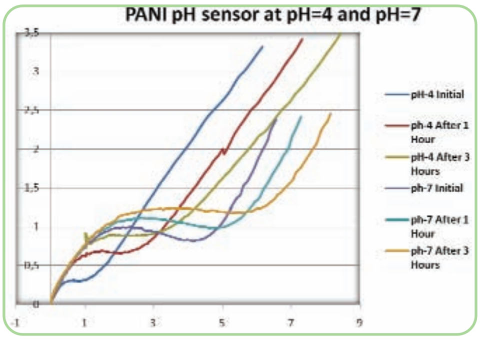


Fig 6. EIS (Electrochemical Impedance Spectroscopy of polyaniline at pH 4 and 7

Results obtained within the FP6 project "Development of a toxin screening multi-parameter on-line biochip system"**TOXICHIP**.
Consortium members: HUJ, Israel; IMT, Romania; JRC, Italy; TAU, Israel; Scienion, France; Vigicell, France; ISMB, Italy

"MICRO HEAT SINK MICROPROCESSED ONTO SURFACE"

To obtain integrated micro heat sinks microprocessed directly onto the on silicon wafers SiO2 passivated were realized firstly test structures, aiming to replace the planar power device needing be cooled, and mostly for its characterization. A test structure contain a Pt power resistance (R = 220Ω) and two Pt thermoresistances (R1 = 900Ω and R2 = 800Ω). They were obtained by high vacuum Cr/Pt (20/100 nm) thin films deposition onto a positive resist layer of about 2μm patterned before by contact photolithography in UV. Then, the resist was removed and after, it was deposited a Cr/Au (20/250nm) thin film.

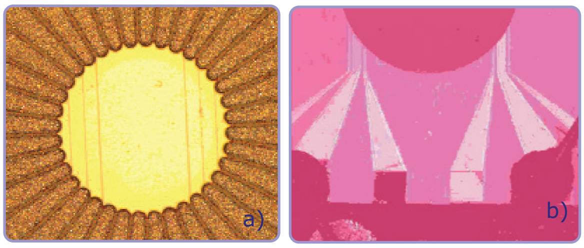


Fig. 1. Microprocessed micro heat sink test structure; (a) central cavity (still having resist), (b) mounted on TO_3 case connected with Al wire, Ø = 120 μm.

To demonstrate the functionality and utility of the new device were designed and realized standard structures microprocessed directly onto the power planar device structures (transistor BU 607 wafers) in the last step of the processing before testing and dicing Fig. 2.

The test and standard structures were mounted onto bases TO_3, connected electrically and covered by TO_3 lids (having 16 holes Ø=1mm on the lateral circumference to could eliminate directly in the atmosphere the air). and in their superior part (central) they have a steel tube having Ø =0,6mm, high of about 8-10 mm having to exterior a plastic tube long of about 6–10cm to could supply the cooling agent (air). The air will enter in the central cavity of the micro heat sink, will pass by the 36 radial channels and will be eliminated by the 16 lateral holes having Ø=1mm on the lateral lid circumference directly in the atmosphere. In conclusion, the air will enter by the central cavity of the micro heat sink, will pass by the channel array being in direct contact with the dissipation surface, and will carry the dissipated heat in the atmosphere, Fig 4.

Fig. 2 – Transistor BU 607 structure having a micro heat sink microprocessed onto the surface mounted on a base TO_3 and Au wire (Ø = 35 μm) connected.

Temperature measurements were made using a digital multimeter type TEKTRONIX model DM 502. Cooling air pressure was p = 45 psi, and flow=2,5 l/min, and air temperature at the entrance was 27–29ºC, ambient temperature, and was maintained by air forced cooling at max 100-110ºC. The results obtained were:

1) For micro heat sink test structures, were calculated next average values (from obtained values): Cdisip=54,006W/cm², RthJA=3,752ºC/W, RthCA=2,252 ºC/W.

2) For micro heat sink standard structures, were calculated next average values (from obtained values): Cdisip=58,737 W/cm2, RthJA=3,445 ºC/W, RthCA=1,945 ºC/W.

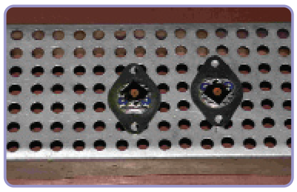


Fig. 4 – BU 607 test structures standard or test mounted on TO_3 cases and close.

