Ministry of Education and Research, Romania

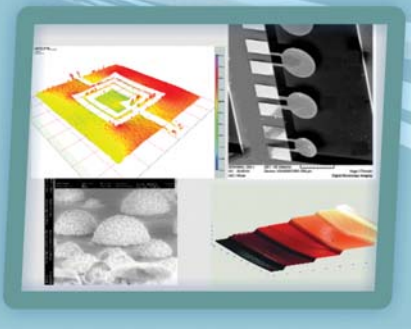
National Authority for Scientific Research

IMT-Bucharest

SCIENTIFIC REPORT 2008

National Institute for R&D in Microtechnologies

From micro- and nanotechnologies
to
convergent technologies










Ministry of Education and Research, Romania
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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 by University "Politehnica" of Bucharest, 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. In 2008, IMT celebrated 15 years of existence. 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).

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). Between 2003 and 2009 IMT was involved in approximately European 25 projects (FP6, FP7 and related). IMT houses a *European Centre of Excellence* financed by the EC (2008-2011) the first one after Romania became a EU member.

The field of activity of the National Institute for Research and Development in Microtechnologies (or simply IMT) corresponds today to micro-nano-bio-technologies. 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.

About the present report

The Scientific Report 2008 starts with *the basic figures about IMT in 2008 and continues with the organizational chart and the Board of Directors* (spring 2009). 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 2008 continued the rapid increase taking place during the previous three years (2005-2007). The volume of investments from various sources during the last three years (2006-2008) is about 6.5 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 2008.

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 jut 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. Occasional training courses have been provided in IMT by companies and by research partners in European projects.

IMT is organizing the *Annual Conference for Semiconductors* (CAS), an IEEE event (CAS 2008 was the 31st 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 7th edition - in 2008).

The institute is editing or co-editing the following publications (all in English): *"Micro- and Nanotechnology Bulletin"* (quarterly magazine, since 2000); *"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 (12 volumes until 2008).

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 Steering Committee of MNT ERA-NET (MNT = Micro- and NanoTechnologies), and in the "mirror group" for the European Technological Platform for Nanomedicine. 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 (1).

Fig.1 (a, b, c) provides information about the number and distribution of researchers active in IMT in 2008 (74 persons). More then one third of them are senior researchers (a). 65% of them have the Ph.D. degree or are Ph.D. students (b). The average age is slightly above 40 years (c).

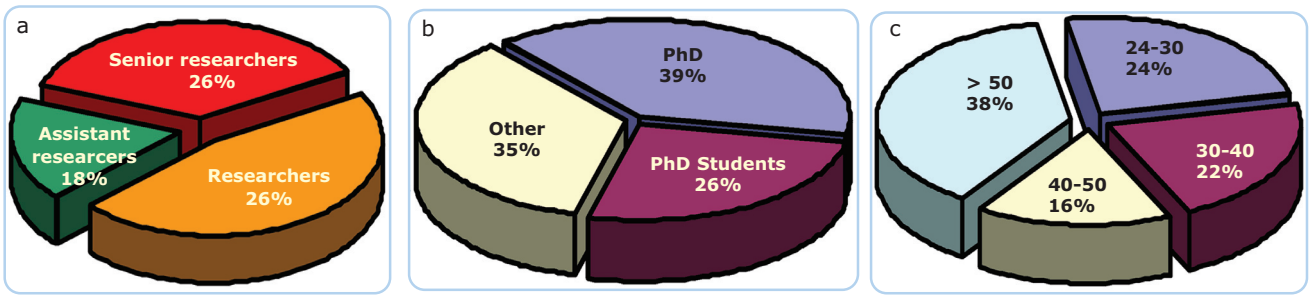


Fig 1 - Researchers active in IMT (74)

Fig.2 gives information about the total number of specialists active in IMT in 2008 (107 people): researchers and specialists providing technical services. Their background is shown in Fig.2. The male (59) - female (48) number is relatively balanced.

The number (and age distribution) of specialized IMT personnel temporarily working abroad (24) is shown in Fig. 3 in comparison with the personnel active in the institute (107).

Fig 2 - Background of researchers and specialists providing technical services (107)

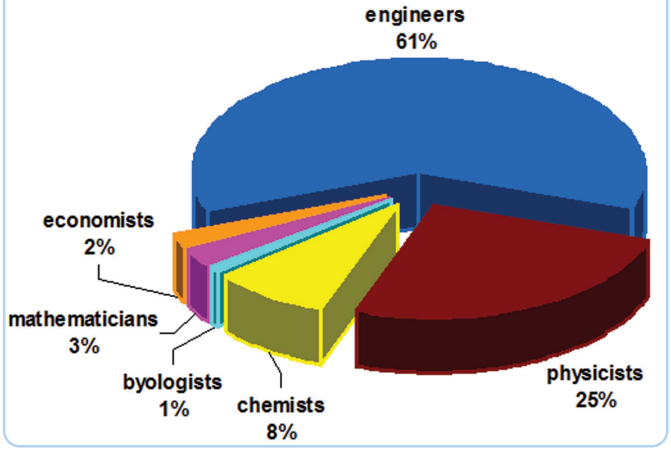
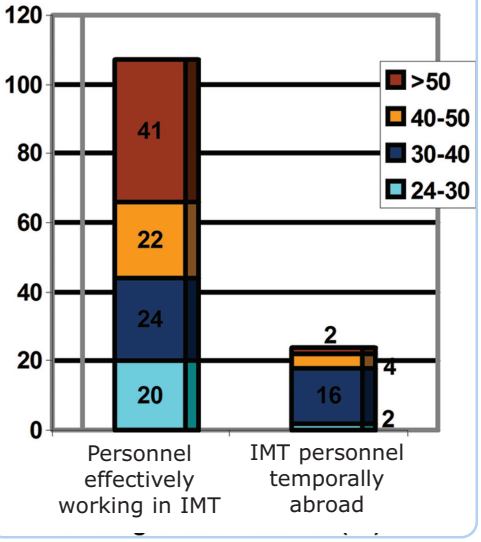


Fig 3 - Age distribution of specialised personnel (107+24)



Funding sources.

Fig. 4 shows the funding sources in 2008 (a), excluding investments from various contracts, as well as the evolution along the last six years (b). In 2008, the majority of total funding (68%) comes from national R&D programmes (competitive funding, through open calls) and only 16% is provided by core funding (public money available to national institutes for R&D, since 2003).

Fig 4a -Funding sources (EUR), 2008

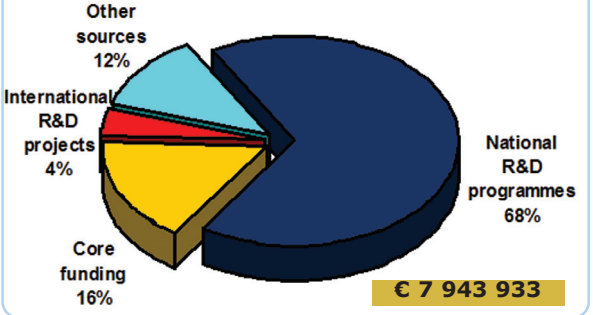
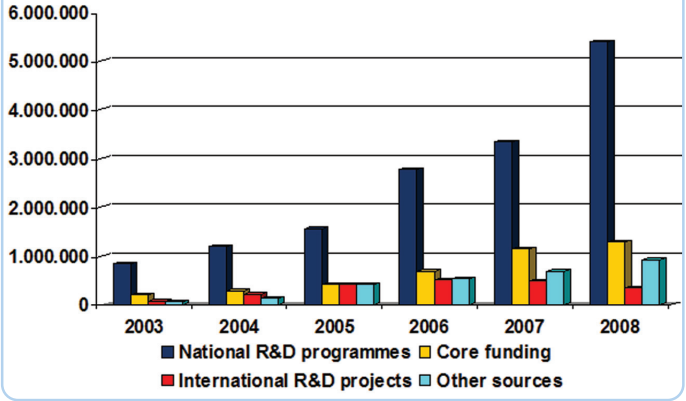


Fig 4b - Funding sources (EUR), 2003-2008

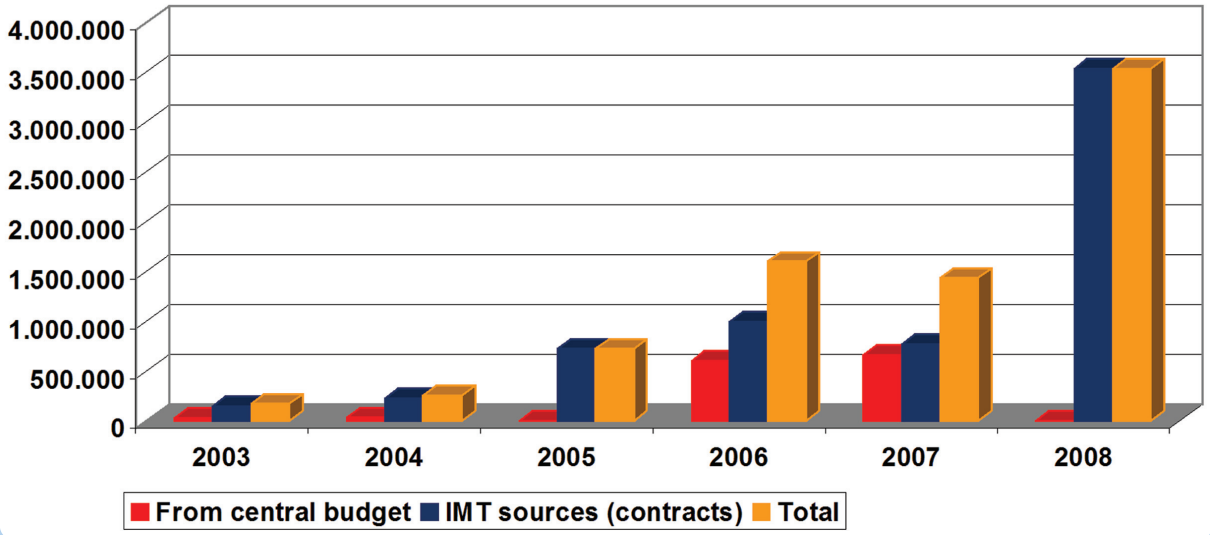


Human resources, funding sources, investments (2).

Investments: dynamics and structure.

The dynamics of investments during the ten years of existence of IMT as a national institute (2002-2007) is even more spectacular. Fig. 5 shows the evolution from 2003 to 2008. The average level of annual investments is very low by international standards. 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. The substantial increase in investments during the last three years was provided to a large proportion by funding from R&D projects financed from the national programmes, including infrastructure projects.

Fig 5 - Evolution of IMT investments (EUR), 2003-2007



The structure of these investments is shown in Fig.6. For the previous 5 year time period (2003-2007) a substantial part of the money (64%) went into technological equipment (Fig. 6.a). However, investments for technological equipments accounts for only 20% from the total (record) amount invested in 2008 (Fig. 6.b), whereas the characterization equipments increased to a significant percentage (64%).

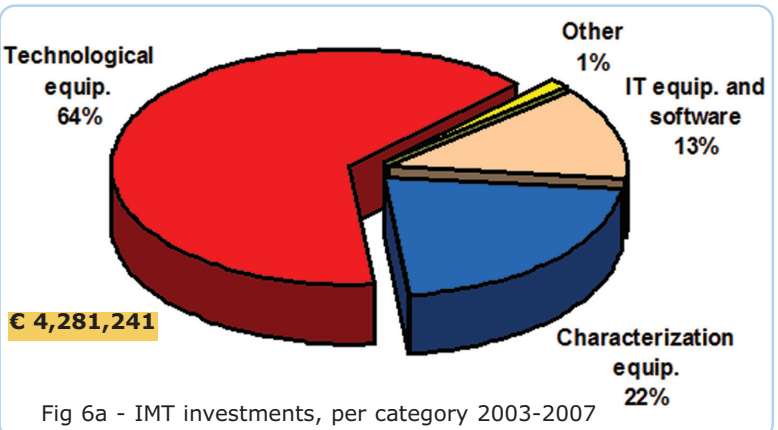


Fig 6a - IMT investments, per category 2003-2007

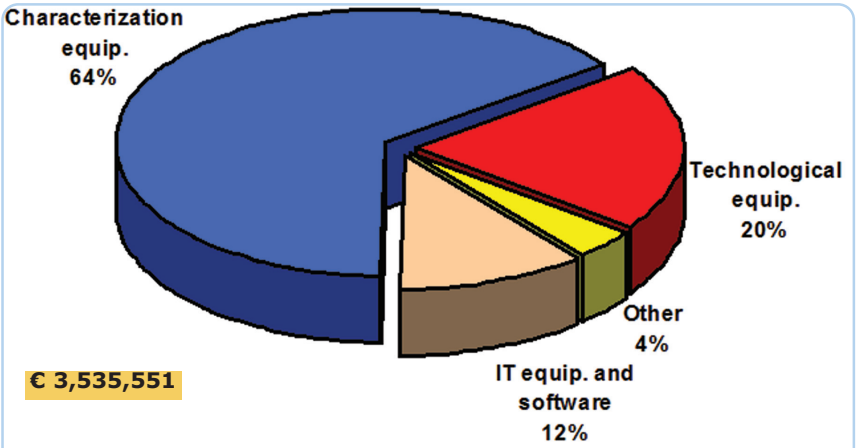
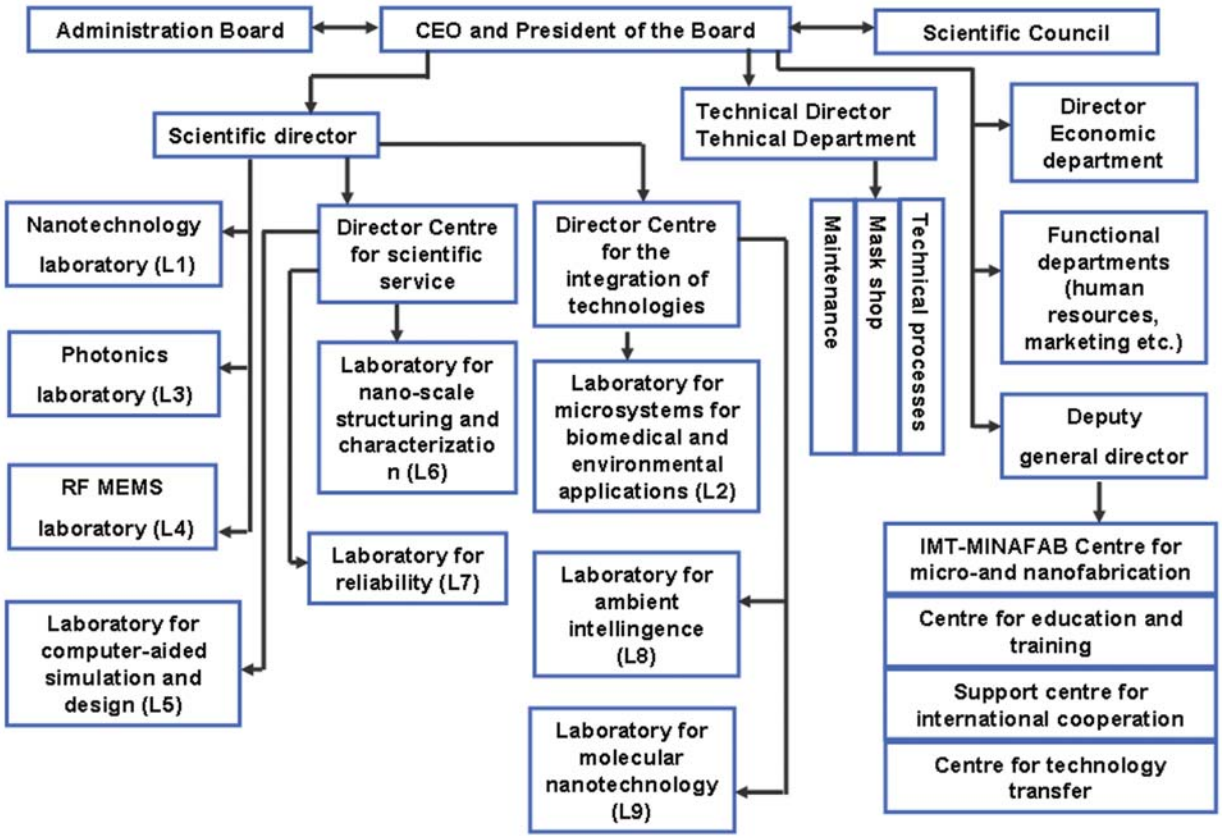


Fig 6b - IMT investments, per category 2008

Note: The use of these new equipments will be shared with some partners in R&D projects financed by national programmes. The use of these equipments is also open for industry and educations trough the centre of services IMT-MINAFAB.

Organizational chart



Raluca Müller received the M.Sc (1978) in Electronics and Telecommunications from "Polytehnica" 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 Polytechnical Institute in 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, which are also the main area of research in which I am currently working. He is co-author of several books.

Radu Cristian Popa graduated in 1989 the Poytechnic 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.

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

Information valid at the time of printing (spring 2009)

Infrastructure: IMT-MINAFAB

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

The main achievement of 2008 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 in 2009) 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 is 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

EQUIPMENTS AND EXPERIMENTAL LABORATORIES

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;

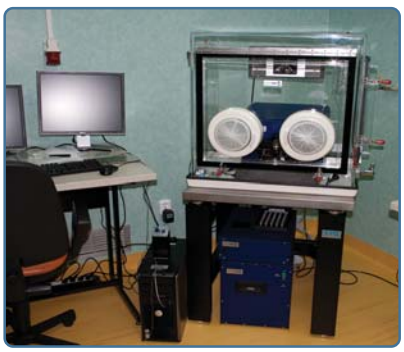
Scanning Probe Microscope SPM-NTEGRA

- **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 pattering 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) have been created 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) was acquired
• A spectrum analyzer up to 110 GHz (from Anritsu) was acquired

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 micowave devices based on carbon nanotubes (CNT) and graphene;

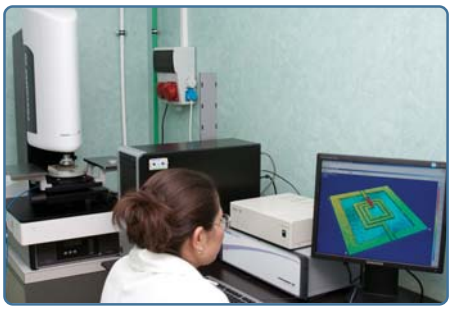
Upgraded to 110GHz set-up for "on wafer" S parameters measurements (left), Generator up to 110 GHz and the Spectrum Analyzer up to 110 GHz (top).

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

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 results 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;

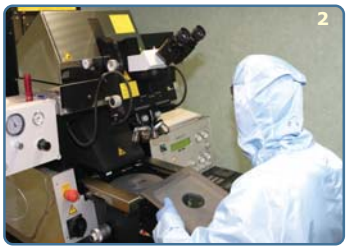


White Light Interferometer (WLI) - Photomap 3D Standard 2006 (FOGALE NANOTECH, France);

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

EQUIPMENTS AND EXPERIMENTAL LABORATORIES

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



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).

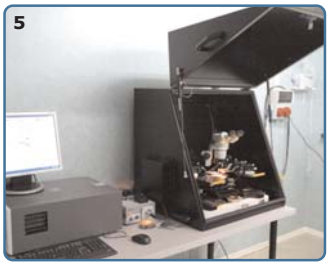
Thin film deposition: **- Electron Beam Evaporation an DC sputtering system AUTO 500** (BOC Edwards, img 4);

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);



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.

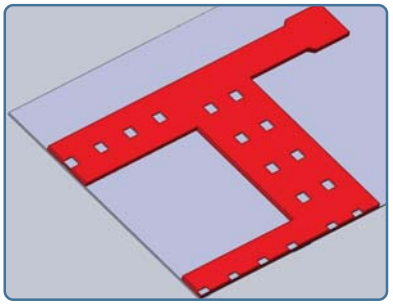
Also, the Reliability Laboratory offers **other reliability services**, such as:
- **Training courses on: Quality&Reliability** assurance for semiconductor devices; Reliability accelerated testing for MEMS; Failure analysis at accelerated testing; Characterisation of microelectronic devices and MEMS;
- **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

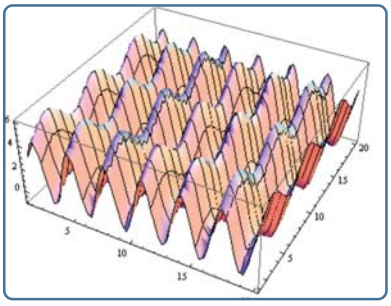
EQUIPMENTS AND EXPERIMENTAL LABORATORIES

Computer technique for simulation and design:

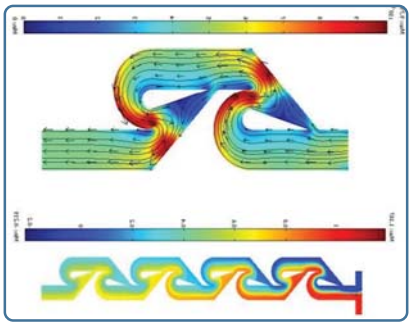


Design of a RF switch - Solidworks

- ***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



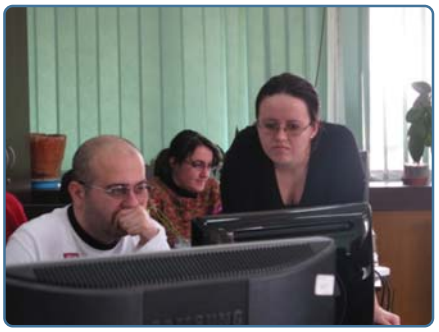
COMSOL Simulation of a Tesla micromixer
National Project Computer aided design for microfluidic components

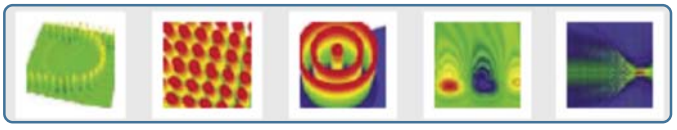
Graphics

- **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;

NANOMORPH

The laboratory for characterization of nanoscale morphology

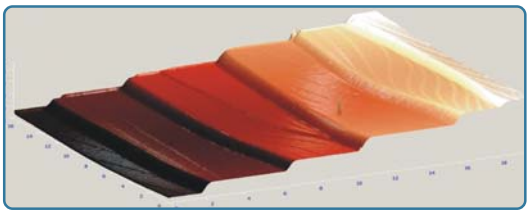
NANOMORPH laboratory is in process of accreditation as a testing laboratory by RENAR –Romanian Accreditation Association - National Accreditation Body. By accreditation it is certified that the laboratory activity complies with SR EN ISO/CEI 17025/2005 international standard "General requirements for the competence of testing and calibration laboratories".

