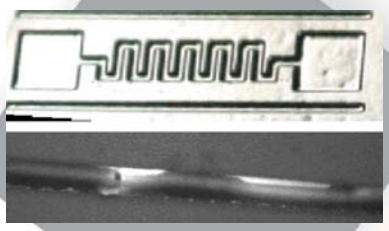
National Institute for R&D in Microtechnologies

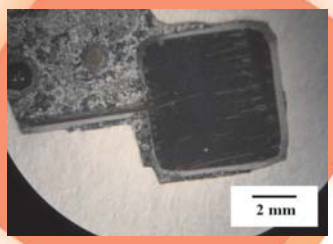
IMT -Bucharest

SCIENTIFIC REPORT 2006

NANOTECHNOLOGIES

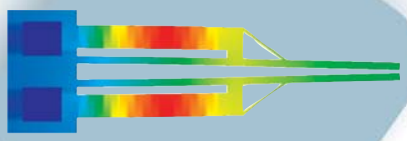


MICROSYSTEM TECHNOLOGIES

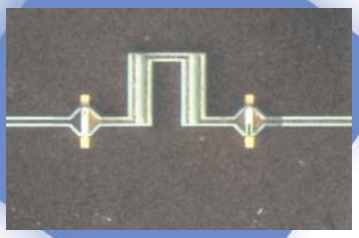


MICRO AND NANO PHOTONICS

FROM SIMULATION....



RF MEMS



....TO FABRICATION

European Commission officials visiting IMT-Bucharest

With the occasion of the Info- and brokerage event in new technologies and materials (FP7/2007: NMP/ICT) **"Cooperation in industry-oriented research in an enlarged Europe",** Bucharest, Romania, on 22-23 March 2007, **Dirk Beernaert**, *Head of unit "Nanoelectronics", DG Information Society and Media, EC* and **Nicholas Hartley,** *Acting Director "Industrial technologies", DG Research, EC visited IMT-Bucharest* and wrote down the following remarks in the institute *Guest Book*:

"I very much enjoyed the visit of the Institute and the Conference. IMT is doing interesting work. The work is also important for future long term applications and for innovation in the nanotechnology, bio-nanotechnology field and for nanophotonics. I hope they get fast the right equipment to play on important role on the European scene.

In the Conference, I have very much appreciated that they form a good focal point for the local and for the participants from the NMS. This is very much appreciated…

Dirk Beernaert, *DG-IST, Head of Unit Nanoelectronics*"

"A very impressive centre with a good team during interesting and important with. I have very much enjoyed this visit. Thank you for your excellent hospitality – good luck for the future and keep up the good work.

Nicholas Hartley"

With the occasion of the Info and brokerage event: **"Micro- and nanosystems in the FP7/2007 call",** Bucharest, Romania, 24 May 2007, **Augusto de Albuquerque**, Head of Unit, INFSO G.2 Microsystems, EC, visited IMT-Bucharest.

The main point of visit was IMT-Bucharest technology area, which allows structures manufacturing at the micrometer or nanometer scale. The new equipments acquired during the last years were presented. Some of the laboratories such as *Micro and Nano-Photonics*, *Simulation Modelling and Computer Aided Design* lab and *Micromachined structures, microwave circuits and devices lab* have been visited also.

After the visit, **Augusto de Albuquerque** wrote down the following remarks in the institute Guest Book:

"I enjoyed very much to see the very good infrastructure and the organization to build the full chain: simulation, design, testing and manufacturing. Congratulations for the very systematic building of competence in MEMS, Photonics and Nano-Bio convergence. Best wishes for the future.

Augusto de Albuquerque, *Head of Unit Microsystems, EC-DG Information Society and Media*"

Ministry of Education and Research, Romania

National Authority for Scientific Research

National Institute for Research and Development in Microtechnologies

IMT-Bucharest

SCIENTIFIC REPORT 2006

Research and technological development

Technology transfer and innovation

Education, training and dissemination

Networking

Design: Elena Stanila (IMT)

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Foreword

The scientific report 2006 marks ten years of activity of IMT-Bucharest as a national institute. In financial terms, the volume of activity of IMT increased considerably during the last three years (2004-2006). Even more impressive was the increase in the volume of investments. While the money invested in 2006 alone are significantly higher than money invested in the previous five years (2001-2005) taken together, the structure of investment was also dramatically changed, with 72.5% of money going to technological equipments. The science and technology park for micro-and nanotechnologies MINATECH-RO, with a second clean room and new equipments (such as electron beam lithography and RIE) was officially inaugurated in June 2006.