PATENT: *No 122449/30.06.2009, titled "Procedure to realize microfluidic devices", Antonie Coraci, Cecilia Podaru, Elena Manea, Eremia Iancu, Victor Moagar Poladian.*

Project Manager: Antonie Coraci antonie.coraci@imt.ro,
Coordinator: IMT-Bucharest; Inovation project, step I, dec 2007.

SYNTHESIS AND CHARACTERIZATION OF NANOPOROUS TIO_2 FILMS ON SI SUBSTRATES FOR SOLAR CELLS APPLICATIONS

TiO_2 samples for solar cells applications were prepared by the electrochemical oxidation of pure titanium thin film deposited onto various substrate types including silicon, SiO_2 and borosilicate glass. Titanium layers of 100 nm thickness were deposited on substrate by sputtering. Anodization was conducted using a conventional two – electrode system. The influence of anodizing parameters on the surface morphology was investigated in detail to optimize the process in order to obtain the porous structure. Depending on fabricating conditions and further heat treatment titanium oxide can be obtain in several polymorphic forms, including anatase and rutile. The formation process of the porous structure and the change in surface morphology induced by heat treatments is evident. Annealing at 723 K in N2 for 30 minutes proves improving of the anodic thin film (from amorphous to anatase phase) crystallization and increases its transparency. After annealing at 1133 K in N_2, for 30 minutes the anatase is converted in rutile phase.

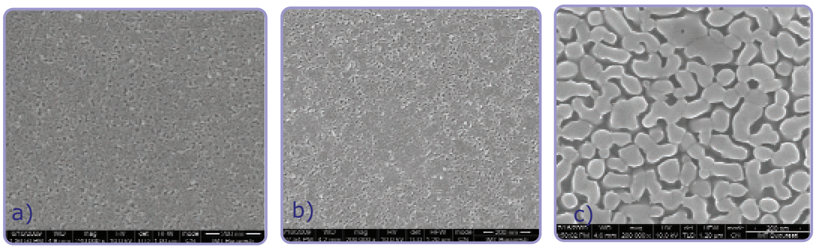


Figure 1- SEM image of TiO2 layer a). Untreated; b). Treated at 723 K; c). Treated at 1133 K

TiO_2 film was doped with phosphorus and palladium to improve electrical conduction. Doping was realized using different processes like chemical deposition during anodizing process and low temperature treatment in a doping furnace at 723 K using nitrogen atmosphere for phosphorous and electrolyze of palladium chloride solution or a chemical reduction process of palladium chloride with hydrofluoric acid for palladium doping. Titanium oxide is an versatile material used in high efficiency, low cost solar–cells applications due to its chemical inertness, eco friendly nature and photostability.

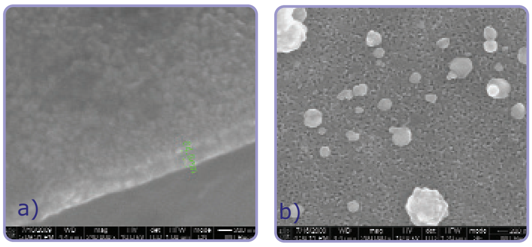


Figure 2 – SEM images for TiO2 phosphorus doped-a); and palladium doped-b)

PN II Program, Contract No.32 – 158/2008
Researchers: E. Manea, C. Obreja, A. Popescu, M. Purica, F. Comanescu, V. Schiopu

L8: Laboratory for ambiental technologies

- Mission
- Main areas of expertise
- Research Team
- Services offer

Mission: • Developing new technologies in the areas of Microsystems technologies: technological design, technological simulation and technological development up to the prototype level;
• New materials development (i.e. nanocomposites);
• New assembly techniques for Microsystems (based on MCM);
• Technological services: technological assistance and consultancy (technological flows design, control gates, technological compatibilities) and defect analysis on technological flow;