For tests done in NANOMORPH laboratory we use new (max. two years old), state- of- the art instrumentation. The equipments were purchased from manufacturers that have implemented ISO 9001:2001-based quality management systems.

NANOMORPH laboratory is provided with certified reference materials used as working standards as well as other reference materials intended for performance checking and evaluation for all utilized instruments. Equipments are operated by high qualified and experienced personnel. *Financed by* the *P-CONFORM project, Excellence Research Program, Romanian Education and Research Ministry - CEEX 2006 (contract nr. 234/10.08.2006)*

Services provided with AFM Microscopy:

Assessment of 3D topografy of sample surfaces at micronic and nanometric scale by Atomic Force Microscopy (AFM). The data are primarily intended for graphic representation, but could also be used for characterization of parameters of interest (roughness, step heights, line widths etc).



AFM image of step patterned Si. Individual step height: 15 nm. Individual atomic planes could be noticed in the 3D rendered image.

Sample types: Semiconductor, dielectric, metallic or ceramic surfaces and/or coatings for use in micro and nanotechnology field.

Equipment: SPM (Scanning Probe Microscope) Ntegra Aura (NT-MDT)

Specifications:
- scan range: 100x100x10 μm
- provided with capacitive sensors
- noise level: X,Y: 0,3 nm, Z: 0,06 nm
X, Y non-linearity (with closed-loop sensors) < 0.15 %.

See also Equipments and Experimental Laboratories - page 9.

Contact: NANOMORPH Laboratory *manager:*
Phys. Raluca Gavrila, e-mail: raluca.gavrila@imt.ro
Web: http://www.imt.ro/NANOMORPH

MICROLAB

Laboratory for advanced characterisation of microwave and millimeter wave components and circuits

MICROLAB is on its way to be accredited as a testing laboratory by RENAR - The Romanian Accreditation Association, the national accreditation organization. By this accreditation, the laboratory is attested to be functioning according to the international standard SR EN ISO/CEI 17025/2005, "General requirements for the competence of testing and calibration laboratories".
Project P-CONFORM, CEEX 2006, contract no. 233/10.08.2006

The laboratory for advanced characterization of microwave and millimeter wave components and circuits in the frequency range of 0.5 GHz-65 GHz consists of a vectorial network analyzer (VNA) and a probe station. The entire measurement procedure is assisted by computer and the measured data are available on line.

Potentially beneficiaries could be EU companies that want their products to be characterized and tested according to the EU standards.

The VNA assembly and the measurements station

Services:
- the designing, production and testing of the measurement devices required for the microwaves devices and circuits characterization activities.
- characterisation in the frequency range of 0.5-65 GHz

Equipments:
- The VNA assembly and the measurements station - Vectorial network analyzer ANRITSU - VNA 37397D Anritsu (frequency range 40MHz-65GHz)
- Measurement equipment on Karl Suus PM5 wavers; (see also Equipments and Experimental Laboratories - page 10).

First results: The new laboratory possibilities have helped us to win of the following FP7 projects:
- Center of Excellence in Microwave, Millimeter Wave and Optical Devices, based on Micro-Electro-Mechanical Systems for Advanced Communication Systems and Sensors (***MIMOMEMS***), 2008-2011;
- Enabling MEMS-MMIC technology for cost-effective multifunctional RF-systems integration (***MEMS 4 MMIC***), 2008-2011;

Contact: MICROLAB laboratory manager: *Dr. Mircea DRAGOMAN. E-mail: mircea.dragoman@imt.ro*.
Web: http://www.imt.ro/microlab

OPTOLAB

Laboratory for optical and opto-electrical measurements and testing of materials and optoelectronic devices

OPTOLAB is on its way to be accredited as a measurements and testing laboratory by RENAR - The Romanian Accreditation Association, the national accreditation organization. By this accreditation, the laboratory is attested to be functioning according to the international standard SR EN ISO/CEI 17025/2005, "General requirements for the competence of testing and calibration laboratories".

Spectral Elipsometer- SE XUV 800

OPTOLAB is a laboratory for studying, measurements and testing of optical and structural properties of thin mono- and multi layers and bulk organic/anorganic materials (dielectric layers, conductive transparent oxide, bio-samples) and micro/nano photonic and optoelectronic devices. Development of the laboratory for this purpose is based on high performance equipements and existing resources.

Proiect P-CONFORM, CEEX 2006, contract nr. 97/10.08.2006

Services

- ***Raman Spectroscopy***: chemical compounds identification, characterization of molecular structures, to determine the composition and phase of composites materials, determination of: crystaline orientation of thin layers, oxides deposited on semiconductor substrate, polymers, micro/nanostructures characterization .
- ***Ellispometry:*** Characterization of thin mono or multi layers (oxides, polymers, compozite materials, etc.) regading refractive index n,k and thickness.

Contact: OPTOLAB laboratory Manager:
Dr. Munizer PURICA, e-mail: munizer.purica@imt.ro
Web: http://www.imt.ro/optolab

Equipments

- Micro-Raman Spectrometer Lab Ram HR800 produced by HORIBA JOBIN YVON for material physical-chemical characterization;
- Spectral Elipsometer - SE XUV 800;
- Spectrophotometers: SPECORD M42 for UV_VIS_NIR spectral range, SPECORD M 80 for IR;
- Monochromater, Monospek 1000;
- Optical fiber testing modules and laser diodes;
- Optical table and accessories (filters, radiation sources, positioners, s.a.) digital confocal and metalografic-Epival Interphaco microscope; (see also Equipments and Experimental Laboratories - page 10).

LIMIT

Laboratory for conformity evaluation of microtechnologies products

LIMIT is on its way to be accredited as a measurements and testing laboratory by RENAR - The Romanian Accreditation Association, the national accreditation organization. By this accreditation, the laboratory is attested to be functioning according to the international standard SR EN ISO/CEI 17025/2005, "General requirements for the competence of testing and calibration laboratories".

Project P-CONFORM, CEEX 2006, contract nr. 98/10.08.2006

Objective: LIMIT is a laboratory for conformity evaluation of micro technologies products in concordance with European Union demands. Development of the laboratory for this purpose is based on high performance equipments and existing resources. An important role is assigned for developing R/D activities in micro and nano technologies.

The experimental set-up for electrical characterization at various temperatures: Equipment for electrical measurement 420 SCS (left) and Equipment for temperature conditioning ThermoStream (right).

Structure: - Electrical characterization (characterization of micro and nano technologies products according approved standards and special specifications);
- Mechanical and climatical tests (application specific tests development for micro and nano technologies products);
- Long time tests (storage and endurance tests in various environmental and electrical conditions);

Equipments from M4 project

- Electrical characterization system and measurement equipments Keithley 4200SCS;
- Temperature conditioning equipment for electrical measurement - Temptronic TP04300A-8C3-11;
- Damp heat Climatic chamber, Angelantoni, Italia;
- Temperature chamber with Forced air circulation Memmert (Germany)/UFB 400;
- Vacuum oven MEMMERT (Germany) – VO 400;
(for a complet description of the equipments see Equipments and Experimental Laboratories - page 11).

Services:

- Qualification tests (electrical, mechanical and climatical tests and long time tests);
- Reliability tests (normal and accelerated tests);
- Electrical characterization of micro and nano technologies products;
- In house tests (Tests and test programs on demand with specified parameters);
- Test certificate (for tests programs performed);
- Consultancy (tests programs, product standards, documentation etc.).

Contact: LIMIT laboratory Manager: ***Eng. Virgil ILIAN, e-mail: virgil.ilian@imt.ro***
Web: http://www.imt.ro/limit

L1: Laboratory of Nanotechnology

Affiliated to the Romanian Academy (of Sciences)

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: Functional nanomaterials, Nanobiosystems, Nanophotonics and Microelectromechanical Systems.

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 utilizing the various technologies developed in nanofabrication and MEMS 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 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

- "Drug delivery system based on microreservoirs array with porous silicon resorbable membrane caps", Romanian-Greece International Cooperation, Decembrie 2005-2008;
- "Nanostructured silicon for optical biosensors", Romanian-Italian International Cooperation, 2006-2008;
- "Suface engineering techniques to investigate inorganic-biomolecular interfaces", research project in the frame of NoE-NANOFUN-POLY; "European FP6 Network: Nanostructured and Functional Polymer-Based Materials and Nano-composites;
- A "system-in-a-microfluidic package" approach for focused diagnostic DNA microchips-DNASIP, MNT-ERA, 2008-2010.

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

Award: Marioara Avram, Irina Kleps si Anca Angelescu,Gold medail to the EUREKA 2008- The Belgian and International Trade Fair for Technological Innovation, Brussels, *Procedure of realization a spin valve magnetotransistor*.

Team from left to right: Florea Craciunoiu; Adina Bragaru; Mihaela Miu;Monica Simion; Irina Kleps; Marioara Avram; Teodora Ignat; Mihai Danila; Andrei Avram;

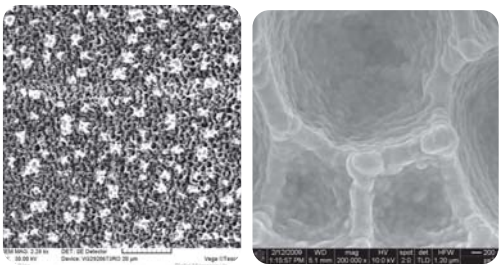
Laboratory Head - Dr. Irina Kleps (irina.kleps@imt.ro)

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.

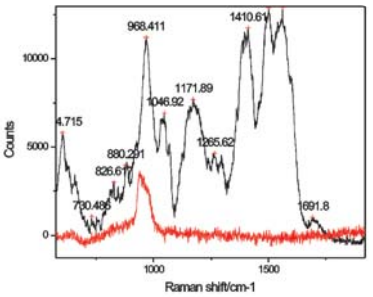
Dr. Kleps participated in several European projects: INCO-COPERNICUS SBLED (1998-2001), EMERGE (guest experiments at IMM, Germany) Metallics (2000-2003), PHANTOMS (Network of Excellence on Nanoelectronics) (2001-2004), NANOFUN-POLY (2004-2008). She was involved as expert for project evaluation in the 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 IMT representative in ETP-Nanomedicine and expert for nanotechnology risk assessment at national level.

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



SEM images of different Au/PS substrate for SERS

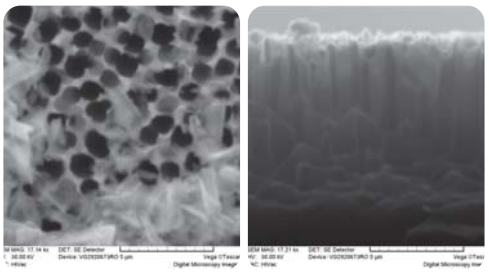


SERS spectrum - 785nm - of 11-MUA on PVD-gold substrate/porous silicon (black) and PVD- gold substrate/silicon (red) obtained by immersion of the gold substrates in 2mM 11-MUA aqueous solution for 24h.

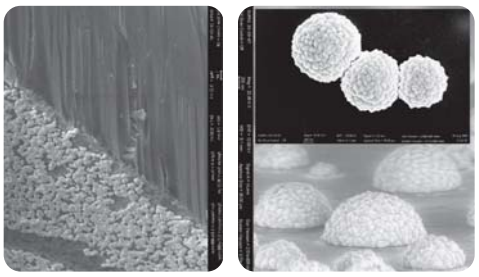
Financed by the National University Research Council (2007- 2010)
Coordinator: Dr. Irina Kleps, irina.kleps@imt.ro

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

The project "Study of membrane - electro-catalyst nanocomposite assemblies on silicon for fuel cell application" scope is fabrication of a nanostructurated silicon based electrocatalytic proton exchange membrane.
The silicon substrate has been subjected to an electrochemical porosification process for nanostructuration and after a chemical functionalisation of internal surface to achieve the appropriate chemical bondings, a further impregnation with Nafion protonic solution led to specific characteristics for ionic and electronic conduction (1). The enhancement of platinum catalytic function has been obtained by deposition of a metallic nanoparticle array conform to the figure 2.



1. SEM images of PS + DMF + Nafion

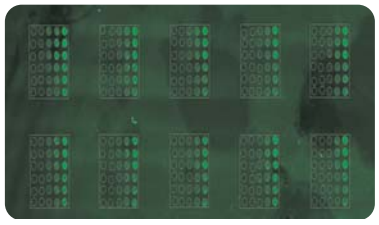


2. The XRD – SAXS analyses confirm the (111) predominant texture of particles representing an advantage for envisaged applications in fuel cell complex devices.

Financed by the National University Research Council (2007- 2010)
Coordinator: IMT Bucharest, Dr. Mihaela Miu, mihaela.miu@imt.ro

MULTI ALERGEN BIOCHIP REALISED BY MICROARRAY TECHNOLOGY (MAMA)

The aim of this work is to test more types of compatible materials with the biological material. Three types of substrates: glass, silicon and porous silicon were tested. All these materials were chemically modified in order to obtain active groups for covalent or physical bonding with the biological material. These modifications are made to uniform the surfaces hydrophobicity, to decrease the noise produced by LASER excitation and to improve the spots morphology. 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 determin the minimum limit of the detection and the scanning parameters. Then, the BSA (Bovin Serum Albumin) protein fluorescent marked with Cy3 in PBS (Phosphate buffered saline solution) was printed. It was used ten serial dilutions of the BSA protein and the concentrations were between 2^{-9} and 1mg/ml. Every dilution was printed for 3 times and it were obtained 2 columns with 5 subarray on every columns. Every subarray have 6 columns and 5 lines and it were printed 2 dilutions on every line.



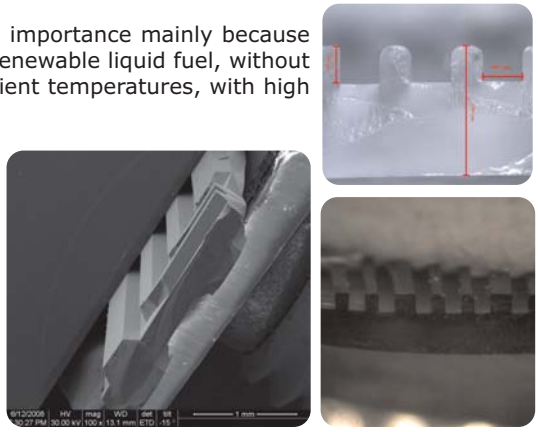
The design of an array printed with a protein using serial dilutions

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;

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

Since the 1990s, the direct methanol fuel cell (DMFC) has gained importance 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.

The project"Miniaturised power source for portable electronics realised by 3D assembling of complex hybrid micro- and nanosystems (MiNaSEP)" proposes the development of fabrication technology to achieve 3D device architectures at the micrometer-scale, to increase the total area of reactive surfaces per unit volume without increasing the footprint area. The standard design of fuel cell comprises an anode part, a cathode part and a proton exchange membrane sandwiched in between the anode and the cathode, usually built on 2D geometries and assembled into 3D shapes.
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).

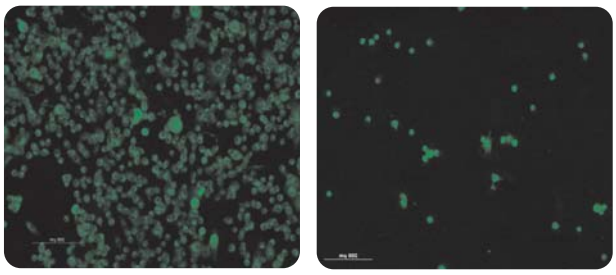


Test structures for microfluidic system: silicon and PDMS components

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;

NANOSTRUCTURES FOR ACTIVE DRUG DELIVERY WITH THERAPEUTICAL POTENTIAL (NANOCONTER)

We have developed new methods for nanostructured PS microparticle and protocols for their functionalised and impregnation with different substances, such as chondroitin sulfate, lactoferrin and N-butyldeoxynojirimycin for drug delivery applications. The microfabricated particles were have been tested in vitro at the Intitute of Biochemistry. Morphological changes and viability in cells attached to the devices were visualized by fluorescence microscopy, following NBD-C6 ceramide labeling. This dye is a specific marker for Golgi apparatus and the integrity of this compartment reflects the normal cell behaviour.Our preliminary biocompatibility experiments revealed that all the devices tested allowed the cell adhesion but cell viability are decreased compared to control.

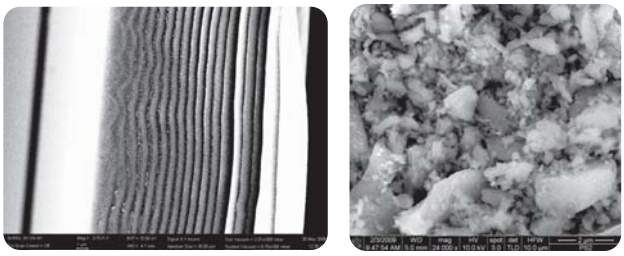


Mouse melanoma B16 F10 cells proliferation on different PS devices: A- control cells; B- PS-terapeutic substance.

CEEX Project (2006- 2008)
Coordinator: Institute of Biochemistry, Bucharest, Dr. Mihaela Trif, trif@bichim.ro
Partners: IOB; INSB; University of Bucharest Faculty of Biology; IMT- Bucharest; ICECHIM;

SILICON BASED MULTIFUNCTIONAL NANOPARTICLES FOR CANCER THERAPY (NANOSIC)

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). It was demonstrated that PS multilayer structuration is a high productivity of method for microparticles fabrication. The alternance of ultrathin layers with different morphologies and corresponding pore diameters ranging from few nanometers to tens of nanometers determine a cleavage phenomenon when a simple ultrasonation treatment is applied. Smaller microparticles were obtained by ball milling treatment. Iron oxides nanoparticles of 50 nm on PS microparticle surface and smaller inside the pores were chemically deposited to assure imaging and targeting functions.



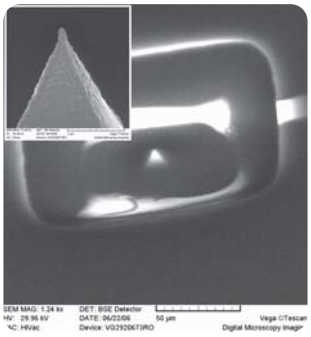
PS multilayers obtained on p+ Si

Microparticles with nanoporous structure lower than 8 μm

Gold, silver, and iron oxides were chemically or deposited by evaporation on porous silicon in order to assure biocompatibility, targeting, antimicrobial and terapeutic properties.

PNCDI Program (2007- 2010). Coordinator: IMT Bucharest, Dr. Irina Kleps, irina.kleps@imt.ro
Partners: INSB Bucharest and IOB Bucharest;

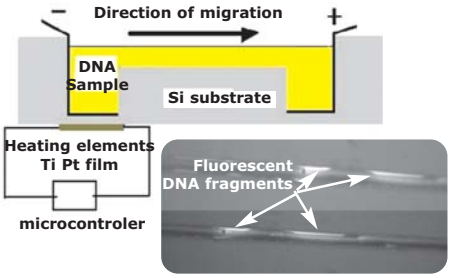
DEVELOPMENT OF NEW COMPLEX TOOLS FOR PROTECTING HEALTH: LABORATORY-ON-A-CHIP SYSTEM (TOOPROLAB)



SEM images of the NE elements on the bottom of reactor system and electrical recording of the neuron transmembranal current

The first objective of this project was the development of a new laboratory-on-a-chip (LOC) device for biomedical studies that consists on a microfluidic system coupled to microelectronic or optical transducers with nanometric features, commonly called biosensors. This device is a hybrid system with sensing element on silicon (Si) chip and microfluidic system on polydimethylsiloxane (PDMS) substrates, taking into account their particular advantages. Different types of nanoelectrode arrays were positioned in the reactor. The experimental structures have been tested for neuronal electrophysiological recording and it was demonstrated their capacity to measure one cell signal. Also, the silicon surface nanostructuration allowed us to perform optical measurements, PL and FL, which revealed the interaction appeared in biohybrid system (biological material / inorganic material). In this way, by bringing together the results from two sets of measurements, optical and electrical, recorded with the same chip, a better understanding of the cell behavior has been achieved. The recorded extracellular potential shows that: at the largest distance between cell and sensitive element is a capacitive coupling and a rectifying inward component appears at further approaching, leading finally to a resistive response.

The second objective of the project was the development of a new silicon micro-bio-chip for rapid testing of DNA material. This chip integrates two classical processes for DNA analysis: polymerase chain reaction – PCR – technique for fragments amplification and electrophoresis for separation of DNA fragments respectively.



Optical fluorescent images of DNA fragments separated along the channel by electrophoresis (straight channels).

CEEX Project (2005-2007);
Coordinator: IMT-Bucharest, Dr. Irina Kleps Irina.kleps@imt.ro;
Partners: InterNET SRL; DEXTER Com SRL; Faculty of Medicine Faculty of Biology, METAV SA; Faculty of Chemistry, Faculty of Physics, INCDFLPR, LABOR&SOFT, ROMES SA;

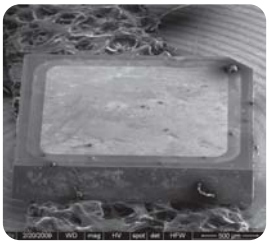
INTEGRATED MICROFLUIDIC SYSTEM FOR ADVANCED IN VITRO BIOCHEMICAL ANALYSIS FOR DIAGNOSTIC AND TREATMENT IN MEDICAL APPLICATIONS (MICRO-DIAG)

Micromixer (bottom)
Microsplitter (top)

The microfluidic device incorporates a sampling, dispensing and delivering system for magnetic marked biomolecules or with intrinsic magnetic properties, and it consists of two main modules. The first module contains: a rotary viscosimeter, for viscosity measurements; microchannels with input and output reservoirs for fluid transport and a microfluidic platform that can trap, measure, manipulate and sort magnetic marked biomolecules in an array of magnetophoretic spin valves. The second module is the detection and measurement magnetoelectronic system consisting of a double Wheatstone bridge with four sensing GMR resistors and four reference shielded GMR resistors. This magnetic microsystem could detect the presence of bioparticles or microbeads. These microdevices enjoy the advantage of being compatible with silicon IC fabrication technology. It is possible to build an array of GMR sensing elements that can simultaneously tests multiple biological molecules. The originality consists of extracting information regarding molecular interactions and rheological properties of the biological non – Newtonian fluids from a single microsystem.

CEEX Project (2005- 2008); Coordinator: IMT-Bucharest, Dr. Marioara Avram, marioara.avram@imt.ro;
Partners: "Politehnica" University of Bucharest, "Transilvania" University of Brasov, ROMES SA, Genetic Lab SRL, Bucharest;

INTEGRATED MICROFLUIDIC SYSTEM FOR ADVANCED IN VITRO BIOCHEMICAL ANALYSIS FOR DIAGNOSTIC AND TREATMENT IN MEDICAL APPLICATIONS (MICRO-DIAG)



SiC sensor diode

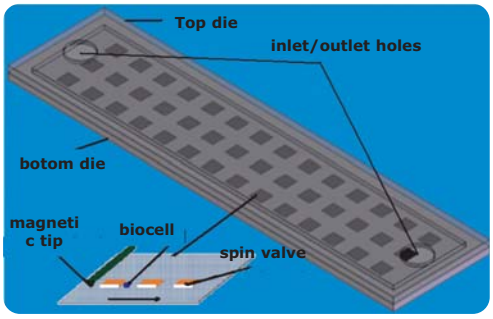
Diamond sensor diode

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.

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.



The design of the microfluidic platform for magnetophoretic blood cells separation

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

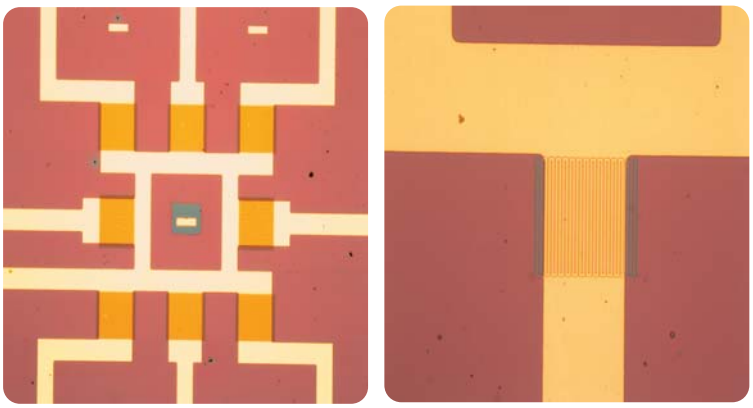
The proposed intelligent microsystem can be used to: immobilize the peripheral nerves inside microchannels; investigate the interactions in supramolecular systems; reveal some new interactions and solve the mechanisms through which these interactions can trigger the behavior of peripheral nerve fascicles (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. 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.

CONTROLLING THE INTERACTION BETWEEN HUMAN AND BACTERIAL CELLS WITH NANOSTRUCTURED SURFACES; STRATEGIES FOR ACHIEVEMENT "INTELLIGENT" BIOSURFACES, NANOINT

The aim of this project is to control the interaction between the human and bacterial cells with nanostructurated surfaces. In order to investigate the cell culture, it was used two different methods (SPR- Surface Plasmon Resonance and impedance measurements), and it was developed a device with submicrons interdigitates electrodes, made in a 100 nm gold film. In the area of the microscale interdigitates electrodes the gold layer is about 40-50 nm in order to make SPR measurements. The areas of the interdigitates electrodes are accessible by the circuits and metal pads in order to make the interface with the measurements devices. The interested elements are 8 areas of the interdigitates electrodes, made in a 50 nm gold layer, deposited on silicon so that there are three size digitates: 1 micrometer, 0.5 micrometer and 0.2 micrometer.


"mix and match" lithography: EBL nanooelectrodes config on SiO_2/Si substrate (general view and detail)

Program CEEX (2006-2008);
Coordinator: International Centre of Biodynamics, Bucharest, Dr. Eugen Gheorghiu, egheorghiu@biodyn.ro;
Contact person for IMT Bucharest: Phys. Florea Craciunoiu, florea.craciunoiu@imt.ro;

SERVICES OFFER AND CONSULTANCE ACTIVITIES:

(i) MICRO- AND NANOSTRUCTURED SILICON FABRICATION

• Fabrication of porous silicon (PS) layers (2-500 mm thickness) on n+ or p+ Si, 4inch diameter.
• Fabrication of meso- and macroporous silicon membrane (thickness 500 μm) on n+ or p+ Si, 4inch diameter.
• Fabrication of Si nanostructured microparticles (2-10 μm with pore/fibrils diameters of 10-50 nm);
• Fabrication of PS multilayered structures with various thicknesses;
• Fabrication of Si nanowires;

Florea Craciunoiu (florea.craciunoiu@imt.ro)

(ii) MICROARRAY BIOCHIPS:

Development of technologies/devices (microarrays, biosensors) for biological material investigation and detection (proteins, DNA, enzymes) on various substrates (silicon, glass, polymers).
• Fundamental research for study of biomelecular recognition reaction;
• Development of applications for medical diagnosis;
• Controlled deposition of biologic material;
• DNA and protein microarrays fabrication according to the user specifications.
• Nanostrutured support surfaces fabrication for microarray chips.
• Chemical surface functionalisation for biological samples immobilisation (DNA, protein, cells);
• Microarray microsystem analysis by fluorescence spectroscopy.

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

(iii) ELECTRICAL/ELECTROCHEMICAL CHARACTERISATION AND APPLICATION DEVELOPMENT

Material characterization; biosensors and electro-chemical sensors development; bio-systems and bio-surfaces analysis.
• 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;
• Development of electrochemical immunosensor devices for clinical diagnostics;
• Detection of compounds/toxins/pathogens for water, food, environmental quality control;
• Biomedical field: implant biocompatibility studies;
• Fundamental studies of physico-chemical phenomena at bio-hybrid interfaces.
Contact person: Dr. Mihaela Miu

(iv) NANOPARTICLE CHARACTERISATION

Zeta Potential and Submicron Particle Size Analysis

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

(v) 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 person: Phys. Mihai Danila (mihai.danila@imt.ro)

INSTRUMENTS AND EQUIPMENTS

Laboratory of Nanotechnology is in charge with the NanoBioLab (Protein Microarrays) equipped with Plotter microarray (GeneMachines OmniGrid Micro) and Scanner microarray (GeneTAC UC4);

In 2008 Laboratory of Nanotechnology has set up other Experimental Laboratories and new equipments were acquisitioned:

(i) Laboratory for Surface Spectroscopy equipped with Electrochemical Impedance Spectrometer PARSTAT 2273–Princeton Applied Research; Scanning Electrochemical Microscop (SECM), VOLTALAB10 and Trace Master 5;

(ii) Laboratory for x-ray diffraction equipped with Rigaku SmartLab X-ray thin film difraction system;

(iii) Laboratory for Nanoparticles equipped with DelsaNano Zeta Potential and Submicron Particle Size Analyzer and 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.

Moreover, we have full access to IMT technological and characterisation facilities.

L2: Laboratory for Microsystems in biomedical and environmental applications

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 during the last 5 years, and is currently involved in seven FP6 projects, both research projects and support actions.

The laboratory is involved in several **national and FP6 projects and networks**.

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,.

The most important **International projects:**
- **INTEGRAMplus** *("Integrated MNT platforms and services – Service Action")* – FP6 IP, IST, 2006 – 2008,
- **TOXICHIP** *("Development of a toxin screening multi-parameter on-line biochip system")* – FP6 STREP, IST, 2006 – 2009; Network of Excellence: **4M** (*"Multi-Material Micro Manufacture: Technologies and Applications"*) – FP6 NMP NoE, 2004 – 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: Claudia Roman; Carmen Moldovan; Bogdan Firtat; Rodica Iosub; Cristina Pachiu; 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 contact person for IMT in **INTEGRAMplus** IP (IST), dealing with technology convergence and integration and virtual design and manufacturing. She is responsible from IMT side in the TOXICHIP project, STREP (IST), for the development of temperature, pH sensors and O2 sensor integrated into a microfluidic platform for toxicity detection. She is 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. She is a member of: **IEEE and Science and Technology Commission of the Romanian Academy** and **NEXUS Steering Committee Member**. The scientific activity is published in more than 55 papers in journals, books and communications in Proceedings.

L2: The most important running projects

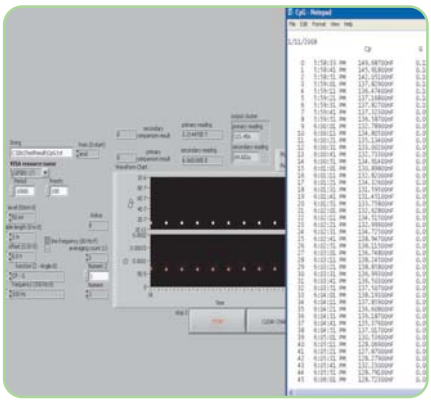
"Integrated MNT platforms and services – Service Action" – INTEGAMplus
(Contract no. 027540).
Project coordinator: Dr. Christopher Pickering, QinetiQ, Malvern, UK.

MICROFLUIDIC PESTICIDE BIOSENSOR

Characteristics:
- The biosensor is based on silicon chip and acetylcholinesterase biomaterial
- The sensitivity of the sensors is in the range of 10^{-9} M- 10^{-6} M
- The sensor is reacting at organophosporus compounds that can be found in food, water, drugs, soil, vegetables, fruits.
- The answer of the sensor is fast and the overall preparation and measuring operation can be done in less of ½ hour.

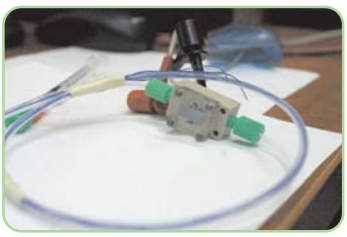
Overview: The biosensor is placed into the microfluidic module which allows the preparation of the sensor by injection of the electrolyte, the introduction of the sample and the electrical signal recording by using 4 spring probes connecting the biosensor pads with the measuring instruments.

IMT has developed the silicon chip, the electrolytes and the specifications for sensor preparation and measuring. The sensor is a consumable one and needs to be removed after every detection step. According to end-users requests, the pH and temperature can be monitored inside the microchannels. A pH and a temperature sensor will be placed close to biosensor side.



Print screen of the Labview interface

The microfluidic module hosting the silicon biochip was developed in partnership with Epigem Ltd., UK.

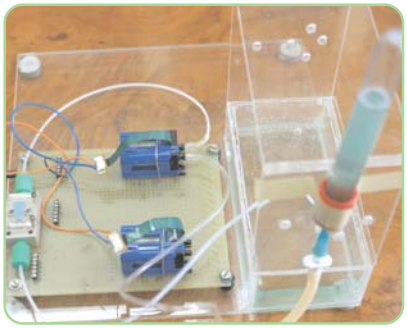


Microfluidic pesticide biosensor

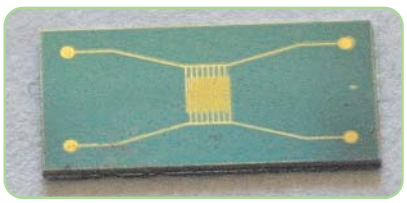
The sensor's measurements were performed using a LabView environment.

The system can be a useful tool for Food Inspection Laboratories (milk, water, juice, etc), Food industry, Pharmaceutical industry, Environment and Agriculture organizations, allowing fast detection, fast replacement of samples, data acquisition and data storage. The system will be low cost, user friendly, precise and efficient.

PESTICIDE BIOSENSOR

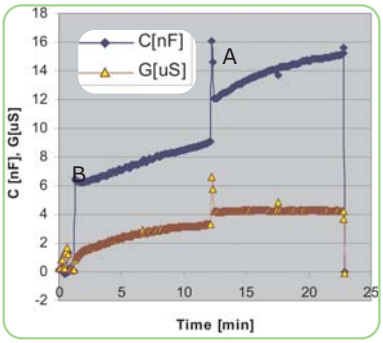


Silicon biochip into the microfluidic module, pumps and reservoirs



The interdigitated silicon chip

The interdigitated electrodes surface is functionalised for biomaterial deposition in oxygen plasma, Plasma Etcher Etchlab 200, than Poly(ethylene glycol)300 (PEG): Ethanol (EtOH) 1:1 solution is deposited by adjustable air-displacement pipette (Gilson) 0,2 μL, as matrix for immobilized enzyme (AChE). The sensor was placed into a fluidic module which contains the electrical connections, injection and/or fluid transport and the reaction chamber with 2,5 μL volume, to ensure the measurements.



Conductance and capacity versus time: A- substrate injection, B – inhibitor injection

The silicon chip is based on interdigitated electrodes, 6mm x12 mm which are deposited with acetylcholinesterase enzyme.

Measurements

The impedimetric acetylcholinesterase (AChE) biosensor allows the detection of the pesticides by the enzyme blocking in the presence of pesticide in the sample near 10^{-6} M.

Example: ***Detection of Dichlorvos.*** Acetylcholine iodide as substrate was injected and a clear and fast increase of the capacity and conductivity has been observed (Figure 3, point A). The evolution of the values was monitored for 10 minutes. Then, it was injected an inhibitor solution, Dichlorvos 10^{-6} M in the same electrolyte solution (point B), which remained in contact with the immobilized enzyme for the next 10 minutes

After the injection of the inhibitor (insecticide Dichlorvos), measured values of the conductivity remained constant while the values of the capacity tend to be stabilized at the end of the measuring period. This demonstrates that the enzyme reaction was blocked by the presence of the studied insecticide.

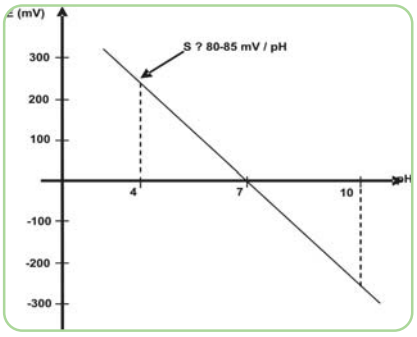
* Results obtained within the FP6 project **INTEGAMplus**
Project coordinator: Dr. Christopher Pickering, QinetiQ, Malvern, UK.
Consortium members: Coventor, France; CSEM, Switzerland; Epigem, UK; IMM, Germany; IMT, Romania; ITE, Poland; Silex, Sweden; ULAN, UK; Yole, France.

EUKARYOTE TOXICHIP PLATFORM

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

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.



pH Measurement

Measurements:

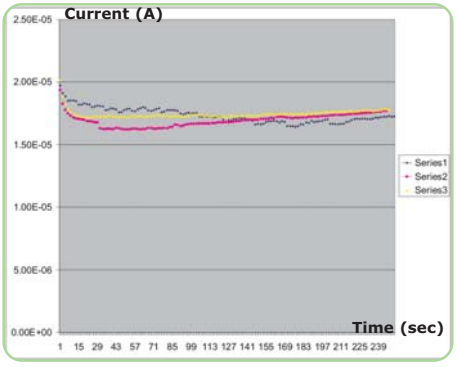
pH Measurement
It is a voltage measurement at zero current. The instrument must to have the input resistance higher as 100MΩ.

Measurement of the diluted O_2

It is a current (I) measurement in the range of μA at a preset voltage of (between -700 and -900mV) applied on the working electrode.

In order to reduce the problem of O_2 consumption during the measurement step, it is very important to define the appropriate duration for measuring (in LabView).

In our experiment we used 6-10 seconds, no more than 10-15sec is recommended. After measurement, the voltage source must be electrical decoupled to avoid any O_2 consumption.

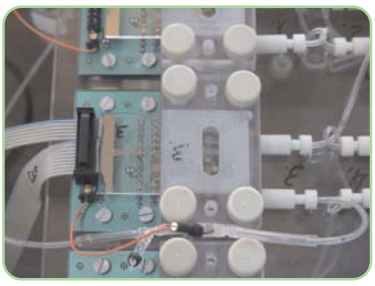


Measurement curves of O_2 - Very High concentration oxygen media (micro Amps range)

The measurement cell answer at O_2 is linear, with the values 0.00μA for CO_2 = 0. From that reason the current initially measured will be considered the current corresponding to saturation of the solution with O_2 (100% at the ambient pressure and temperature, which is corresponding at ~ 8mg O_2 / litter in water).
We are applying -900mV on the working electrode versus the reference electrode. We started with low values of Voltage and we are increasing the voltage value up to the point (-900mV) where the measured current is clearly "measurable" as an indication that the reaction is taking place.

$$½\ O_2 + H_2O + 2e^- \rightarrow 2HO^-$$

It is very important to measure O_2 in short duration steps (up to max 10 sec/ measurement).


Picture of the microfluidic module and sensors


TOXICHIP group at Tyndall, Cork

*** Results** obtained within the FP6 project "Development of a toxin screening multi-parameter on-line biochip system" **– TOXICHIP**
Project coordinator: Dr. Eric Moore, Tyndall National Institute, Cork, Ireland. Consortium members: HUJ, Israel; IMT, Romania; JRC, Italy; TAU, Israel; Scienion, France; Vigicell, France; ISMB, Italy.

L3:Laboratory of micro/nano photonics

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

Mission: Research and development activities in the field of micro/nano-photonics 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 of 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;
- **optical and electrical characterization** of materials and devices;

International co-operation

FP6: Waferbonding and Active Passive Integration Technology (**WAPITI**), STREP, Priority 2 (IST), Thematic area: Optical, opto-electronic, photonic functional components.
Advanced Handling and Assembly in Microtechnology - **ASSEMIC** (2004-2008), Marie Curie Research Training Network;
Multi-Material Micro Manufacture: Technologies and Applications **4M**, NoE – priority 3, NMP;
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;

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

Specific facilities:

Modeling and simulation: Finite-Difference Time-Domain (FDTD) simulation and design software **Opti FDTD 6.0,** waweguide optics design software- **OptiBPM 8.1,** software for design and modelling of of active devices based on semiconductor heterostructures **(Opti-HS);** integrated and fiber optical gratings design software **(OptiGrating);** software for active device simulation (including transport, thermal and optical properties) -**LaserMod**.

Characterization: spectrophotometers for UV-VIS-NIR and IR spectral range; spectroscopic ellipsometer for materials characterization; experimental set-up for optoelectric characterization in UV-VIS-IR spectral range of optoelectronic components and circuits, experimental set-up for characterization of photonic devices Research and High Resolution Raman Spectrometers LabRAM HR.

New: ***Near Field Scanning Optical Microscope*** **Alpha300 S System** is a Scanning Near-field Optical Microscope (SNOM) that combining the characterization methods of SNOM, Confocal Microscopy (CM) and Atomic Force Microscopy (AFM) in a single equipment.
Applications: *imaging* the optical properties of a sample with resolution below the; diffraction limit with applications in nanotechnology, nanophotonics, nanooptics and plasmonics; *materials research*; *single molecule detection*; *life sciences*; *fluorescence characterizations;*

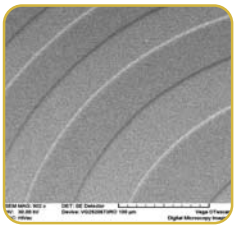
Laboratory Head — Dr. Dana Cristea (dana.cristea@imt.ro)

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 since 2002; since 1990 she was 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.

Development of micro optical devices

- **Fresnel mirrors with 2 and 4 levels** (for the first time in Romania), and minimum feature size 2.4 μm. The chip size is 5x5 mm2, and the lens diameter is 4 mm. The etching depth is 150-160 nm for the 2-level structure (λ/4) and ~80 nm for the second etching step (for 4 level structures). Lenses with focal length of 3, 4, 5, 6 and 7 cm have been obtained for red radiation (630 nm). The structures were processed using optical lithography and reactive ion etching of SiO_2.