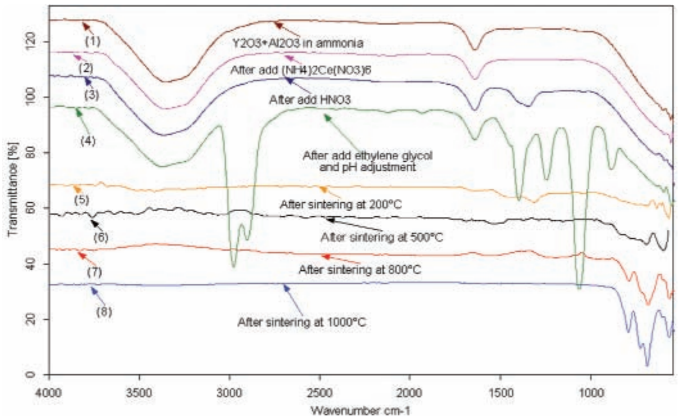
Main areas of expertise: Design, simulation and develop individual technological processes for Microsystems technology (as piezoelectric integrated microsensors, high speed photodetectors and white LED micromatrix) and technological compatibilities MCM technologies and other nonstandard assembly technologies for Microsystems technological design.

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

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

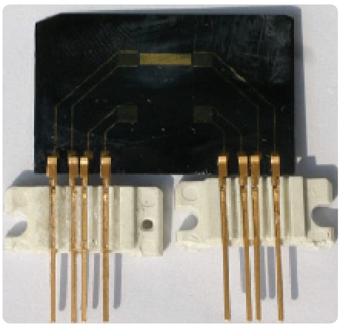
• ***Services Offer:***
• Technological assistance for technological flow design, control gates and technological compatibilities
• Consultancy in technological compatibilities;
• Spectrometric characterization;
• Defect analysis on technological flow;
• Assembly techniques for MST;
• Dicing;

Example:



Study of the process for manufacturing of the YAG:Ce - Steps process

- FTIR Equipment for characterization.
Contact person: Veronica Schiopu
(**veronica.schiopu@imt.ro**);
- **UV-VIS Spectrometer** (AVANTES);
- **Rapid Thermal Processing RTP** (not instaled);



Example of assembly
Contact person:
Ileana Cernica
(**ileana.cernica@imt.ro**)

Laboratory Head — Dr. Ileana Cernica (ileana.cernica@imt.ro)

She received MSc. on Electronics and Telecommunication (1981) and PhD in Microelectronics (1998) 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 research scientist at National Institute for Research and Development in Microtechnologies, currently coordinates 5 national R&D projects and was responsible person in EUREKA Umbrella project MINATUSE and Romanian-German Centre for Micro and Nanotechnology Project.

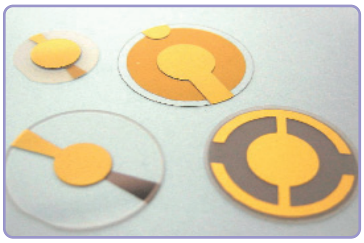
She is project evaluator in national RD programs (CEEX, CNCSIS PNCDI II) , and MNT-ERANET, IEEE and SPIE member and associate professor at University "Politehnica" of Bucharest (Faculty of Electronic, Telecommunication and Information Technology). Her scientific activity was published in more than 65 papers in international journals/conferences, 104 technical reports and is author or coauthor of 10 Romanian patents (3 of them won silver and 1 gold medals at International Inventions Exhibition in Brussels and Geneva) and 3 books.

PIEZOELECTRIC MICROSENSORS SYSTEM, 3D INTEGRATED, FOR MULTIPARAMETER MEASUREMENT, ANALYSIS AND CONTROL

Main aim: Development an integrated system for interconnection of five resonance sensors, having the sensitivity for measurement of temperature, force, pressure, viscosity, different concentration of chemicals.

Preliminary results:

- Designing of multiparameter sensors on quartz substrate and langasite
- Simulation, modelling and technological processes of piezoelectric sensors
- Simulation and functional modelling of multielectrod structure
- Design of technological/electrical characterization and signal analysis
- Simulation and functional modelling of multielectrod structure
- Functional simulation of structure on piezoelectric substrate
- Establishment of control parameters and technological characterization for multiparameter sensors



Types of sensors used as ME

Multisensors on quartz with CrAu electrodes

PIEZOSENZ, PNCDII 2007-2010,
Coordinator IMT Bucharest**.**
Project manager: Ileana Cernica (ileana.cernica@imt.ro)
Partners: Valahia University of Targoviste; ROM-QUARTZ S.A;
National Institute for R&D in Electrochemistry and Condensed Matter – INCEMC Timisoara;
University Politehnica of Bucharest (CCO, DCAE)

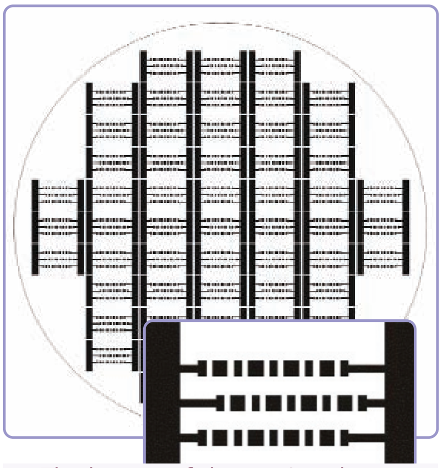
SEMICONDUCTOR MICROMATRIX FOR LIGHTING SYSTEMS

Main aim: Obtaining a semiconductor micromatrix with white light emission, configured on flexible substrate for indoor lighting systems.

Achievements:
Low electrical consumption, more rugged and damage-resistant, applicable for different surfaces (i.e.: corrugated), the white light is not tied for the eyes and the micromatrix is designed as to be an area of continuous light.

Application: semiconductor micromatrix which emits white light could replace the bulb and fluorescence for local illuminate.

Beneficiaries: hospitals (illumine for night time), manufactures of cars (illuminate inside for passenger without driver disturb), manufactures of ships (civil and military) - for lighting closed spaces;



The lay-out of the semiconductor micromatrix (on mask and detail)

This work was supported by NUCLEU, a national program for R&D.
Project manager: Veronica Schiopu (veronica.schiopu@imt.ro).
Coordinator: IMT-Bucuresti

WOOD - POLYMER COMPOSITE WITH COMPONENTS OF NANOSTRUCTURED MATERIALS AND NANOSENSORS FOR IMPROVEMENT OF INDOOR ENVIRONMENT

Main aim: The walls (plates) of wood-polymer structure using wastes of wood processing and wastes type PET and plastic bags. As the main objective for environment protection after that the walls will be processed with nanomaterials protection to allow the environmental increasing.

Results: Were obtained 4 types of "wood-polymer" composites: PAL-D, PAL-PE (polyethylene), PAL-PE-AM (maleic anhydride) and PAL-PE-nanomaterials (TiO2 and ZnO), which were used chips of wood fibers of various shapes and sizes and different agents of compatibility. For "polymer – wood" plates has demonstrated the functionality from physical – mechanical properties for different experimental models which shown following aspects:

- The plates type as PAL – D (as chips dezintegrated melamine PAL and new type of ureic resin) – have a thickness swelling after immersion in water more reduced (6.61% respective 17.44%) against of stratified PAL (17.32% respective 18.38%); water absorption (773.38kg/m3 against 684.86 kg/m3); resistance at static bending (23.79N/mm2 against 20.64N/mm2)
- The plated types PAL – PE with same adhesive type has thickness swelling with much reduced thickness as PAL classical stratified (3,0%, respective 21%); water absorption (17.32% against of 18,38%); density is higher (1005kg/m3 against 684.86 kg/m3), resistance at static bending effort lower with 70%;
- The plated types PAL – PE - AM with same adhesive type has thickness swelling reduced (1%) as PAL classical stratified almost the same value (water absorption (18%); density is higher (908kg/m3 against 684.86 kg/m3), resistance at static bending effort is smaller (14N/mm2 against 20.64N/mm2).
- The plated types PAL – PE with nanomaterials have a thickness swelling after immersion time of 24h (3.15 – 3.14%), water absorption after immersion (20.5 – 20.4%); density (1005.3kg/m3 -1005.4 kg/m3); resistance at static bending is about 70% smaller.

NANOPROTECT, PNCDII 2007-2010, Coordinator IMT Bucharest**.**
Project manager: Ileana Cernica **(ileana.cernica@imt.ro); Partners:** Partners: "Petru Poni" Institute of Macromolecular Chemistry – ICPAM Iasi; National Institute of Wood – INL Bucharest;INCDO-INOE2000, Research Institute for Analytical Instrumentation Cluj; S.C. NATURA SRL – Biertan, Sibiu; Transilvania University of Brasov