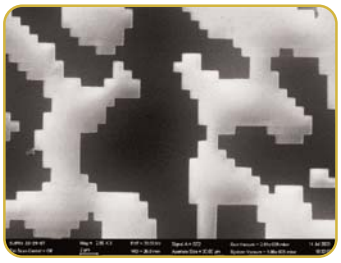


SEM images of Fresnel lens with 2 levels and 4 levels (details)

Reflected light in the focal plane: Fresnel lens with 4 levels

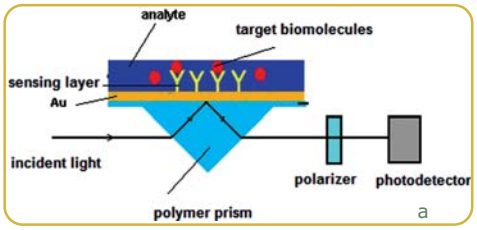
- **Diffractive optical element** for generation of IMT logo was designed using Lith software (Raith) and obtained electron beam lithography in a PMMA layer 160 nm thick (first time in Romania). The pixel size is 1 μm. The size of the DOE is 1x1 mm^2.

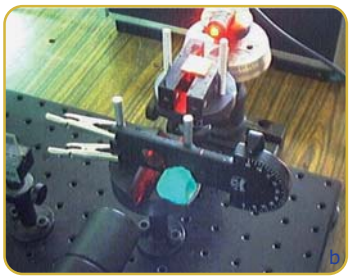
Far field recostruction image

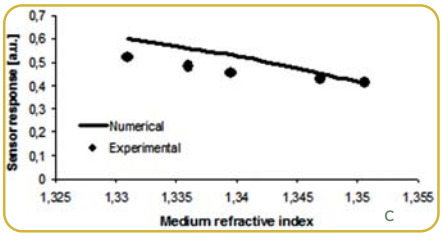


SEM image- detail of the DOE

- **Development of bio-sensing applications based on micro-optical components;** Chemo/biosensors based on Surface Plasmon Resonance (SPR) have been experimented using polimeric microprisms obtained by replication of an original (glass prism). The prism base is covered by a gold layer and a senzitive layer.







a) Sensor structure; b) Image of the characteriation set-up; c) Sensor response (chemical sensing) function on analyte refractive index. The refractive index depends on the concentration. Experimental dots are for an alcool concentration of 5, 10, 20 and 25%

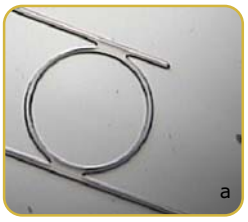
CEEX Project 2006-2008, Micro-optical devices for optical processing;
Co-ordinator: IMT-Bucharest, Project manager: Dr.Dana Cristea (dana.cristea@imt.ro)

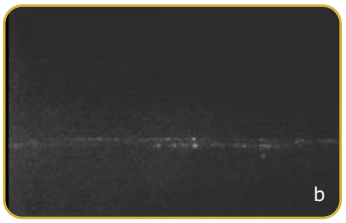
Mixed technologies for microphotonics

- **Development of sol-gel technology for micro/nano photonic applications.**

(Cooperation with Institute of Physical Chemistry "I.G.Murgulescu" of Romanian Academy, Laboratory of Oxide Materials Sciences, Laboratory of Oxide Materials Sciences

The multilayer titania and silica-titania waveguides undoped and doped with $Er3^+$ were prepared by sol-gel technology. This is a flexible and convenient way to prepare oxide films on several types of substrates. Optical waveguides and photonic circuits (microring resonators) were obtained by patterning Er-doped SiO_2-TiO_2 sol-gel layers deposited on oxidized silicon wafers (oxide thickness over 1700nm). Two techniques were used for patterning: wet etching in buffered oxide etch (BOE) solution and reactive ion etching in CF_4. Reactive ion etching offers a better control of the etching process and lower over-etching.

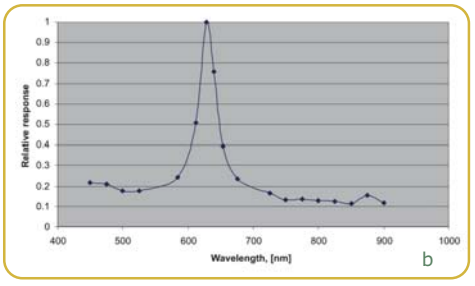




a) SEM image of a TiO_2 ring resonator;
b) IR image of an SiO_2-TiO_2-Er –based waveguide (light propagation λ= 1550 nm).

- **Multilayer structures with controlled optical properties**

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.

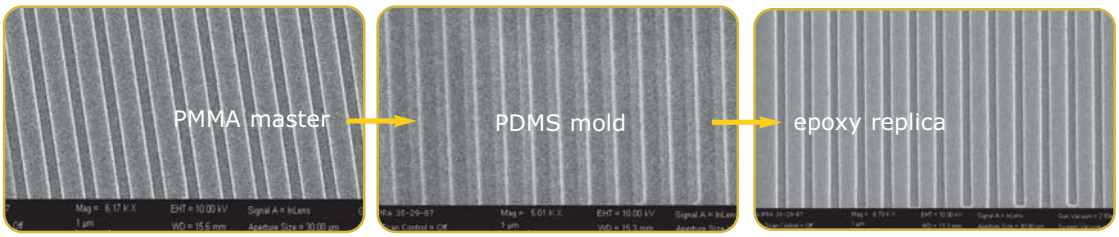


a) Optical microscope image of the structure.
b) Relative spectral response of the structure.

CEEX Project 2005-2008, Development of mixed technologies for micro/nano structures and photonic systems with application in communications.
Co-ordinator: IMT-Bucharest, Project manager: Dr.Dana Cristea (dana.cristea@imt.ro)

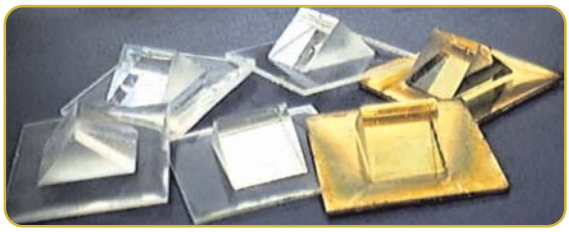
Replication techniques for micro and nano-optical components

•**Development of replica molding techniques for replication of optical elements and microfluidic structures** with feature size in the micron and submicron range.



Diffraction gratings and channels with sub-micron dimensions

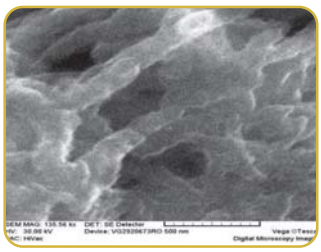
Fresnel lenses (operation in transmision) replicated in PDMS using a SiO_2 master



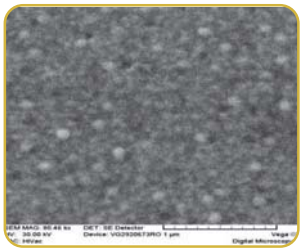
Prisms for SPR sensors obtained in epoxy rewsin using a glass original (master) and a PDMS mold (negative copy).

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

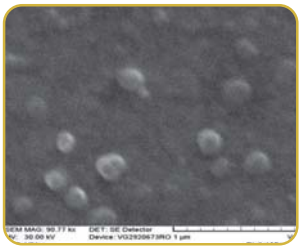
Polyaniline films for sensor applications



SEM image- PANI EB



SEM image- PANI – Ag..



SEM image- PANI – TiO_2

Possible applications: bio-chemical sensors, organic light emitting diodes, electro-mechanical actuators, anti-corrosion coatings, electro-magnetic screens, microwave absorbing material, anti-reflection coating, electro-chromic mirrors and ultra-capacitors.

Co-operation with Politehnica University in CEEX Project 2006-2008; Contact: Paula Obreja (paula.obreja@imt.ro)

Optical properties of nanostructured materials

Numerical and theoretical investigation of nonlinear left – handed metamaterials. The response of a right and left handed metamaterial based on a square array of Mie resonators has been investigated using both analytical and numerical methods (finite difference time domain). A linear metamaterial exhibits a band gap in which the electromagnetic field obeys an evanescent propagation. Due to the dependence of the material constants with respect to the field amplitude, the nonlinear metamaterial exhibits the gap solitons.

CEEX project Module II 2006-2008; Contact person dr. Cristian Kusko

Investigation of passive and active photonic devices with advanced functionalities

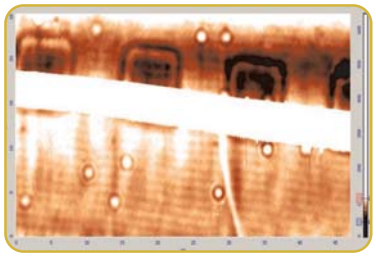
Various active or passive photonic devices based on ring resonator configurations present a variety of applications in optical signal processing, optical communications and sensing. For designing a ring resonator device with a correct functionality a series of analytical and numerical methods (transfer matrix method, 3-dimensional finite different time domain simulations) have been used in order to determine the modal nature, losses, and spectral characteristics of multimode ring resonators with small radius.

MINASIST + project No. PN06240302 (2006-2008), Contact person dr. Cristian Kusko

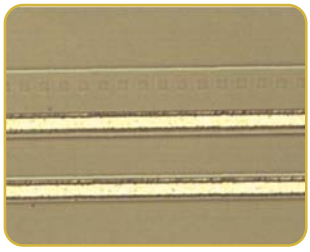
Integrated chip for sensing application

The chip is composed of SU-8 waveguides and Y junctions integrated with silicon photodetectors.
The optical coupling waveguide - photodiode is obtained with a grating realized in the bottom clading of the waveguide (pitch 4 μm). The coupling eficiency depends on the refractive index of the surrounding media.
Applications: chemo and biosensors.

Optical image of the waveguide coupled with the photodiode



AFM image of the coupling region (waveguide placed on the grating)



Optical image: grating etched in SiO_2

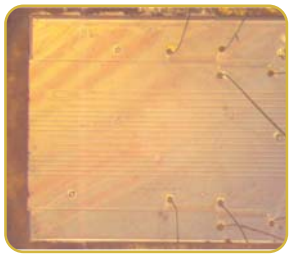


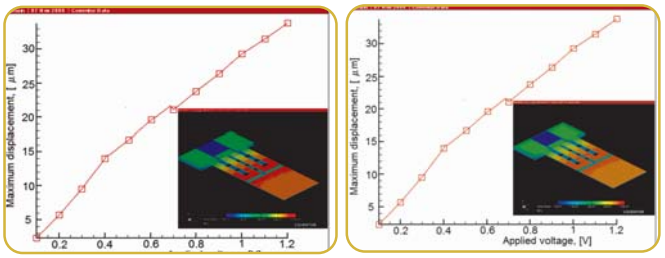
Image of the chip with bondig wires for the photodiode

MINASIST+ PROJECT (2006-2008)
Contact person dr. Dana Cristea (dana.cristea@imt.ro)

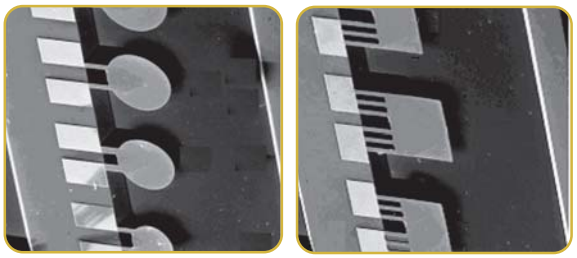
Development of reflective microoptics components on silicon substrates movable micromirrors

Movable micromirrors represents one of optical- MEMS devices which are widely used in different types of applications such as cross connects and switches in optical systems, laser adjustable cavities, miniature scanning devices, communication and sensors applications. Movable micromirrors can be actuated by different means, such as electromagnetic actuation, electrostatic actuation, piezoelectric actuation and thermal actuation based on bimorph layer or a resistance integrated on silicon substrates .

After performing micromirrors simulations using Coventorware software, the micromirrors with different geometry were obtained on on silicon or SOI substrates by wet etching, RIE, thermal oxidation, lithography and metal deposition by vacumm evaporation technique.



Displacement versus applied voltage for micromirror with different geometry on silicon substrate (inside-stress distribution on structures)



SEM image of micromirrors with circular and rectangular geometry obtained on silicon substrates

MINASIST+ project No. PN06240303 (2006-2008):contact person dr. Munizer Purica (munizer.purica@imt.ro)

SERVICES OFFER:

(i) 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.

(ii) Testing the optical properties of samples for the ability to reflect or transmit light by spectrophotometric measurements-transmistance, absorbance spectra [T(λ),A(λ)], surface reflectivity of the texturized and porosified layers.

(iii) 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). - **Contact person: Dr. Munizer Purica (munizer.purica@imt.ro); Florin Comanescu**;

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

(iv) 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.
- **Contact persons: dr. Cristian Kusko (cristian.kusko@imt.ro); dr. Mihai Kusko (mihai.kusko@imt.ro)**

L4: Laboratory of micromachined structures, microwave circuits and devices

The laboratory is one of the promoters of the RF - MEMS topics in Europe and had 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 has successful applied to a FP7 project in the REGPOT 1 /2007 call becaming (together with the microphotonics Lab a "European Centre of Excellence in Microwave, Millimetre Wave and Optical Devices, based on Micro-Electro-Mechanical Systems for Advanced Communication Systems and Sensors".

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 semiconductor (Si, GaAs, GaN) micromachining;
- Acoustic devices (FBARs and SAWs) based on micromachining and nanoprocessing of wide band gap semiconductors (AlN , GaN);
- Micowave devices based on carbon nanotubes;
- Microwave devices using CRLH materials (metamaterials);
- MEMS and NEMS technologies developement;

International projects - FP7 "MIMOMEMS" - FP7 SCA action, IMT coordinator, (2008-2011);
MEMS 4 MMIC Strep (2008-2011) - IMT member.

International bilateral cooperations: The laboratory has bilateral governmental cooperation with University of Pretoria, South Africa.

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 (INFOSOC and RENAR programme) 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 of them with PhD in physics, electronics, microwave and chemistry), 1 early stage researcher (PhD in electronics), one PhD student in physics.

Specific facilities: "On wafer" measurement system in the 0.1 -65 GHz range: microwave network analyzer Anristu in the range 0.04-65 GHz, and Karl SUSS Microtec Probe Station, obtained through a successful CEEX project (Module 4), Keithley Semiconductor characterization system 4200 SCS, Millimeter wave powermeter in 0.1 - 40 GHz range and measurement accessories., software for microwave electromagnetic simulations (IE3D and Fidelity from ZELAND software packages); Vector network analyzer Hewlett Packard 0.1-18 GHz; Süss Microtech EP 4 prober;

Team from left to right: Alina Cismaru; Alexandru Muller; Gheorghe Sajin; Mircea Dragoman; Dan Neculoiu; Cristina Buiculescu; Ioana Petrini; Dan Vasilache;

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;

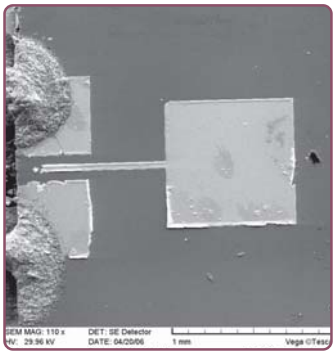
Competences: Silicon, GaAs and GaN micromachining and nanomachining: manufacturing of RF MEMS components and circuits, technological process in GaAs MMICs, design, modeling and manufacuring of microwave passive membrane supported circuits (1997-European priority), micromachined inductors, filters and 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). Dr. Müller has coordinated the European Project FP 4 MEMSWAVE (1998-2001), and was the leader of the Romanian team in the FP6 NoE AMICOM and member of the Board of Directors of this project He is member of Micromechanics Europe Workshop and MEMSWAVE workshop steering committees. He is an expert in project evaluation in the national program Research for Excellence (started in 2005). 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).

Membrane supported GaN FBAR structures obtained by micromachining of high resistivity silicon

GaN membrane supported F-BAR structures were manufactured and characterized. The 2.2 m thin GaN layer was grown using MOCVD techniques, on a high resistivity <111> oriented silicon substrate. Conventional contact lithography, e-gun Ti/Au evaporation and lift-off techniques were used to define top-side metallization of the FBAR structures. Bulk micromachinig techniques were used for the release of the GaN membrane. The bottom side metallization of the micromachined structure was obtained by means of sputtered gold. S-parameter measurements have shown a resonance around 1.2 GHz. Microwave measurements have proved the viability of these types of FBAR structures. The extracted value of acoustic velocity is in good agreement with that reported by other authors on materials fabricated by other methods.



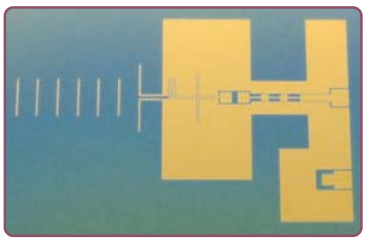
SEM photo (top side) of the GaN membrane supported F-BAR structure. The silver epoxy on the left side is used in order to provide a connection of the ground electrode to the bottom metallization of the FBAR membrane and allow measurements with GSG probes

Achievements: An GaN based resonator on high resistivity <111> silicon substrate for operation around 1.2 GHz has been fabricated using micromachining techniques. Resonator structures of this type can be used as building blocks for the fabrication of high Q and wide bandwidth filters, for use in reconfigurable front-ends of various mobile and wireless applications.

CEEX INFOSOC Project "Integrated RF-MEMS circuits based on silicon, gallium arsenide and wide band gap semiconductors for advanced communication systems - ACOMEMS" (2006-2008)
Co-ordinator IMT-Bucharest, **Project Manager: Dr. A Müller (alexandru.muller@imt.ro)**
Partners: National Institute for Material Physics, "Politehnica " Univ. Bucharest, "Valahia" Univ. Targoviste, "Ovidius" Univ. Constanta, Institute of the Macromolecular Chemistry "Petru Poni", Iasi

77 GHz millimeter wave receiver module based on the hybrid integration of a SiO_2/Si_3N_4 membrane supported Yagi-Uda antenna with GaAs Schottky detector diode

The membrane supported millimeter wave receiver operating in the 60 GHz frequency range was and characterized. The receiver structure is based on the hybrid integration of a Yagi-Uda antenna with a Schottky diode, the antenna having as support a 1.5 μm thin SiO_2/Si_3N_4 dielectric membrane. The fabrication processes is based on silicon micromachining. The experimental characterization of the Yagi-Uda antenna receiver was performed using a measuring set-up designed and realized in the laboratory.



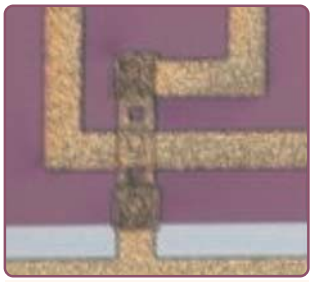
Optical photo of the 77 GHz receiver structure micro-machined on SiO_2/ Si_3N_4 membrane

Achievements: Design, modeling and manufacturing of 77 GHz silicon micromachined receiver structures. The design procedure, the technological processing and characterization techniques open a window of opportunity for the development of innovative architectures for circuits and systems operating at higher frequency, up to the sub-millimetre wave frequency range.

CEEX INFOSOC Project "Integrated RF-MEMS circuits based on silicon, gallium arsenide and wide band gap semiconductors for advanced communication systems - ACOMEMS" (2005-2008)
Co-ordinator, IMT-Bucharest, Project Manager: Dr. A Müller (alexandru.muller@imt.ro)
Partners: National Institute for Material Physics, "Politehnica " Univ. Bucharest, "Valahia" Univ. Targoviste, "Ovidius" Univ. Constanta, Institute of the Macromolecular Chemistry "Petru Poni", Iasi.

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- - technological experiments

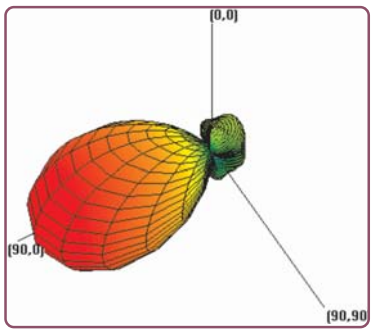
The band pass filters includes resistive switch for standard selection and complex L-C structures suspended on micromachined dielectric membrane and also on the bulk. The switches will modify the values of L-C components. 1.5 μm thick $SiO_2/Si_3N_4/SiO_2$ membranes were obtained by micromachining of <100> high resistivity silicon. Experiments for spiral inductors and interdigitated capacitors suspended on membrane were performed. The first technological experiments deals with obtaining air bridges of the membrane supported spiral inductors. Achievements: Modeling, electromagnetic simmulations of band pass filter and technological experiments for LC membrane supported components.



Detail of the air bridge of the membrane supported spiral inductor

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

Modelling of the monolithically integrated receiver on GaAs to be used as MMID TAG



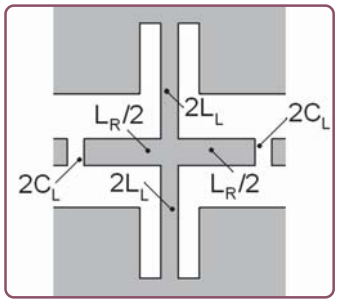
Simmulated radiation pattern for the membrane supported Yagi-Uda antenna from the receiver

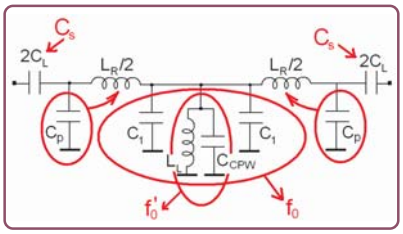
The receiver is modeled and designed considering components supported on membrane, on bulk GaAs and on the transition region. Yagi-Uda antenna monolithically integrated with the Schottky diode is suspended on the micromachined membrane and the band pass filter is on the bulk region. IE3D electromagnetic simulator from Zeland Ltd. was used in design of the membrane supported components.

Achievements: Modeling and design of the monolithically integrated rceiver module from the TAG

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.

Modeling CLRH structures and devices in the milimetric waves domain.