L9: Laboratory for Molecular Nanotechnology

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

Mission: Interdisciplinary laboratory established in 2009, relying on state of the art equipments (belonging to various labs). We work on functional integration of biological components, such as peptides, proteins, antibodies, nucleotides, DNA fragments, etc., with micro-nano processed and patterned inorganic structures, targeting various micro-nano-bio-info applications. We combine substrate preparation and processing, micro-nano scale lithography and controlled molecular deposition, adsorption and manipulation of biomolecules, nanoscale microscopy techniques, and equilibrium/non-equilibrium quantum mechanical numerical analysis, aiming at developing unified experimental and theoretical frameworks for the study of functional properties obtained from the interaction of biomolecules with nano/micro objects. Controlling and investigating the chemical and physical properties of new nanomaterials is another key research orientation. Current research addresses health and environmental applications, focused on developing advanced solutions for biosensors, biosensor arrays, and physical DNA sequencing technologies.

Main areas of expertise:

• Electrochemistry: investigation of redox mechanisms; design and development of electro-chemical sensors, electrochemical biosensors, immunosensors, DNA sensors, etc.;

• Materials chemistry and surface functionalization: -functionalization chemistry for carbon's allotropes (carbon nanotubes, graphene and carbon nanoparticles) and metallic nanoparticles; -development of advanced carbon nanocomposites for thermal, electrical and biomedical applications; -photoluminescent carbon nanomaterials for biological imaging. • Analytical investigations and characterizations (UV-Vis, fluorescence, HPLC, FT-IR, etc.): -nanoscale microscopy and patterning (SPM, dip-pen nanolithography).

• Substrate preparation and processing for molecular nanotechnology applications (micro-nanolithography, metal deposition, plasma etching, annealing).

• ELISA based techniques for the detection of food toxins (domoic acid, ochratoxins, mycotoxins, etc.).

• Modeling and simulation: quantum mechanics modeling and simulation, coupled field analysis. Current focus: theoretical and experimental studies towards innovative physical DNA sequencing technologies: (i) optimal surface immobilization and chemical modification of DNA single-strand molecules in view of STM/STS-based analysis of nucleobase detectability/ identification; (ii) optical-electrical manipulation of DNA strands and controlled presentation to 1D sensing nanostructures (nanotubes, nanowires).

• **Research Team:** 4 senior researchers.

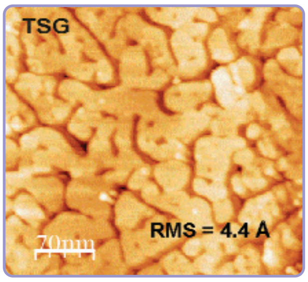
• ***Main tools:***

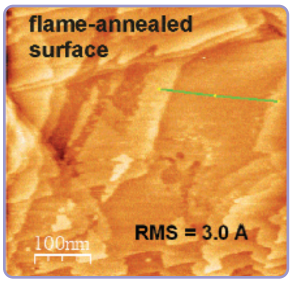
• Modeling and simulation: - SIESTA/TRANSIESTA: package for ab-initio molecular dynamics and electronic structure calculations (molecules and solids) - CoventorWare, ANSYS: multi-physics analysis for MEMS

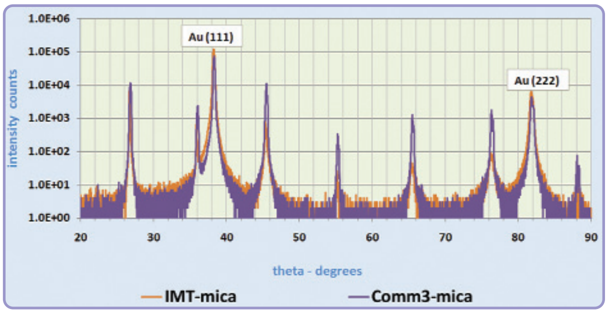
• Processing and characterization available in various IMT-Bucharest laboratories.