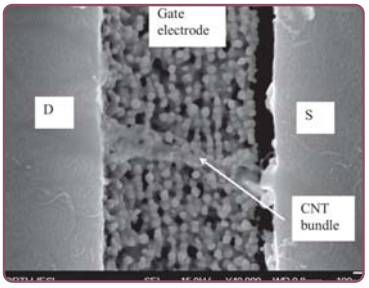
Lay-out of a CRLH structure and it's equivalent circuit.

CRLH (Composite Right-Left-Handed) lines are artificial lines, namely circuits made with concentrated and / or distributed inductors and capacitors. The CRLH balanced line is used to made directional couplers, leaky-wave antennas, pass band filters and non-linear.
In this respect was elaborated a methodology for modeling the millimeter wave propagation through CRLH structures.

Achievements: modeling of the capacitors and inductors in CRLH approach for millimeter waves in CPW (CoPlanar Waveguide) configuration assuring the compatibility with MMIC.

PN II Partnership Prj: Millimeter wave devices on metamaterials microprocessed by laser ablation-METALASER (2007-2010), **Co-ordinator, IMT Bucharest. Project Manager: Dr. Gheorghe Ioan Sajin-(gheorghe.sajin@imt.ro);**
Partners: INCDIE ICPE CA Bucharest; "Politehnica" University Bucharest, INCD-FLPR Bucharest.

Nanoelectronics based carbon nanotubes



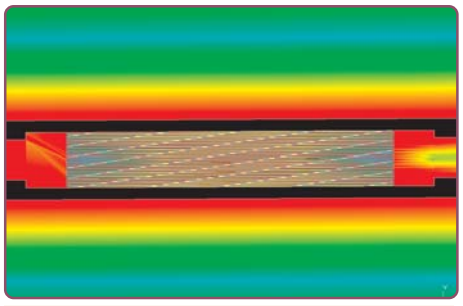
A FET-like configuration based CNT.

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 of a CNT bundle over a dielectric trench.

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


Current distribution at 10 GHz for interdigital structure on Si with (L =1 μm) and a CNT-DNA thin film of 200 nm (red coulour is asigned to the most intense propagated power.

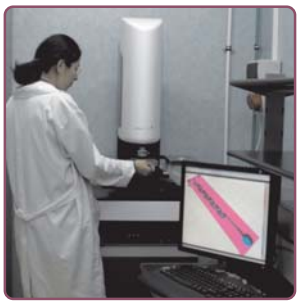
The aims of the first research step of the project finalized at the end of February 2009 were to identify the solutions to functionalize CNT with DNA and design of the test structures for detection of CNTs functionalized with DNA.

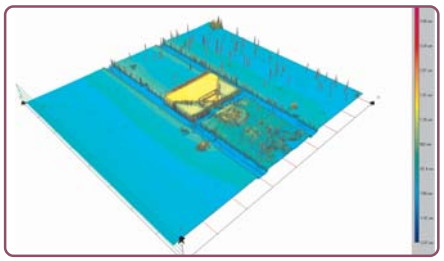
Achievements: The simulation of electromagnetic test structures to sense CNT functionalized with DNA.

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

Acquisition and installing of FOGALE Pilot 3D while light interferometer

The white light interferometer is an equipment that perform optical, non-contact profiling of rough surfaces, that uses interferometric techniques as well as digital signal processing algorithms produce fast, accurate, repeatable three-dimensional surface profile measurements. When combined with more traditional phase-shifting measurement techniques, this produces an instrument capable of profiling surfaces with roughness ranging from 1Å to 20 µm, and measurement steps up to 2mm

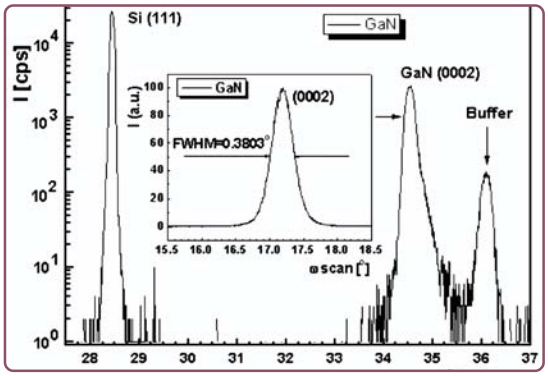




The instaled white light interferometer and a resulting 3D image of a membrane supported Schottky diode

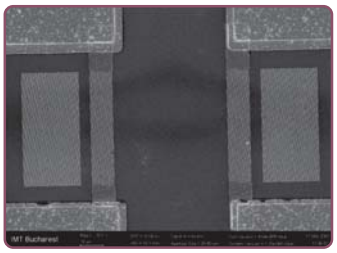
PN II Capacities Project "System of microphysical and millimeter wave characterization of components and circuits for advanced communications SIMMCA" (2007-209)
Co-ordinator, IMT-Bucharest, **Project Manager: Dr. Alexandru Müller** (alexandru.muller@imt.ro)

LATE NEWS: Recently first acoustic devices operating at frequencies higher then 4 GHz, based on GaN/Si processing developed for the first time in the world by IMT- Bucharest in cooperation with FORTH Heraklion

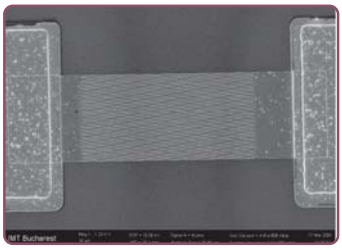


XRD analysis of the FBAR structures manufactured on GaN/Si wafers. The inset presents the rocking curve of the GaN layer

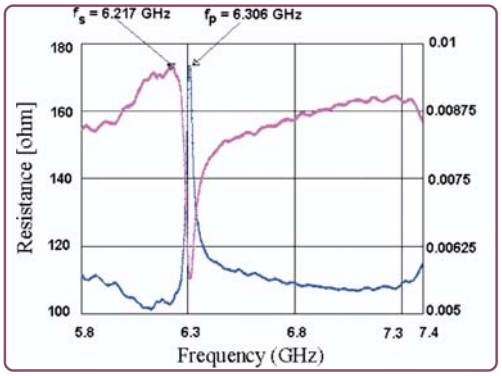
Optical photo of the series connection of the FBAR structures (a) top view top illumination; (b) top view bottom illumination



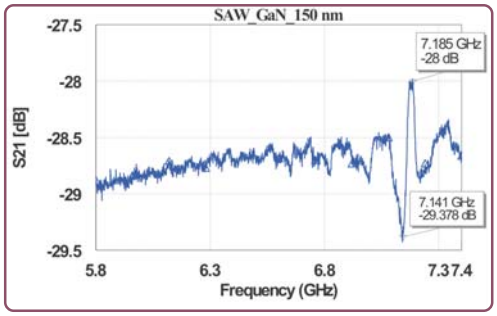
Face to face SAW resonators structures with 150nm fingers



Series connection of SAW structures with 250nm fingers and interdigits



Resistance and conductance of the FBAR series connection structure manufactured on the 0.54µm thin GaN membrane, resulted from the S parameter measurements. Series and parallel resonance frequencies were determined from these curves



Transmission between two SAW IDTs spaced at 50 µm. The structures have IDT with fingers and interdigits of 150 nm and have no reflectors

DISSEMINATION

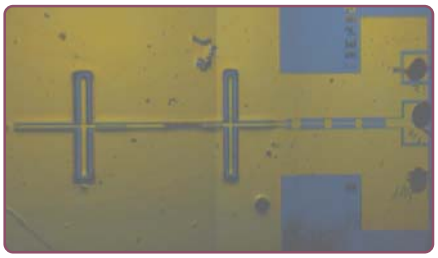
The volume **"Recent developments in MEMS technologies for microwave and millimeter waves circuits"** - editors L Pradell, L Jofre, (Universitat Politenica de Catalunya), A. Müller (IMT), D. Dascalu (IMT), R Plana (LAAS Toulouse) - was launched at Fodele in July 2008, during the **9th edition of the International Conference on RF MEMS "MEMSWAVE".** The volume was printed in the **Micro and Nanoengineering Series** coordinated by Prof Dan Dascalu and was edited by the Romanian Academy Press. The volume contains the extended papers of the 8th MEMSWAVE Conference, Barcelona, 2007. The international MEMSWAVE conference was generated by IMT Bucharest in 1999, in the frame of the MEMSWAVE project.

L4 - FP7 projects

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

Project No 202897 financed (2008-2011) through the "Regional potential" part (REGPOT call 2007-1) of the European Framework Pogramme (FP7), starting date May 2008 (**www.imt.ro/mimomems**).

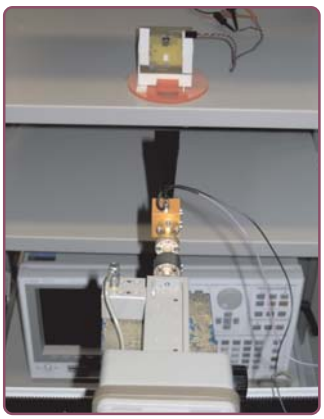
Co-ordinator: **Dr. Alexandru Muller**, **alexandru.muller@imt.ro**



The optical photo of the fabricated receiver structure

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 Microwave, Millimetre Wave and Optical Devices, based on Micro-Electro-Mechanical Systems (MEMS) for Advanced Communication Systems and Sensors.

The main objectives of the MIMOMES project are:
- "Exchange of know-how and experience". This activity will be done by twinning with two research centres: a) LAAS-CNRS in Toulouse which has strong expertise in silicon based RF and millimetre wave microsystems, photonic devices, and circuits manufacturing and characterization, and b) FORTH-IESL-MRG in Heraklion which has excellent knowledge of IIIVs (GaAs and related semiconductors) and wideband gap semiconductor processing (GaN, AlN).



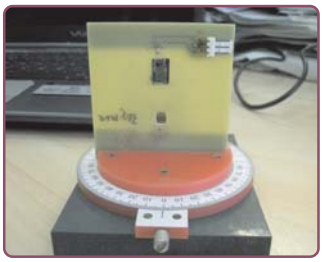


Photo of the experimental set-up and detail

The first experimental "test vehicle" was a GaAs monolithic integrated micromachined receiver module for 60 GHz with double folded slot antenna, technological developed together with FORTH - IESL - MRG and measured together with LAAS Toulouse and VTT Finland.

The GaAs monolithic integrated micromachined receiver module was processed at FORTH-IESL-MRG by IMT together with FORTH-IESL-MRG scientists. The design was performed by IMT and the microwave characterization was performed together with LAAS Toulouse and VTT Finland.
- **"Recruitment of incoming experienced researchers"** will allow IMT to hire 2 Post-Doctoral researchers with expertise in nanophotonics and microwave millimetre wave devices, and MEMS for advanced communication systems and sensors The researchers will be initially hired for 20 month fellowships with 6 monthly reviews. At the end of the period, the researchers will have the possibility to become full time IMT employees. An announcement regarding the hire intention for 2 postdocs was posted on the website of the project..
- "Acquisition, development or upgrading of research equipment" 50% of the total funding of the project is dedicated to this objective: ♦ Near field scanning optical microscope (SNOM): Acquisition finished in August 2008, delivered in October 2008. It was installed at IMT Minafab Facility and is fully operational; ♦ Upgrade to 110GHz the 1-65 GHz set-up for "on wafer" characterization: Acquisition finished in December 2008. It will be installed in April 2009; ♦ Frequency synthesiser up to 65GHz-110 GHz. Acquisition finished in December 2008. It will be installed in April 2009; ♦ Au plating facility for semiconductor wafers will be purchased in 2009. 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 the first International Scientific Session at the CAS Conference 2008 (13-15 October 2008): 3 oral sessions and 1 poster session with invited lecturers: G. Konstantinidis (FORTH Heraklion); T. Vähä Heikkilä (VTT Helsinki)
- **"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"). Connected to the MIMOMEMS project a proposal for the 2nd Space Call in FP7program was submitted: the STREP "MIcrowave Nitride nOvel Technologies for Advanced tUnable and RecOnfigurable Satellites - **MINOTAUROS**" The consortium is composed of 7 partners from 5 European countries; Project leader: Thales Alenia Space (Toulouse-France), a leading actor in the space industry. Members in the consortium: LAAS CNRS (France), IMT-Bucharest (Romania), FORTH Herakion(Greece) FEMTO ST (France) EPFL (Switzerland), Azurro (Germany). We are waiting for the evaluation result.

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

STREP project financed (2008-2010) 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*.

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

L5: Simulation, Modelling and Computer Aided Design Laboratory

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, being also involved in European and national research projects.

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**

Others expertise of the lab's members include: elastomer based microstructures; optical processing and storage of information; micro-systems applications in the field of energy; manufacturing and characterization of materilas for advanced nanoelectronic devices based on oxidic materials; techiques of chracterizations as cathodoluminescence and photoluminecence

Research Team: The team has a multidisciplinary expertise in: mathematics, physics, electronic and mechanics 4 PhD, 3 physicists, 2 engineers (mechanical and electrotechnical), 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** with 8 quad-core Intel Xeon MP 2.93 GHz processors, 196 GByte RAM and 1 TByte HDD + 876 GByte external storage; • Computer network used for training

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

International networks and projects:

Partner in international FP6 Projects:

- **MI-Lab on chip**- "Lab-on-a-chip implementation of production processes for new molecular imaging agents- STREP (2005-2008), NMP-No 516984; coordinator University of Liege, Belgium
- **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
- **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" ComEd (2008-2010); Coordinator BWAW Thüringen GmbH, Germany, Contract No: DE/08/LLP-LdV/TO/147174 (2008-2010)

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 dedicated software tools: COVENTOR 2008 and ANSYS;
- Mask Design, Process Editor, 3D building and mesh;
- Modeling for technological processes/ optimizations;
- **Computer Aided Engineering and Analysis (using FEM, FVM, BEM tools)**;
- **Microfluidics analysis; Electro-thermo-mechanical and piezoelectric analysis**; **Coupled field simulations**: thermo-electro-mechanical;

Team from left to right:
Rodica Voicu; Victor Moagar-Poladian; Oana Nedelcu; Catalin Tibeica; Florina Ravariu; Gabriel Moagar-Poladian; Rodica Plugaru; Irina Codreanu

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 with ICCE Bucharest; since 1994 she is with IMT Bucharest. Currently R. Müller is **Head of Scientific Services Department and Coordinator of the Simulation, Modelling and Computer Aided Design Laboratory**.

Her main scientific interests include design and technological processes for sensor 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 is coordinator of several national research projects and scientist in charge from IMT - Bucharest in international projects as: *FP 6: 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 70 scientific papers presented at conferences and published in journals (Sensor & Actuators, J. of Micromechanics and Microengineering, Appl.Optics., Journal of Luminescence etc).

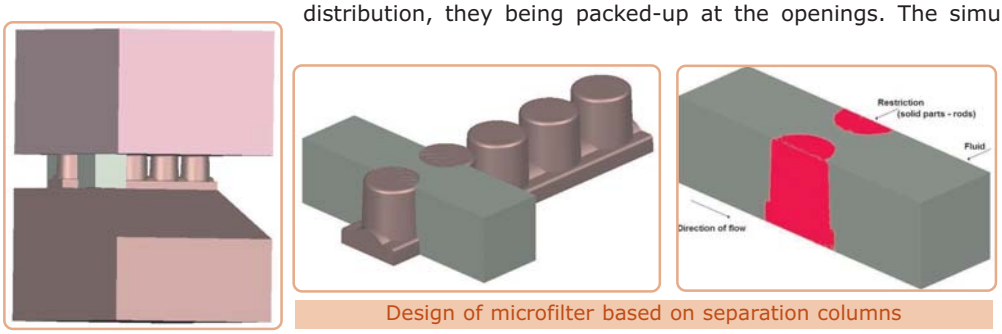
L5: Participation in FP6 projects

Implementation of Production Processes for New Molecular Imaging Agents
MI-lab on chip-Lab-On-A-Chip

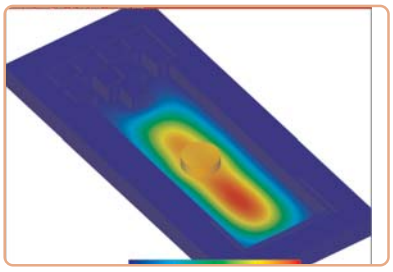
STREP-FP6**,** Priority 3 **NMP,** No 516984, (2005-2008)

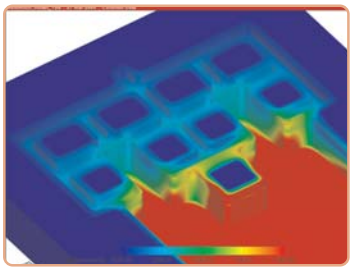
Coordinator: ***University of Liege, Belgium.*** **Partners:** Trasis S.A. Belgium, Bartels Mikrotechnik GmbH Germany, IMT- Bucharest Romania; GG.Tec injection Belgium, Universite Henri Poincare–Nancy France.
IMT- Bucharest (contact person: ***Oana Nedelcu- oana.nedelcu@imt.ro***)

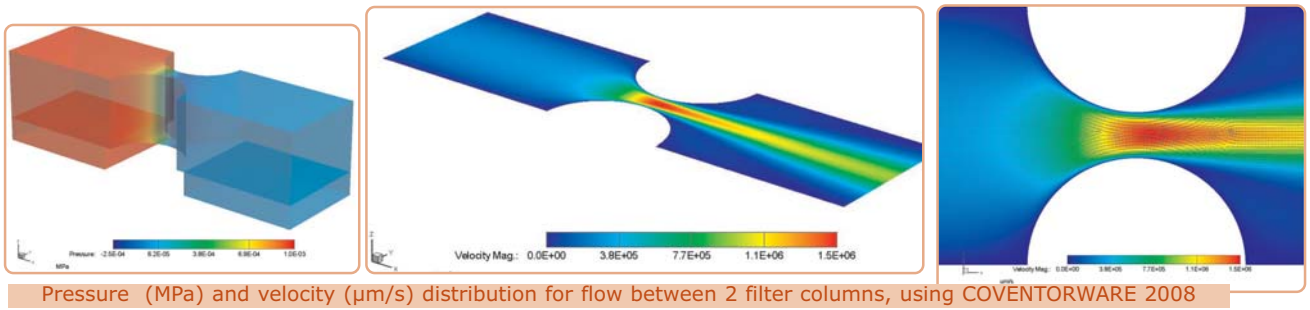
Results: Filter Simulation and Implementation of the filters into the chip - The objective of this work was to design and simulate the filtering system that is required for chemical processing flow into the chip. The filters have to retain the particles of solid phase in the cavity, but still keeping the liquids flow as freely as possible through the solid phase. Also, studies on possible ways to implement the filters into the chip were carried out.
The concept to implement the filter uses a narrow slit rather than any other method involving the structuring of the foils (which require more sophisticated production methods). The different designs that were studied rely upon a series of slits wider than the average diameter of the beads (50 to 70μm). The slits keep the beads in place due to their size distribution, they being packed-up at the openings. The simulations were performed for pressure drop in the range of 5-50 kPa. A problem to be solved was the bulging of the plates due to the pressure in the cavities, which could cause the slit located at each end of the cavity to widen and therefore making possible leakage out of solid phase.



Design of microfilter based on separation columns


Simulation of displacements (bulging) due to internal pressure- view from the bottom size


Displacements distribution: a detailed view on the channel



Pressure (MPa) and velocity (μm/s) distribution for flow between 2 filter columns, using COVENTORWARE 2008

Improvement of Industrial Production Integrating Macro-, Micro- and Nanotechnologies
IPMANN

Project coordinator: **Christian Woegerer- PROFACTOR Research and Solutions GmbH, Austria**
IMT-Bucharest partener, contact person Dr. Raluca Müller (raluca.muller@imt.ro);
FP6 NMP2-CT2006-033205; (2006-2009)

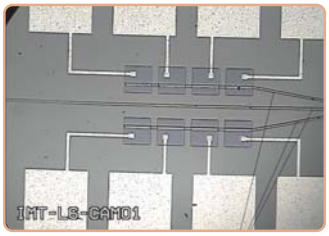
Results: Coordination of Disseminarion Workpackage.
Active participation with scientific talks at different IPMMAN/MINAM sections within EU events:
• **SEMINAR on Micro- and Nanotechnologies for Industrial Applications** - organized by MINAM Platform and the ISQ - Instituto de Soldadura, Lisbon, Portugal- March 2008
• **MINAM Special Section** at The **7-th The Coating's** and **the 3-rd ICMEN** International Conference on Manufacturing Engeneering, organized by the Laboratory for Machine Tools and Manufacturing Engineering - Aristoteles University of Thessaloniki- EEDM, Greece, October 2008
• **MANUFACTURING 2008 Conference**, Budapest, Hungary- November 2008
• Contributions to **MINAM Newsletters-MNT Future Vision**.

Sensors and actuators microstructures for microrobotic pozitioning, mechanical and biological manipulation - MEMSAS

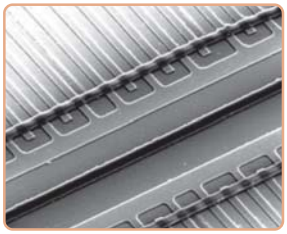
MEMSAS (2005-2008); Project type: CEEX – Contract No. 28/2005- INFOSOC;
Project coordinator: IMT Bucharest; **Project manager: Dr. Raluca Müller (raluca.muller@imt.ro);**
Partners: INCD-SB, INCD-FLPR, Univ. "Politechnica" Bucharest, Univ. "Valahia" Targoviste

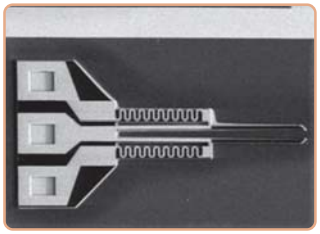
The project scope was to develop two kinds of microstructures, using microelectronic and MEMS technologies: optical position sensors, based on different configurations and thermo-actuated microgrippers, using surface micromachining techniques.

Results: An original configuration was proposed for a microsensor which can function as positioning sensor for detecting the position of an object placed on his axis in 0-300 μm domain and as proximity sensor. In the second case it can find out the presence of very small objects, in a predefined area, without measuring the distance between the sensor and the object.

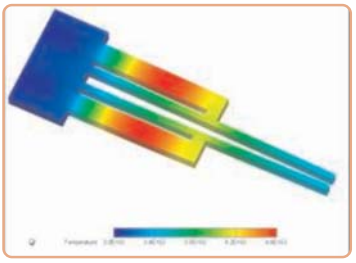


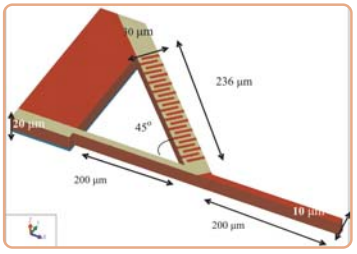
Optical microscope image of the linear photodetector arrays integrated with SU8 optical waveguides.


Detail of the MSM photodiode (interdigitated structure integrated with the SU-8 optical guide).


SEM image of the metallic (Cr-Au) resistance of the microgripper

These constructions were composed of two different types of photodetectors: PIN photodiodes and Schottky (MSM) photodiodes both integrated with SU-8 optical waveguides. The optoelectric characterization of the photodiodes has shown a breakdown voltage greater than 90V at 100μA and a dark current less than 0.02 nA at 5 V reverse bias. The device has a very good rectifying characteristic with low absolute leakage current. A responsivity of 0.39A/W for of 630nm wavelength and 20V bias was obtained.


Maximal values of the temperatures in the microgripper when a voltage of 0.25 V is applied-simulation with CoventorWare tool



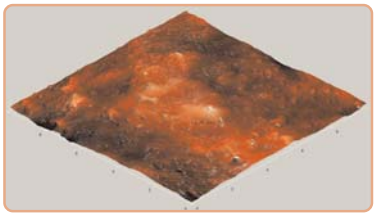
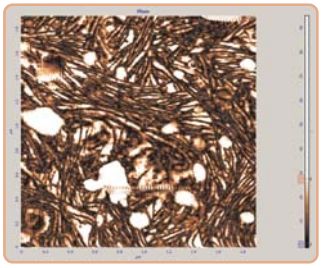
Design of the half of microgripper model without the SU-8 layer on the 0.25 V is applied - simulation with CoventorWare tool (Rodica Voicu – PhD student)

A new design was developed for a **polymeric microgripper**, which can realize a movement of the gripping arms with possibility for positioning and manipulating of the gripped object. Two models of the microgripper, electro-thermo-mechanical actuated, using low actuation voltages, designed for SU-8 polymer fabrication were investigated and compared. Finite-element analyses (**FEM**), using **COVENTOR-WARE 2008** tool, were performed in order to evaluate the relation between the displacement, temperatures and the electrical current passing through the metallic layers. Different thickness of the polymeric layers was considered in order to evaluate the minimum out of plane displacements that can occur in the behaviour of the microgripper. The choice of biocompatible materials, as SU-8, together with the low actuation voltages and large deflection produced at low temperatures, makes this microgripper highly suitable for bio-manipulation experiments in air or in aqueous media. Other potential applications of these devices are micro-relays, assembling and miniature medical instrumentation.

Unconventional Materials for Microtechnology – Research and Experimentation of Elastomer Based Microstructures for Applications in the field of Microsystems

NOELSYS (2005-2008); Project Type: CEEX 15 I 03 / 2005 INFOSOC; Coordinator IMT-Bucharest; Project manager: Dr.Gabriel Moagar-Poladian (gabriel.moagar@imt.ro); Partners: S.C. ICEMENERG S.A., Univ. Bucharest, S.C. IPEE-ATI S.A., S.C. ProOptica S.A., S.C. Optoelectronica – 2001 S.A.

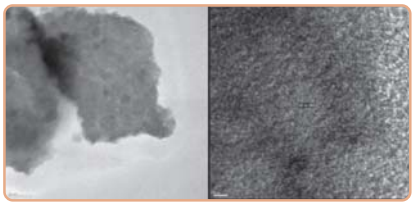
Results: Deposition of elastomeric thin films (policloroprenic, butilic and butadien-styrenic rubbers) with very good adherence to surface and good surface topography. Nano-crystallization of the film as a consequence of its thermal annealing was observed. Extensive characterization of the deposited films, as regards surface topography, structure, spectral properties (by FTIR method) and internal mechanical stress. An improved type of infrared sensor was conceived and will be registered at OSIM. An original method of stress determination in the elastomeric thin film was tested experimentally and compared to measurements made by other means (optical polarimetry). The internal mechanical stress is less than 3,7 kPa. Papers presented at conferences and sent to publication.



AFM images of the elastomer thin film. a) on a 10 μm x 10 μm scale; b) phase image on a 2 μm x 2 μm scale, a different location.

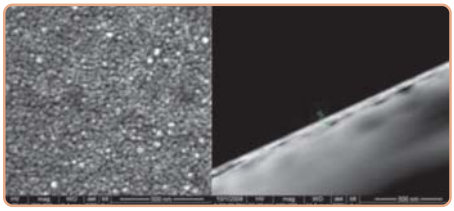
NATIONAL PROJECTS

Electronic Nanodevices Based on Oxidic Materials

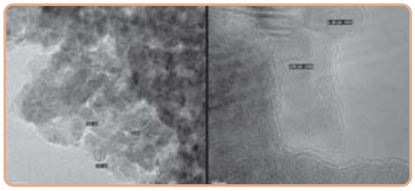
NANOXI (2007-2010); Project Type: PNII- Contract Nr. 11-048; **Coordinator IMT- Bucharest;**
Project manager: Dr. Rodica Plugaru (rodica.plugaru@imt.ro); **Partners:** University Politehnica of Bucharest (UPB-Bucharest), Institute of Physical Chemistry "I.G. Murgulescu" Romanian Academy, National Research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



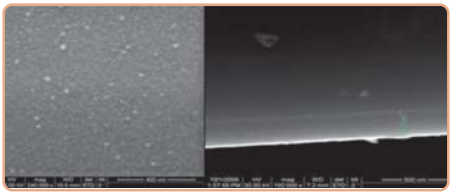
HR-TEM images of ZnO thin film deposited by RF magnetron sputtering from ZnO target. The grains size is less than 50 nm, with (002) oriented nanocrystallites and wurtzite structure.



SEM surface and cross section images of the ZnO (Zn 0,05 M 1) film, formed by 4 successive sol-gel deposited films, annealed in air at 500°C, 1h.



Bright Field HR-TEM images of ZnO thin film deposited by DC magnetron sputtering from Zn target and further oxidized in air at a temperature of 450°C for 3h. The nano-crystallites size is less than 20nm, are (100) and (002) oriented, and their structure is wurtzite.



SEM surface and cross section images of the ZnO (Zn 0,05 M 1) film, formed by 4 successive sol-gel deposited films, annealed in air at 500°C, 1h.

Results:

• **Experimental studies** on thin films semiconductor oxides deposition by sol-gel and DC/RF magnetron sputtering methods, for advanced optoelectronic and magnetic devices. Characterization of morphology, thickness, grains size, texture, structure, refractive index, transmittance, extinction coefficient, fluorescence properties and elemental composition.
1. Sn-Zn-O (Sn/Zn=1) thin films obtained by sol-gel route;
2. ZnO thin films and ZnO:Al doped thin films obtained by sol-gel route;
3. ZnO thin films deposited using DC and RF magnetron sputtering from Zn and ZnO targets;

• **Tunnelling leakage current characterization** of silicon oxide and high-k dielectrics for advanced semiconductor devices. Numerical simulations were performed using ATLAS devices simulator software package from Silvaco. An iterative approximate method was used to calculate the 1D MOS structures main electric parameters without using the Schrödinger-Poisson equations. This method is based on approximation of effective field function of doping parameters. The tunnelling currents can be calculated more rapidly and the study for different gate dielectric stacks can be made.

• **Ab initio study of electronic structure of semiconducting oxides**. Modelling of defects influence on localized states. Ab initio calculations were performed using the FPLO code in order to explore the electronic structure of semiconductor oxides for advanced opto- and magneto-electronic devices. The oxygen deficiency in these materials may be used to tune the material optical and magnetical properties. The computational study was devoted to understand the effect of oxygen vacancies (OVs) on the electronic structure of rutile and anatase TiO_2. Various OVs concentrations and distributions in the supercell permitted to determine the vacancy-induced states localization and structure, the effect of vacancy concentration on the orbital occupation numbers, as well as the vacancy energetics. The present results, reflect the real material behavior.

Unit of Analog Optical Processing of Image Type Information

PROIMAGE (2006-2008), Project Type: CEEX 139 I 03 / 2006 INFOSOC;
Coordinator IMT- Bucharest; Project manager: Dr.Gabriel Moagar-Poladian (gabriel.moagar@imt.ro);
Partners: Univ. Bucharest, S.C. Optoelectronica – 2001 S.A., S.C. RD Concept S.R.L.

Results:
a) The architecture of an analog optical processor was conceived.
b) The emulation software was tested for applications in the field of radiology.
c) Several papers were conceived and are under preparation.

Applications of high technologies based on microsystems and nonlinear optics for the measurement of the electric current parameters on the high voltage lines

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

We have devised several methods for exciting microsystems used for measuring the electric current parameters on high voltage lines. Because these microsystems work in very harsh conditions, the reading of their displacement is made optically. We have devised several optical methods that can be suited for this purpose. A new method, based on advanced materials, was conceived for the voltage measurement. The method is now subjected to patenting at OSIM.

Micro-welding systems for microsensors and actuators for micro-joining of circuit elements and packaging

MICROWELD (2007-2008); Project Type: PN II Project.
Coordinator ISIM, IMT-Bucharest partner,
Contact person: Eng. Phys. Victor Moagar-Poladian (victor.moagar@imt.ro)

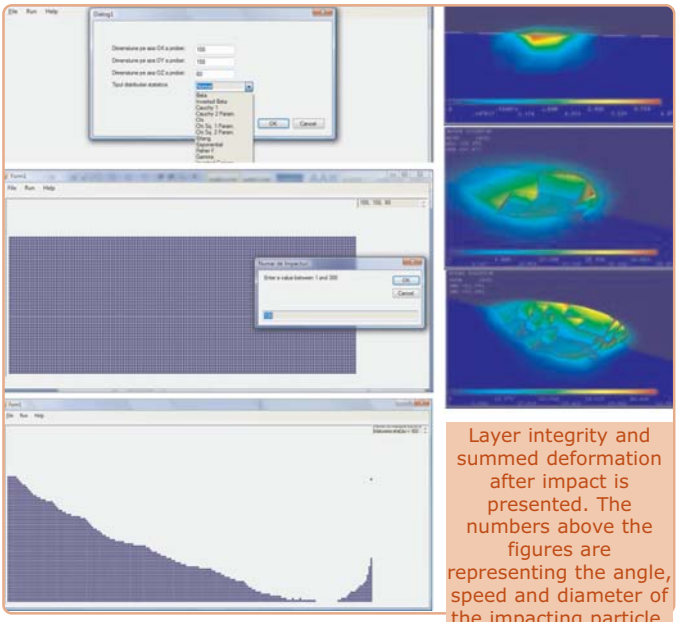
Results: The aim of the project is the development of the knowledge in the field of technologies dedicated to micro-assembling of MEMS components by developing 3 methods of micro-joining of metallic and non-metallic materials that are commonly used in MEMS devices. These welding procedures will respect either one of the following conditions: - to realize a good electrical contact between different components of MEMS; - to enable a good sealing for MEMS devices. *IMT-Bucharest role in the project is the design and simulation of the behavior of the micro-welded components under exploitation conditions and the characterization of the quality and the properties of the welding.*

New materials having high anti-corrosive performance with applications across different domains for the use environtments presenting complex and severe loads

INTERMAT (2006-2008); Project Type: CEEX Project;
Coordinator ICEMENERG, IMT-Bucharest partner,
Contact person: Eng. Phys. Victor Moagar-Poladian (victor.moagar@imt.ro)

Results: The project has as expected result the fabrication of new protection materials that have to eliminate the disadvantages of the present protection materials, namely: limited or specialized domains usefulness, toxicity, high number of different types of layers needed to provide enough resilience to aggressive environment. These new materials will have an use in industrial fields by providing protection against harsh environments (high temperature, aggressive chemical agents, abrasion, thermal and mechanical shocks, etc.).

The role of IMT-Bucharest in this project is to provide simulations regarding the protective layer behaviour in contact with different types of aggressive agents. Due to the complexity of the problem, the software used was ANSYS Multiphysics 11.0. The results of several cases of impacts simulated in ANSYS for the previous year were the input for the a home made software, based on Monte Carlo simulation, in order to achieve the protective layer state.



Layer integrity and summed deformation after impact is presented. The numbers above the figures are representing the angle, speed and diameter of the impacting particle.

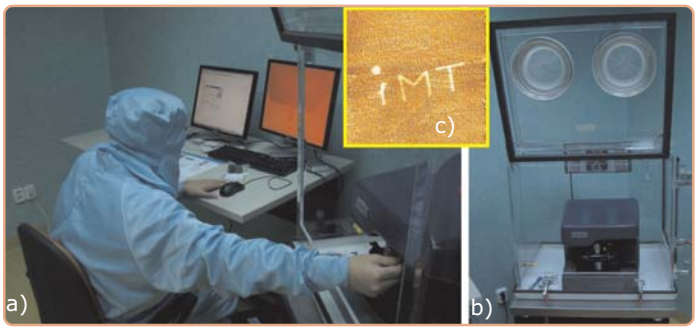
Home made Monte Carlo simulation software (based on ANSYS simulations), providing the number of colision until protective layer penetration

National projects: Capacities

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 Moagar-Poladian (gabriel.moagar@imt.ro)

Results:
Dip Pen Nanolithography system (already installed and put into work). This scanning probe lithography technique allows pattering in nanometric range ans is direct writing method that can use molecular and biomolecular "inks" on a variety of substrates. Current activity is that of training and improving work with the system.



Images of:
a- Seting-up the system. Left monitor: used for working with the CAD-like software that controols the system; right monitor (orange): real-time imaging of the cantilever tip; extreme right (blue): the NScriptorTM system. The window of the environmental chamber is open. RiGht"
b- the NScriptorTM system setup with the window of the environmental chamber open.
c- Text written on a gold substrate with MHA (16 – Mercaptohexadecanoic Acid - Image size is of 5 microns x 5 microns, the width of the letters is of 115 nm while the dot on "i" radius is of 180 nm.

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)

The aim of the project is the development of the knowledge in the field of technologies dedicated to micro-assembling of MEMS components by developing 3 methods of micro-joining of metallic and non-metallic materials that are commonly used in MEMS devices. These welding procedures will respect either one of the following conditions: - to realize a good electrical contact between different components of MEMS; - to enable a good sealing for MEMS devices.

IMT-Bucharest role in the project is the design and simulation of the behavior of the micro-welded components under exploitation conditions and the characterization of the quality and the properties of the welding.
The main objective of the project is 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 supplementary modules [ARCHITECT - system-level modeling environment, SEMulator3D (semiconductor software), EM3D (Electromagnetic 3D Solver)], SolidWorks (design of complex geometries), Matlab, Mathematica (technical computing software packages), OriginPro8 (tehnical graphics and scientific data processing and interpolation); ***Hardware:*** computers, graphic station for design, workstation for simulations; ***Other:*** Training room for courses and services in MEMS design, modelling and simulation, including presentations / dissemination facilities.

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 diagnosis and treatment (medical imaging, drug delivery), genomics, ink-jet devices.

National basic funding projects:

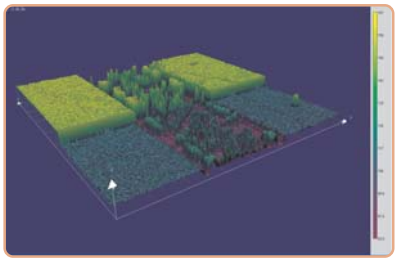
Reserch for integrated photonics and microfluidics structures based on SU-8 and others polymers

MINASIT PLUS (2006-2008);
Project manager: Dr. Raluca Müller (raluca.muller@imt.ro)

SEM phots of SU8 mirochannels.

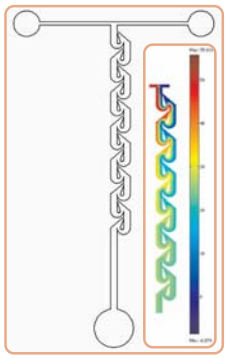
Results: We desined and manufacture different configurations of microchannels to be used in microfluidic applications, obtained in SU-8. Simulations of fluid velocity were performed using COMSOL Multiphysics software. Rectangular and y-shaped microchannels, with vertical walls and high aspect ration wrere obtained. We fabricated a microfluidic device, with an array of Cr/Au electrodes, which control the fluid flow of an aqua solution where have been introduced different nano-particles as: magnetite- Fe_3O_4, magnetite Fe_3O_4-functionalized with silver particles, Fe_3O_4- functionalized with gold particles, and gold nanoparticles. The microfluidic is composed of an inlet, an outlet and a microfluidic channel with a width of 100 μm and a length of 5000 μm. The flow was controlled by applying a small voltage on the electrodes array.

Magnetite crystallites Fe_3O_4 + Ag



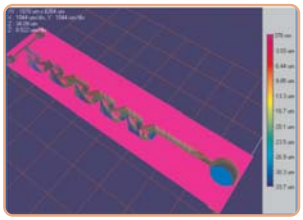
WLI profilometry of the microchannel, with bottom electrodes for a fluid containing nanoparticles

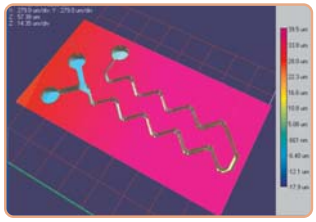
Computer aided design for microfluidic components

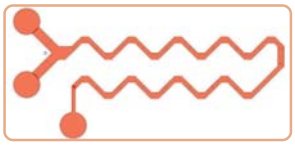


MINASIT PLUS (2006-2008);
Project manager: Mat. Oana Tatiana Nedelcu (oana.nedelcu@imt.ro)

The project scope was to develop new design of microfluidic components, particularly micromixers.
Results: Two concepts of micromixers have been designed, microfabricated in polymer (SU-8) and characterized by simulation and measurements (test structures).







The figures above present different steps related to design, simulation (COMSOL Multiphysics) and characterization using 3D profilometry (WLI) for 2 types of micromixers

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 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: 3 senior researchers - background in Physics and Electronic Engineering an early stage researcher (Physics) 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 equipments. 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.

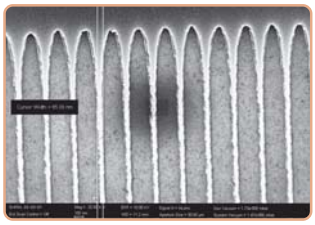
International projects: **FP7** ***CATHERINE*** "Carbon nAnotube Technology for High-speed nExt-geneRation nano-InterconNEcts"- STREP- FET proactive (2008-2010), ***Coordinator*** **Consorzio Sapienza Innovazione, Italy.** ***Partners:*** CNIS-Italy, TUD-Netherlands, CIRIMAT-France, USL-Italy, ULV- Lativia, 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 of CATHERINE 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

Electric contacts at nanoscale- 65 nm width lines



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 include: Electron Beam Lithography, Scanning Electron Microscopy and Scanning Probe Microscopy (mainly AFM Surface morphology imaging and characterization), force sensors for Atomic Force Microscopy. A 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

Laboratory for morphological analysis at nanometric scale

The SPM equipment acquired within the NANOMORPH project

The project aims at establishing a laboratory for nanometric scale morphological characterization of material surfaces. The laboratory will be certified to ISO IEC 17025:2005 standard for testing and calibration laboratories and will provide high- quality AFM and SEM characterization services for research and/or production of materials whose surfaces have a nanometric scale structure. At present the laboratory is fully functional and under accreditation by the National accreditation Body- RENAR.

NANOMORPH (2006-2008). Project type: CEEX- Module IV/P-CONFORM, Infrastructure development for evaluation and certification of conformity;
Project no. 234/2006, Coordinator: IMT Bucharest;
Project manager: Phys. Raluca Gavrila (raluca.gavrila@imt.ro).

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

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

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. The laboratory facilities were completed by acquiring a state-of-the art equipment for nanomechanical characterization and several equipments that would allow the use at maximum performance of the existing EBL installation: Fixed Beam Moving Stage (FBMS), Gas injection system (GIS) for Electron Beam Induced Deposition (EBID) and a system of nanomanipulators.