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

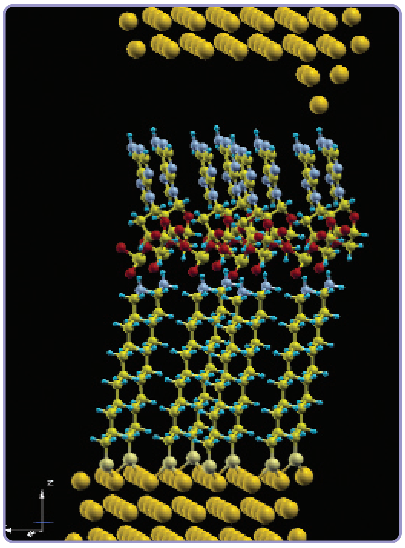
Recent results



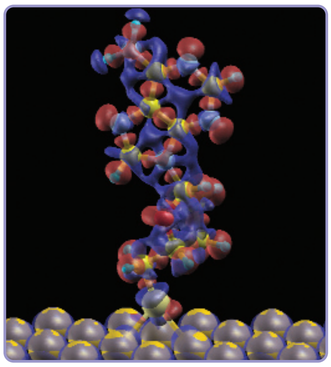




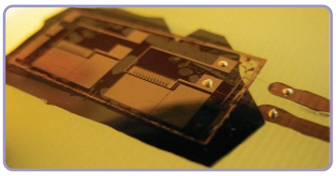
Advanced Au (111) substrate preparation for molecular depositions: high flatness and crystallinity.



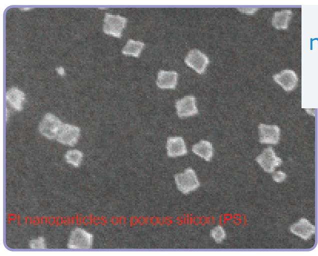
Calculation model for STM analysis of DNA nucleotides immobilized on alkanethiol monolayers adsorbed on Au (111)



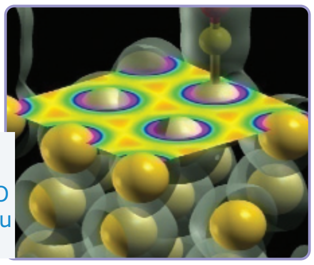
Difference charge distributions for adsorbed thiolated adenine.



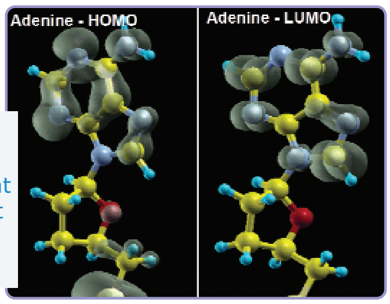
Experimental structure for DNA stretching.



Crystalline Pt nanostructures on porous silicon



Electronic structure calculation: CO adsorbed on Au (111)



HOMO/LUMO charge distributions at Gamma point for thiolated adenine.

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2. **Laser Scanning Calibration for Porous Silicon Substrate Useful in Microarray Applications**, Monica Simion, Irina Kleps, Lavinia Ruta, Lucia Lazar, Adina Bragaru, Mihaela Miu, Ion Baciu, 32nd Edition, IEEE International Semiconductor Conference, CAS-Proceedings, Vol. 1, 12–4 October, 2009, Sinaia, Romania, pp. 147-150.

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10. **Electrochemical Processes and Characterization of Doped TiO_2 Thin Films**; Relationship Between Preparation Conditions And Nanostructure, E. Manea, L. Staicu, A. Popescu, A.C. Obreja, A. Dinescu, V. Schiopu, 32nd Edition, IEEE International Semiconductor Conference, CAS-Proceedings, Vol. 1, 12–14 October, 2009, Sinaia, Romania, pp.163-166.