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

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

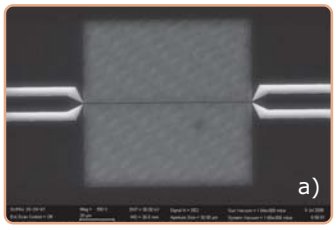
FEG-SEM

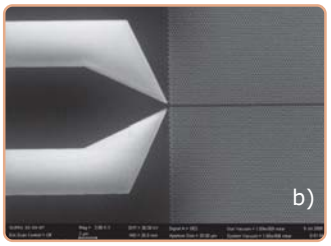
The main goal of this project is to complete the equipments of the lab with a state of the art Field Emission Gun Scanning Electron Microscope (FEG-SEM) able to work with low accelerating voltages for true surface imaging: resolution bellow 1.5 nm at 1kV accelerating voltage, in-lens detectors for SE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

B- . Research projects

Network of scientific services for nano-scale structuring and characterization, with applications in the development of convergent technologies





SEM photos of the experimental PC structures: b) the whole structure, including the taper sections c) detail of the taperd region

This Network for scientific research services and characterization tools at nano-scale bring together 11 well known research institutes and academia, which use in common characterization and manufacturing equipments and complementary skills, to successfully utilize in co-operation and partnerships the complete range of nano potential. The main results were disseminated in the frame of nantional events as National Semniar for Nanotechnologies (organized by IMT) and Functional Materials (organized by IMNR) and at an important number of international events, including MINAM Seminar on Micro- and Nanotechnologies for Industrial Applications, Portugal (March 2008).
Different demonstrators of nanodevices were developed as: nanostructured TiO_2 and ZnO thin films on Si/SiO_2substrates (IMNR), for photonics applications and solar energy convertion; nanodevices based on Carbon nanoparticles for field emission devises and gas sensors; photonic crystals (IMT) which can be used in optical communication circuits for complex optical processing. We the fabricated two-dimensional photonic crystals (PCs) obtained by direct patterning of positive PMMA electronoresist, using the Electron-Beam Lithography technique (EBL). The fabrication of the device was a challenge because we integrated the PC waveguide configuration with a taper optical waveguide on the same substrate. The finite difference time domain (FDTD) simulations were used to predict the optical behavior, and in particular the band gap. Although the refractive index contrast between the PMMA and the SiO_2 substrate is not very high, numerical simulations confirm that the structure acts as a waveguide in the visible spectral region.

NANOSCALE-CONV (2005-2008); Project type: PN II CEEX- CALIST; No. 6111/2005
Coordinator: IMT- Bucharest;
Project manager: Dr.Raluca Müller (raluca.muller@imt.ro)

B- . Research projects

RTN-NANOEL-Romanian Technological Network for integration in the European Platform for NANOELectronics (ENIAC)

Project type: CEEX – INFOSOC No 75 II/2006 (2006- 2008)

Modules for the existing nanolithography equipments were acquired.

Coordinator: IMT- Bucharest; Project manager: Prof. Dan Dascalu (dan.dascalu@imt.ro).

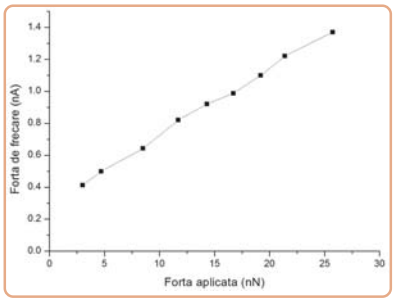
AFM applications to nanomechanical characterization of polymeric surface

Main goals: Design and performing AFM-based experiments on various polymeric materials for studying their elastic, viscoelastic and adhesive properties.

Results: For polymeric materials, which are prone to elastic and viscous deformations during AFM scanning, the interference of mechanical properties in AFM morphological images is generally more important than for than rigid materials. This research allowed us to identify of several types of effects of the mechanical properties of studied polymers on their AFM images (height artifacts due to compression or adhesion of surface features, resolution decrease, scanning rate artifacts due to viscoelastic properties) and to estimate their relative magnitude in practical applications and also provided keys to minimize these effects in AFM images of topography.

A second direction of our research was directed to the investigation of submicronic tribological properties of PMMA by LFM.

Project Type: National basic funding Project MINASIST +, PN 06240105: - (2006-2008); (Project manager: Raluca Gavrila - raluca.gavrila@imt.ro)



Friction force (a.u.) versus applied force for a thin PMMA film. In the peculiar conditions of our experiments the friction forces associated to PMMA and AFM tip follow a generalized form of Amonton-Coulomb macroscopic law, where the adhesive interface force must be considered too.

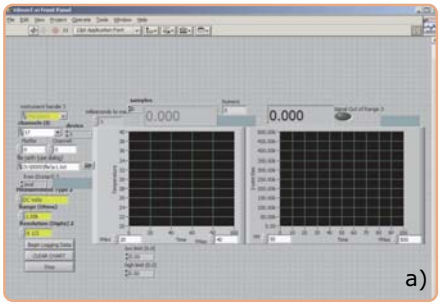
Virtual instrumentation for the characterization and experimentation of microfluidic devices

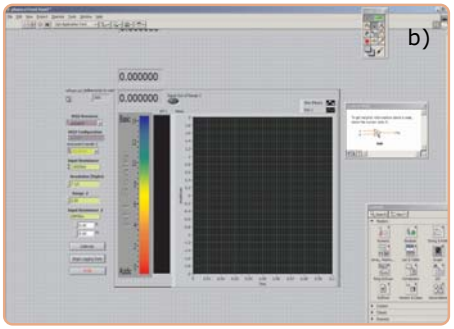
An integrated system for the measurement and characterization of microfluidic devices and sensors was implemented. The system was realized on the basis of PCI and PXI modules from National Instruments. It works under the control of the NI LabVIEW graphical programming software and provide the development of test, measurement, and control applications. It can rapidly and cost-effectively interface with measurement and control hardware, acquire, analyze, and graphical process data, and share results.

PC/LabView/PCI Modules:
- Oscilloscope
- DAQ
- Signal Generator

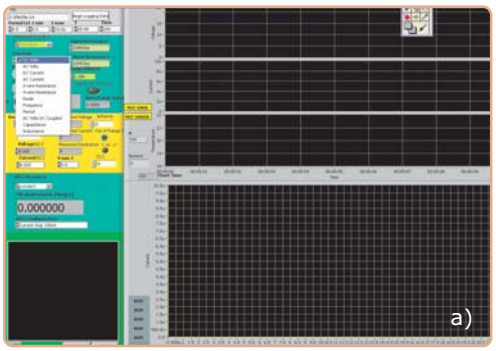
GPIB Interface

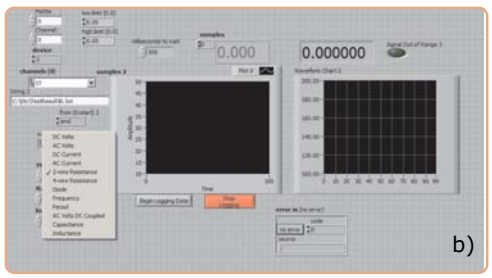
PXI Chassis/PXI Modules:
- Programmable Power Supply
- Digital Multimeter 71/2 digits
- Amplifier
- Controller
- Multiplexer





Virtual Instrument interfaces for the measurement of temperature sensors (a), and pH (b) sensors





Virtual Instrument interfaces for the measurement of small currents (a), and impedances (b)

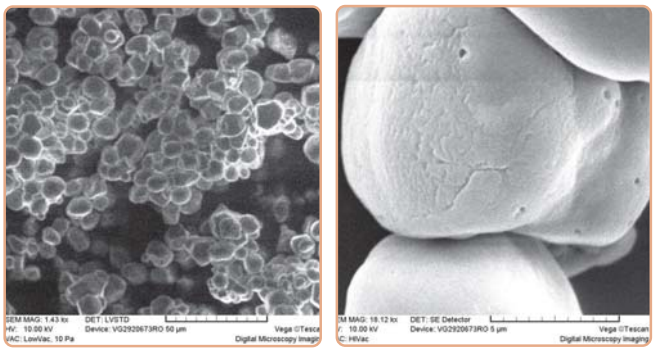
Project Type: National basic funding Project MINASIST+, PN06240203
Project manager: Cecilia Codreanu (cecilia.codreanu@imt.ro)

NATIONAL 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.

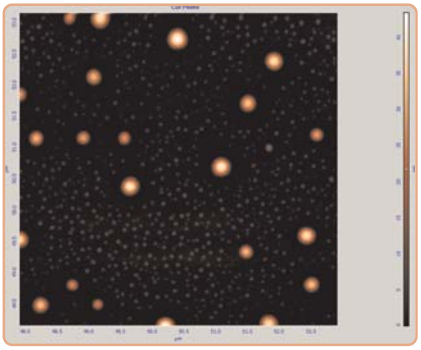
Trainning activities:

Alexandru Herghelegiu: Spring School "Technology for Photonics Integration" , 11 to 17 may 2008, Portoferraio, Elba Island, Italy

Services offered by the LAB: AFM, SEM, EBL

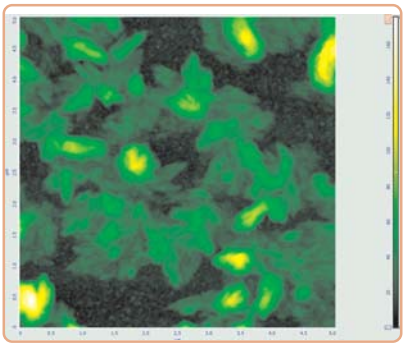
High resolution surface morphology investigations by Atomic Force Microscopy (AFM): 3D surface topography recording and measurement (waviness, roughness, step heights, grains, particles etc);:

SPM SURFACE MORPHOLOGY STUDIES

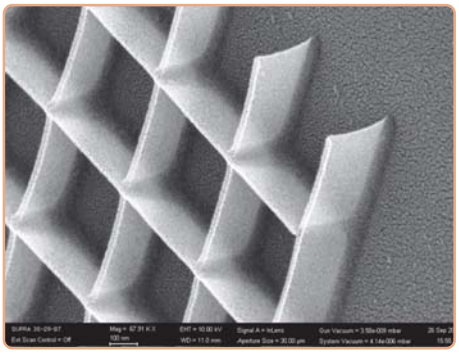


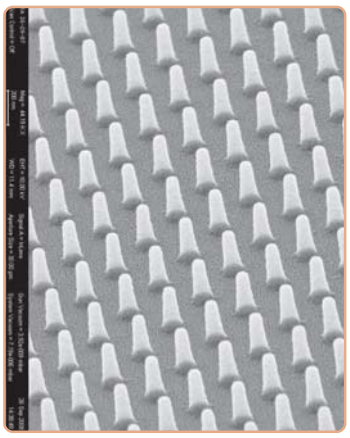
Study regarding the efficiency of a cleaning process for a quartz substrate (AFM image of cleaned quartz surface;) AFM images reveal the persistence of contamination spots with diameters of tens to hundreds of nm and heights down to a few nm.

NANOLITOGRAPHY



AFM image revealing the growth pattern of a sol-gel ZnO thin film on Si for applications in optolectronic devices and gas sensors (scan size: 5x5 μm).





High aspect ratio (12:1) structures in PMMA applications in nanotechnology. Left: crosslines; Rigth nanopilars

L7: Reliability Laboratory

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

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

Main areas of expertise: **Reliability building**: Design for reliability and testability - design for manufacture, Reliability monitoring & screening of micro and nanostructures, Burn-in and selection, Reliability of components used in harsh environment (nuclear, geology, automotive, aeronautics, etc.); **Reliability assessing:** Accelerated testing of micro and nanostructures; Failure analysis & physics, Data processing & Reliability prediction, Behaviour of electronic components in harsh environment, Virtual prototyping;

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

Partner in International Networks: Dr.M.Bazu was member of the Management Board and leader of the cluster "Reliability & Characterisation" of the Network of Excellence ***"Design for Micro and Manufacture PATENT-DfMM"*** (FP6/IST project of NoE, 2004-2008).

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, developed in 2007 by the network ***"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";

Contractor of *"Infrastructure development for reliability research in integrated micro-nano systems"*, project (2007-2009) in the National Research Programme "CAPACITIES";

Contractor of *"Development of a laboratory for assessing the quality of the products of micro technologies according to EU requirements - LIMIT"*, project (2006-2008) in the National Research Programme "National research Programme „Excellence in Research – CEEX ;

Member of the "Interdisciplinary network for synthesis and studying semiconductor and conductor nanostructures for obtaining photonic and optoelectronic devices usable in biology and medicine – NANOCRYSTALNET", project (2005-2008) in the National research Programme „Excellence in Research – CEEX", 8 partners (co-ordinated by the University Politehnica Bucharest).

Specific instruments and equipment:

Environmental testing: Reliability Laboratory contains the Laboratory for evaluating the quality of microtechnology products according to EU requirements, 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;

Research Team: The research team is formed by three senior engineers with background in micro-electronics.

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

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 Microelectronics Reliability and Sensors.

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 1991-2008 (Sinaia, Romania), MIEL 2004 (Nis, Serbia & Montenegro). Author of more than 100 scientific papers (IEEE Trans. on Reliability, J. of Electrochem. Soc), Sensors and contributions to conferences (Annual Reliability and Maintainability Symp., Probabilistic Safety Assessment and Management, European Safety and Reliability Conference). Co-author of a book ("Reliability of electronic components") published at Springer Verlag, in 1999.

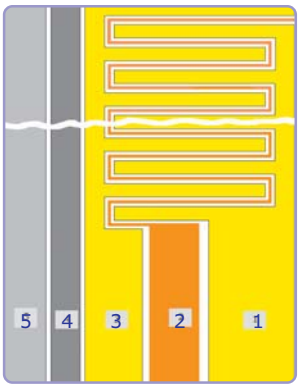
RELIABILITY OF NANOSTRUCTURES

Time degradation phenomena in nanotechnologies (nanostructured materials, nanoelectronic structures and NEMS) were studied.

Achievements: Systems for evaluating the reliability of nanostructured materials, nanoelectronic structures and NEMS were elaborated. The annual project workshop, common with the CEEX project NANOCRYSTALNET (Oct.17, 2008), held at the University Politehnica Bucharest, gathered Romanian specialists in nanotechnologies and four invited specialists, professors at universities from Valencia (Spain) and Gauhati (India).

Project: Technologies at nanometre scale: time degradation phenomena, CNCSIS grant (2006-2008);
Contact person: Marius Bazu (marius.bazu@imt.ro)

BIOSENSOR FOR ENVIRONMENTAL MONITORING



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

Achievements:
A micro transducer was obtained, based on metallic multilayer deposition by vacuum evaporation on a silicon substrate. Three electrodes were configurated: a counter-electrode made by two metallic layers from Cr and Pt; a reference electrode covered with a layer of Ag/ AgCl; and a working electrode made by two metallic layers of Cr and Au. The possibility to choose tyrozinasis-TYR as biological component for achieving toxin detecting biosensors was investigated.

Layout of the microelectrodes: 1- Working electrode (Source); 2- Working electrode (Gate); 3 – Working electrode (Drain); 4 – Reference electrode; 5 – Counter-electrode.

"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°C) and Low temp.(+60…200°C); - Highly accelerated stress test (HAST) - EHS 211M (Espec): Temperature range: +105 ... +142°C, Humidity range: 75%…100% RH, Pressure range: 0.02…0.196 Mpa;
- Damp heat - CH 160 (Angelantoni): Temperature range: -70...+180°C; Speed: 5°C / min, Humidity range: 20…95%RH, between +100 C…+80° 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.

L8: Laboratory for ambiental technologies

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

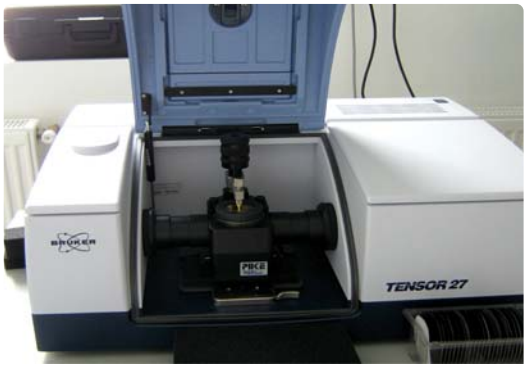
Research Team: The team is represented by a senior researcher (PhD), a senior technological development engineer, 3 PhD students (with background in chemistry and mechanics) and a young engineer specialized in electronic applications field.

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:
- 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**)



FTIR Equipment for characterization.

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), 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 9 Romanian patents (2 of them won silver and 1 gold medals at International Inventions Exhibition in Brussels and Geneva) and 3 books.

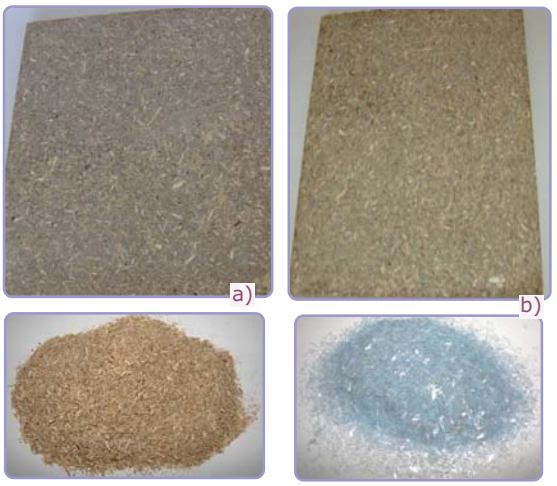
WOOD - POLYMER COMPOSITE WITH COMPONENTS OF NANOSTRUCTURED MATERIALS AND NANOSENSORS FOR IMPROVEMENT OF INDOOR ENVIRONMENT

Main aim: Fabrication of walls (plates) of wood-polymer structure using wastes of wood processing and wastes type PET and plastic bags.

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 disintegrated melamine PAL and new type of ureic resin) – have a thickness swelling after immersion in water more reduced (2,4% respectively 6,61%) against of stratified PAL (3,76% respectively 17,32%); water absorption (7,62% respectively 12,60% and 17,44% respectively 18,38%); resistance at statically bending much higher (23,79N/mm^2 against of 20,64N/mm^2);

• The plated types PAL – PE with same adhesive type has thickness swelling with much reduced thickness as PAL classical stratified (3,0% against of 17,32%); water absorption (21,00% against of 18,38%); the resistance at static bending effort lower with 70%.



"Polymer-wood" plates of disintegrated wood type: a) PAL–PE (polyethylene); b) PAL-PE–AM (maleic anhydride)

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;

NEW TECHNOLOGIES FOR ACHIEVING MICROBIOSENSORS FOR REAL TIME DETECTING AND MONITORING TUBERCULOSIS IN GROUPS WITH INCREASED RISK POTENTIAL

Main aim: Main aim: a microbiosensor for TB manufactured on piezoelectric advanced material substrate

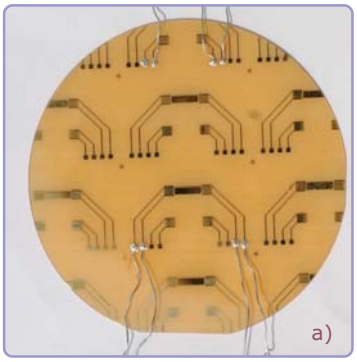
Achievements:

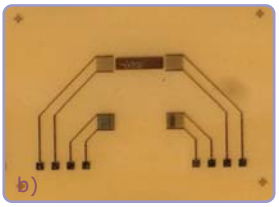
• Development a differential SAW piezoelectric microsensor with a lay-out designed to increase sensitivity and selectivity;

• Development some techniques of compatibilization between microsenzor and sensitive substances;

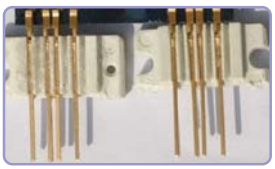
• Processing of the tantalate and langasite substrates for the first time in Romania;

• Microsensors assembly using reusable support;

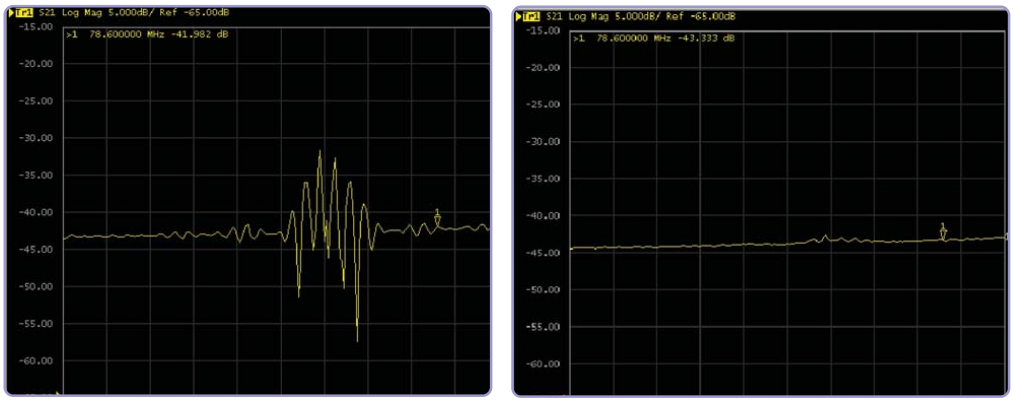




a) Sensor for detection of configured on langasite substrate; b) detail



Type of connectors proposed for sensors assembly



Sensor response in the absence and in the presence of bacillus

MICROBALERT, CEEX 2006-2008, Coordinator IMT Bucharest.
Project manager: Ileana Cernica (ileana.cernica@imt.ro).
Partners: ROMQUARTZ S.A.; PNEUMOFTIZIOLOGY INSTITUTE MARIUS NASTA (IPMP); NATIONAL INSTITUTE FOR R&D IN ELECTROCHEMISTRY AND CONDENSED MATTER TIMISOARA (INCEMC); "POLITEHNICA" University of Bucharest (UPB-CCO); SITEX 45 SRL;

A2: Technology Laboratory for Microstructures

- Mission
- Main areas of expertise
- Research Team
- International projects
- Services

Mission: The Technology Group for Microstructures provides technical support, informations and consulting for the research activity developed in the institute in the Technology Laboratory for Microstructures. Our group acts as a technological support for the institute projects belonging to all laboratories. The spectrum of research activities was considerably expanded through recent investments in new equipments.