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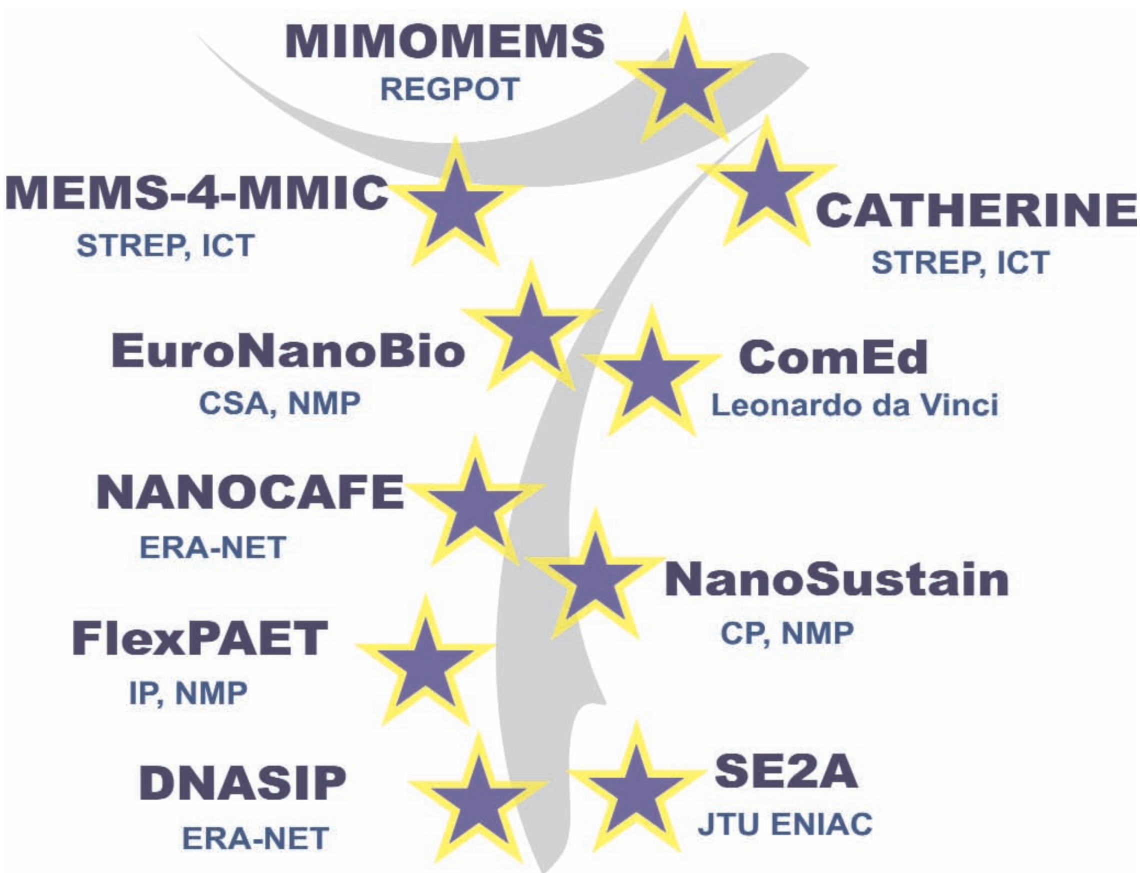

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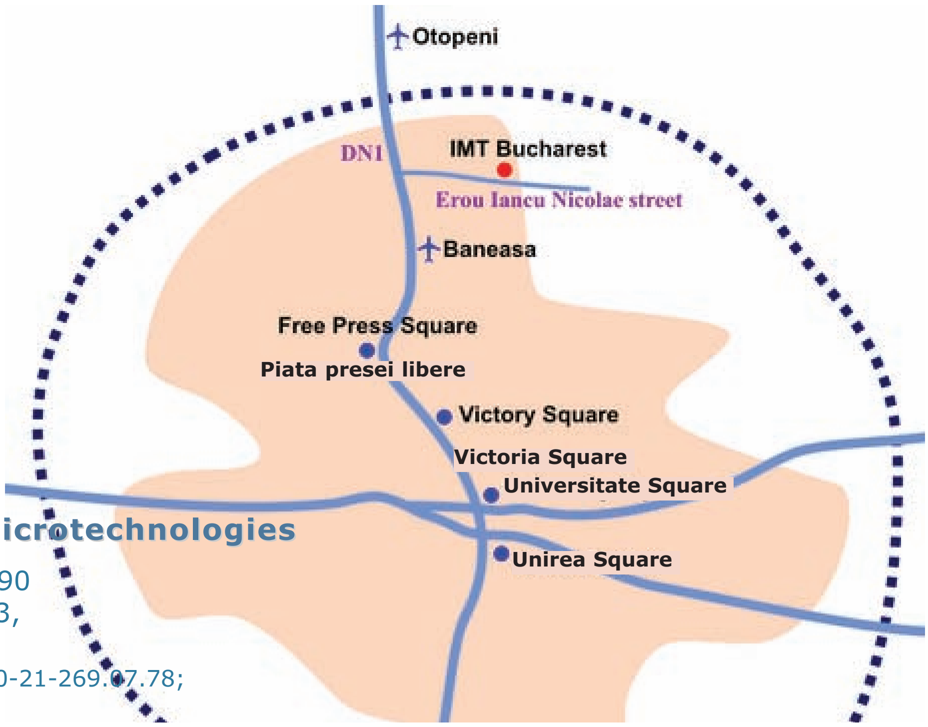

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