Main areas of expertise: The Group covers a broad range of technological process in order to fulfil the requirements for implementation of semiconductor devices, sensors, micromechanical and micro-optical structures, microstructures for bio-medical devices, metallic and dielectric lattices.

The versatility and the adaptability to the various needs of microsystems realization are the major characteristics of the technological processes offered by the Technology Laboratory for Microstructures. Besides silicon wafers, other materials as gallium arsenide, and aluminium nitride can be also processed.

The projects in which the working group was involved, merge the following disciplines: semiconductors technology, semiconductors physics, materials physics, optics, chemistry, biochemistry, microfluidics. In the last time the current research topics include:

• Development of novel technologies for photovoltaic applications;
• Development and optimization of nanoporous silicon and new oxides layers for solar cells applications, essentially as antireflection coating and surface structuring to reduce reflection loss;
• The preparation of macroporous Si as carrier matrix for enzyme, by means of an anodic etching process, compatible to the semiconductor processing in sensor fabrication;
• Development of novel technology to obtain microfluidic devices by substrate microprocessing having applications in thermal transfer and biology.

Research Team: The team is represented by three senior researchers, 1 chemist, and 2 physicists.

International Projects: technological support for the research activity, particularly for the following european projects:

• Multi - Material Micro Manufacture: Technologies and Applications (4M), NoE, Priority 3 - NMP
• Design for Micro& Nano Manufacture (PATENT), NoE, priority 2 - IST
• Advanced Handling and Assembly in Microtechnology (ASSEMIC), Marie Curie Research Training Network.

Services: • Thermal processes (oxidation, dopant deposition/diffusion, annealing) for wafers up to 4";
• Vacuum deposition (thermal and e-beam evaporation techniques) of dielectric and conductive materials. *Available materials:* Al, Cr, Ti, Au, Mo, Ag, W, Ni, Pt, Ni-Cr, permalloy, Cu, Pd, Si, SiO_2, SiO, AlN;
• Ion implantation for energies up to 150 keV;
• CVD from liquid sources for silicon dioxide and carbonitride thin film realisation;
• Photolithography (UV, double side aligners, lift-off techniques);
• Chemical processes; surface cleaning, wet/dry etching, isotropic/anisotropic etching, metal micro-electro-platting or chemical platting, anodic oxidation, sol gel techniques.

Team from right to left:
back row: Colotela Mircea, Gheorghe Elena, Dragan Gabriela, Mihailescu C-tin, Diaconu Adrian, Coraci Antonie, Isar Gheorghe;
front row: Podaru Cecilia, Pandele Elena, Manea Elena, Dobre Tamita, Gheorghe Marin, Stama Vasile;

Equipments for photolithography

Equipments for chemical processes

Laboratory Head — Dr. Elena Manea (elena.manea@imt.ro)

Present position: Dr. Elena Manea obtained the MSc degree in Physics (1978) and Ph.D. in Solid State Physics (1999) at University from Bucharest. 30 years experience in silicon planar technology. Research efforts aiming to develop the scientific knowledge concerning micro and nanaotechnologies and nanostructured materials for applications in the PV solar cells, technologies for microsystems and microsensors domains.

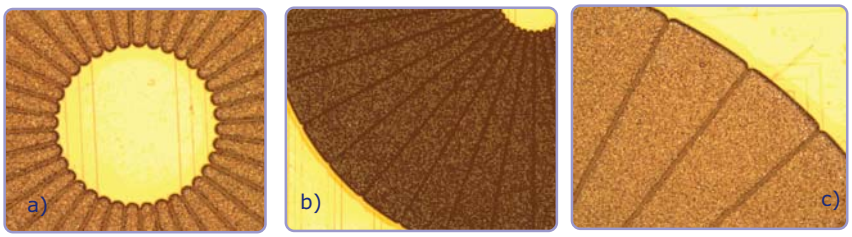
The scientific activity is published in 30 scientific papers in journals (12 published in periodicals ISI ranked), 2 book, more then 200 communications in Proceedings and 12 patents.

"Surface microprocessed micro heat sink"

In the last ten years microprocessing techniques were used to develop many microfluidic systems obtained onto silicon, glass, quartz, or plastic substrates. The proposed technology in this project has the main advantage to use low temperature processing, being cheap and IC fabrication technology compatible.

The present project aims to innovate and develop technological processes in the field of microfluidic devices, having applications in the thermal transfer. It aims to realize silicon surface microprocessed micro heat sinks based on Ni or Cu microchannels having near rectangular cross-section and dimensions 20 – 60 μm (width), 20 – 40 μm (height), and 1700 – 1500μm (length). To obtain Ni, or Cu microchannels (or microchambers) will be used 3 – 4 in silicon wafers, appropriate chemical cleaned (using acid and / or solvent solutions), processed then by the electrochemical deposition onto a resist mask patterned by photolithographic techniques in microchannel arrays radial oriented, see Fig 1, of a metal (Ni/Cu) predeposited in a thin film having about 1000-2000Å onto the substrate (having also a Cr thin film of about 200-300Å to enhance the adherence). The metal will be subsequently electrochemical thickened. The resist film is used as a sacrificial layer, and will be subsequently removed in hot acetone.

These microfluidic devices (micro heat sinks) will be designed using mass and thermal transfer considerations, to could realize the air forced cooling of the IC's chips. Micro heat sinks will be realized in the last step of the planar semiconductor devices fabrications directly onto the chip (wafer) before testing and dicing. The proposed technology to process the microfluidic devices has also the advantage to use a processing technique simple and cheap, has low process temperatures (less than 200ºC) and it is compatible with the power devices fabrication technology. It provides also a very good thermal contact between micro heat sink and chip.



Silicon microprocessed micro-heat sink test structure (using electroplated C), (a) at the center, $Ø_{in}$ = 0,6 mm, (b) center-outside, (c) at the outside, $Ø_{out}$ = 4 mm.

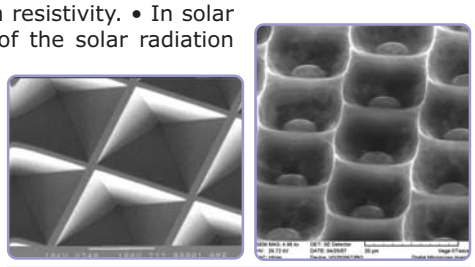
PATENT: - *"Techgnological procedure realize microfluidic devices by silicon microprocessing having applications in biology and thermal transfer",* author A. Coraci; **Silver medal** at the XII edition of the "International Saloon for Inventions, Scientific Research and New Technologies, INVENTIKA – 2008, Bucharest, Romania 7–11 oct 2008, and **Gold medal** at the 57th edition of the International Contest Bruxelles EUREKA , Bruxelles, Belgium, 13–15 nov 2008.

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

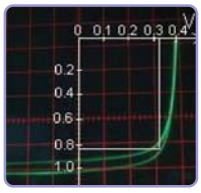
Integrated research to develop high efficiency amorphous and polycrystalline silicon solar cells based on quantum effects using nanotechnology and nonconventional processes (HES - CELL)

The project purposes to design and fabricate high efficiency and low cost PV solar cells on different substrates, using non-conventional technologies and nanostructured materials. Photovoltaic technology permits the transformation of solar light directly into electricity. PV systems can deliver electrical energy to a speccific apliance or to the electric grid. It has the potential to play an important role transition towards a sustainable energy supply system oh the 21 century and to cover a significant electricity needs of Europe.

Design and Fabrication: • For the structuring processes of the high efficiency solar cell surface it was used p-type, <100> Si mono wafers having 3" diameter, thickness 380μm, and 1-2 Ωcm resistivity. • In solar cell fabrication a way of increasing efficiency consists in the elimination of the solar radiation losses on the surface. • There were studied three types of surface structures: honeycomb structure, regular pyramids structure and electrochemical porosification of the silica. The first two structural types were obtained using technological processes from planar technology of the IC's.


Pyramidal structure with the side of 10 μm and 20 μm and "Honeycamb" structure

Applications: • Water pumping for small-scalle remote irrigation, stocwatering, residential uses, remote vilajes, and marine sump pumps; • Lighting for residential needs, billboards, security, highway signs, streets and parking lots, pathways, recreational vehicles, remote villages and schools, and marine navigational buois; • Comunications by remote relay stations, emergency radios, orbiting satellites, and cellular telephones; • Refrigeration for medical and recreational uses; • Corrosion protection for pipelines and docks, petroleum and water wells, and underground tanks; • Utility gryds that produce utility, or comercial scale electricity; • Household applications such as ventilation fans, swamp coolers, televisions, blenders, stereos, and other appliances.



Current-voltage characteristic of "honeycomb" texturized structure:I_{SC}=0,82 mA; V_{OC}=0.4 V; E_e=1.62 mW/cm^2

PATENT: *"Procedure to fabricate solar cells having high efficiency onto momocrystalin silicon",* E. Manea

- **Gold medal** at the 6th International Fair of Innovations, New Ideas, Produces and Technologies – ARCA 2008, 16 – 21 sept 2008 and **Bronze medal** at the XII edition of the "International Saloon for Inventions, Scientific Research and New Technologies, INVENTIKA – 2008, Bucharest, Romania 7 – 11 oct 2008, author E. Manea;

Project Manager: Ph.D. Elena Manea; (elena.manea@imt.ro), IMT – Bucharest

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19. **"Thermoelectric Generator with Polycrystalline Silicon Material"**, I. Bancuta, V. Cimpoca, I.V. Popescu, A. Gheboianu, M. Cimpoca, C. Stihi, Gh. Brezeanu, **Scientific Session: Study in Applied Sciences and Environmental Materials**, 5-6 June 2008, Targoviste, Romania.

20. **"The Improvement of the Thermal Parameters of Different Materials Using Nano-Materials Networks"**, F. Scarlat, M. Oane, I. Cernica, **Scientific Session: Study in Applied Sciences and Environmental Materials**, 5-6 June 2008, Targoviste, Romania.

21. **"Components Nanotexturate for Architectural Coating"**, C. Roman, I. Cernica, A. Gog, M. Roman, M. Miclean, B. Abraham, **XXX Chemistry National Conference**, 8-10 October 2008, Valcea, Romania.

22. **"FDTD Simulations of Far-Infrared Effective Magnetic Activity in Microstructured TiO_2"**, C. Kusko and M. Kusko, 8th **International Conference in Numerical Simulation in Optoelectronic Devices NUSOD2008**, Nottingham, UK.

23. **"THz Left –Handed EM in Composite Polar Dielectrics"**, C. Kusko and M. Kusko, **Nanotechnology Workshop in Scientific Research Diaspora Romaneasca**, September 2008.

24. **"Growth Dynamics of Pulsed-Laser-Deposited AIN FILMS"**, S. Bakalova, A. Szekeres, A. Cziraki, S. Grigorescu, G. Socol, E. Axente, I.N. Mihailescu, R. Gavrila, **15th International School on Condensed Matter Physics**, 31 August - September 5, 2008 Varna, Bulgary.

25. **"S–Doped TIO2 Films With Photocatalytic Activity"**, T.M. Critan, A. Brãileanu, M. Rãileanu, Dorel Critan, N. Drãgan, M. Anastasescu, A. Galtayries, A. Ianculescu, R. Gavrilã, I. Nitoi, P. Oancea, **10th Conference on Science and Engineering of Oxide Materials**, CONSILOX, 10-12 September 2008, Timisoara, Romania.

26. **"Training by Research in Photonics Master Programs"**, D. Cristea, **EOS Annual Meeting 2008**, 29 September - 2 October 2008, Paris, France.

27. **"Micro/nano Fabrication Technologies Based on New Materials for Sensors and Micro-Optics"**, D. Cristea, P. Obreja, M. Kusko, A. Dinescu, **Materials for microphotonics**, 4M Workshop, 15 October 2008.

28. **"MEMS Devices for Applications in the Field of Energy Sensing and Scavenging"**, G. Moagar-Poladian, L. Cioroianu, A. Popescu, V. Moagar-Poladian, G. Cioroianu, G. Boldeiu, A. Dinescu, G. Damian, R. Gavrila, **FOREN**, 15-19 June 2008, Neptun, Romania.

Chapters in books

1. **"GaAs Membrane-supported 60 GHz Receiver with Yagi-Uda Antenna"**, D Neculoiu, G Konstantinidis, T Vähä-Heikkilä, A Müller, D Vasilache, A Stavinidris, L Bary, M Dragoman, I Petrini, C Buiculescu, Z Hazoupulos, N Kornilios, P Pursula, R Plana, D Dascalu, **Vol. 12, Recent Developments in MEMS Technologies for Microwave and Millimeter Wave Circuits**, Series in Micro and Nanoengineering, Publishing House of the Romanian Academy, 2008, pp. 33-41, Editors: Lluis Pradell, Lluis Jofre, Alexandru Muller, Dan Dascalu, Robert Plana, ISBN 978-973-271-688-5.

2. **"Tuneable Bandstop MEMS Filter for Ka and V-Band Applications"**, A. Takacs, D. Neculoiu, D. Vasilache, A. Muller, P. Pons, L. Bary, P. Calmon, R. Plana, H. Aubert, **Vol. 12, Recent Developments in MEMS Technologies for Microwave and Milimeter Wave Circuits**, Series in Micro and Nanoengineering, Publishing House of the Romanian Academy, 2008, pp. 229-236; Editors: Lluis Pradell, Lluis Jofre, Alexandru Muller, Dan Dascalu, Robert Plana, ISBN 978-973-271-688-5.

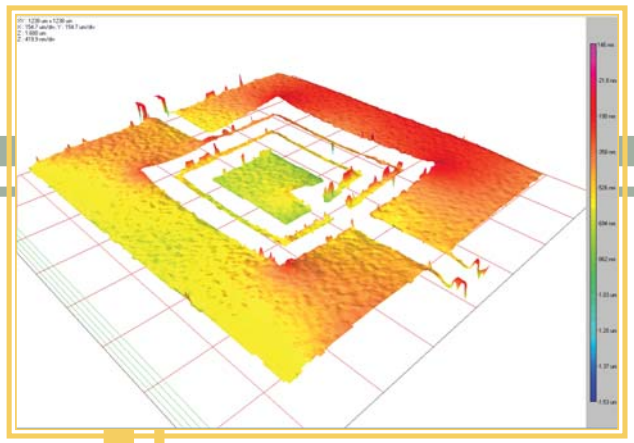
3. **"Novel Micromachined lumped Element Band Pass Filter With an Additional Zero in the Bandstop, for WLAN 5200 Applications"**, A. A. Muller, D. Neculoiu, D. Vasilache, A. Cismaru, P. Pons, l. Barry, A. Muller, **Vol. 12, Recent Developments in MEMS Technologies for Microwave and Milimeter Wave Circuits,** Series in Micro and Nanoengineering, Publishing House of the Romanian Academy, 2008, pp. 237-243, Editors: Lluis Pradell, Lluis Jofre, Alexandru Muller, Dan Dascalu, Robert Plana, ISBN 978-973-271-688-5.

4. **"RF NEMS Carbon Nanotube Based Nanoelectro-Mechanical Systems for Microwave and Millimeter Wave Applications"**, M. Dragoman, A. Cismaru, A.A. Muller, M. Dragomn, D. Dragoman, H. Hartnagel, R. Plana, **Vol. 12, Recent Developments in MEMS Technologies for Microwave and Milimeter Wave Circuits**, Series in Micro and Nanoengineering, Publishing House of the Romanian Academy, 2008, pp. 199-205, Editors: Lluis Pradell, Lluis Jofre, Alexandru Muller, Dan Dascalu, Robert Plana, ISBN 978-973-271-688-5, ISBN 978-973-271-688-5.

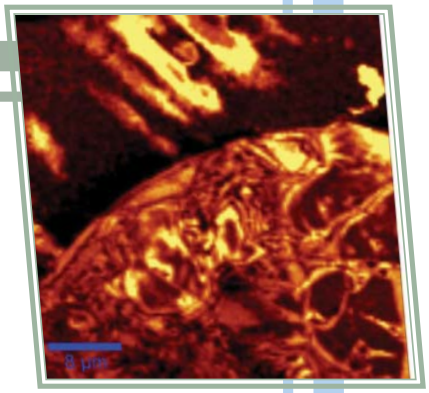
5. **"Magnetic-Based Microfluidic Platform for Biomolecular Separation"**, A. Avram, M. Avram, M. Volmer, D.P. Poenar, C. Iliescu, Series in Micro and Nanoengineering, **New Applications of Micro- and Nanotechnologies**, Publishing House of the Romanian Academy, 2008.

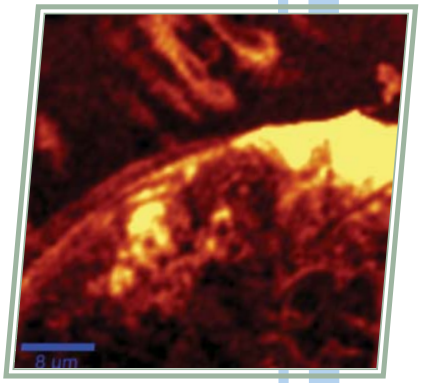
Patents

1. **"Photodetector Micromatrix and Manufacturing Technology"**, Ileana Cernica, Manea Elena, Ioana Dinoiu, BI nr. 121795/30.04.2008.

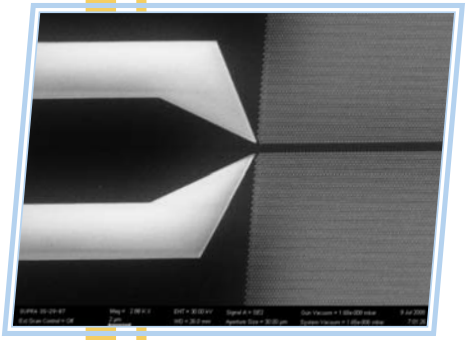


Analysis of the stress influence over the circuit topography;
Equipment: White light interferometer - WLI

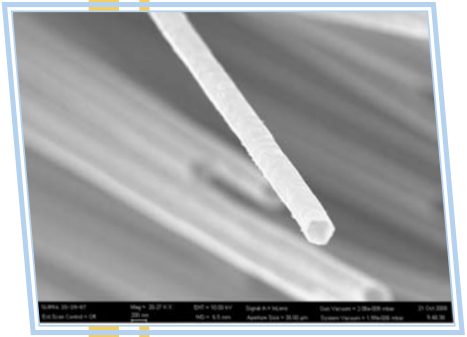




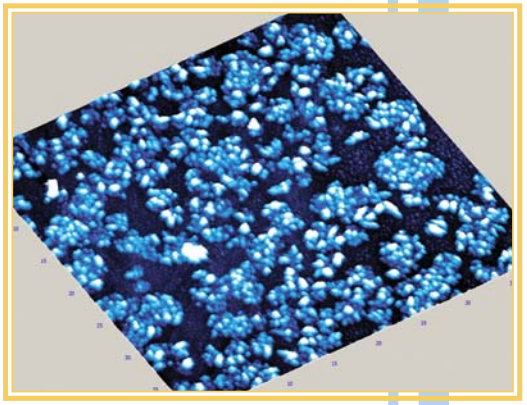
Confocal a) and fluorescence b) imaging of a fluorescent marked BSA proteine.
Equipment: Scanning Near-field Optical Microscope (SNOM)



Fabrication of photonic crystals - Photonic crytals in PMMA on silicon for near IR application

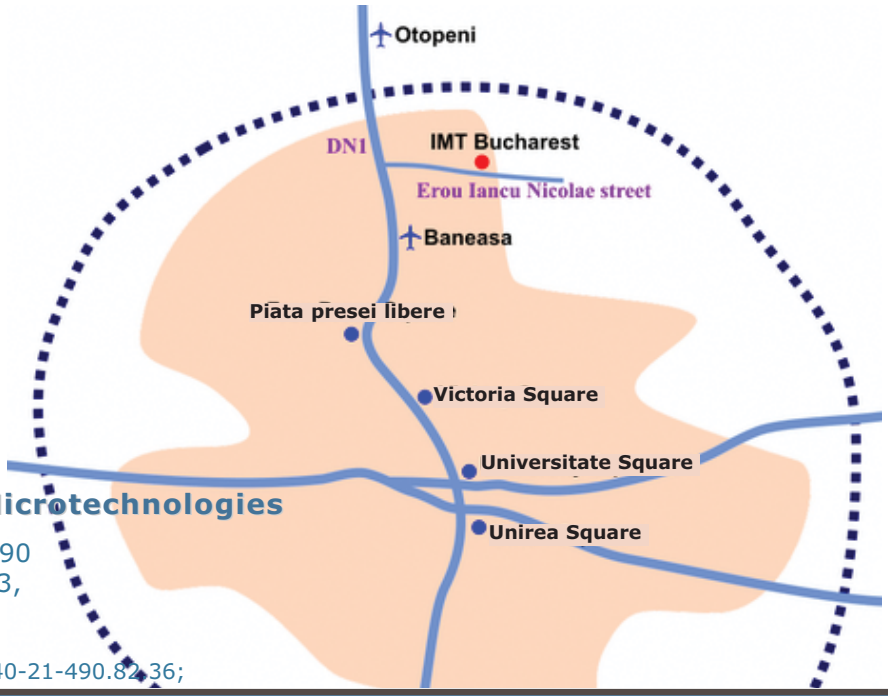


High resolution SEM inspection - Carbon nanotube image
Equipment: Electron Beam Lithography and nanoengineering workstation Raith e_Line



AFM image of a ZnO thin film on Si. Scan range: 40x40 microns. The AFM image was used for evaluating the growth pattern of ZnO, for applications in optolectronic devices and gas sensors.
Equipment: Scanning Probe Microscope NTEGRA Aura - NT-MDT

IMT-Bucharest is publishing annually the Scientific Report since 2005.



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