On the other hand, *two "open" laboratories* (used by a few different groups from IMT, as well as by members of national networks) became operational. They are: *NanoScaleLab* (characterization and structuring at the nanometer scale), and *NanoBioLab* (micro-nano-biotechnology). The initial funding was provided by national networks, but these labs are already attracting other sources of funding.

As a whole, IMT acts a *"technological pole"*, providing various resources from computing to characterization and fabrication and micro- and nanoscale and integrating activities of various actors, from education, research and industry. This concentration of human and material resources may also facilitate a special role of IMT at the regional level.

2006 was a good year for IMT in European cooperation, too (with an intense participation to FP6 and an increased interaction with foreign networks).

The report provides a detailed account of the activity of research laboratories as well as a list of the main publications. Updated information is available on the web page **www.imt.ro**.

Prof. Dan Dascalu

CEO and President of the Board

Dan Dascalu is the General Manager (CEO and President of the Board) of the National Institute for R&D in Microtechnologies (IMT-Bucharest). Founder (1993) the Institute of Microtechnology (IMT), which merged later (1996) with ICCE to create the National Institute of Microtechnologies. Professor at the "Politehnica" University of Bucharest (PUB), Department of Electronics and Telecommunications. Full member (academician) of the Romanian Academy (of Sciences). 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.

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. Member of the Consultative Board for R&D and President of the Commission for "New materials, micro- and nanotechnologies".

IMT: Brief history and strategy

Brief history. **1993 – 1996.** The **Institute for Microtechnologies (IMT)** was set up by a decision of the Romanian Government in July 1993, and it was the first institute of this profile from Eastern Europe. The institute was managing the clean room and the CAD centre of Microelectronica S.A. company, using most of its technical personnel the enterprise. The existing CMOS technologies have been used by IMT for developing chips for MOS power devices and initiating research on silicon microsystems technologies.

1997 – 1999. The National Institute was set up at the end of 1996 by merging IMT with the former ICCE (Research Institute for Electronic Components, working in semiconductor electronics). External contacts had been developed and the access to laboratories abroad was facilitated. IMT coordinated the European project **MEMSWAVE**, *nominated for the* **Descartes prize** in 2002. However, substantial decrease of national funding for research activities (starting 1998) contributed to a major "brain-drain" of researchers from different generations, whereas the investments have been minimal, especially in the computing and communications infrastructure.

2000 – 2003. IMT became visible at the national level, especially by coordinating various projects financed by the MATNANTECH (New Materials, Micro and Nanotechnologies) Programme (2001-2006). The multi-disciplinary characteristic of the activity was emphasized and the activities in the micro-nanotechnologies domain were intensified, also starting projects in collaboration with industrial companies, including Samsung (Rep. of Korea).

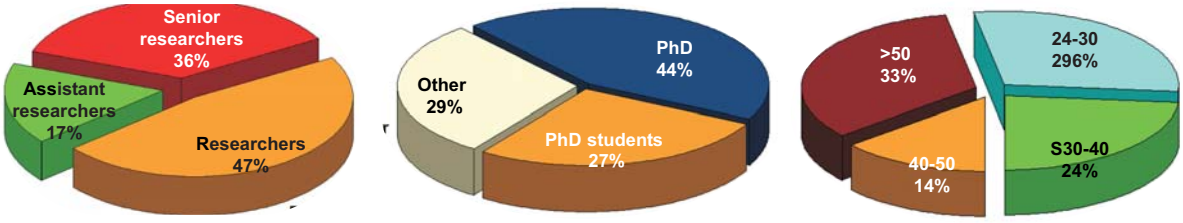
2004-2006. The investments increased, especially as part of contract funding, the clean room was upgraded at international standards (class 100), becoming functional in 2005. IMT intensified its European cooperation by participating to a significant number of FP6 projects. The research thematic area was oriented towards convergent technologies, i.e. micro-nano-bio-technologies. A significant number of research have been financed from the Excellence Research Programme CEEX (2005). Another characteristic feature of this period is the development of technological transfer and innovation infrastructures described in detail in this report.

Strategy. On medium and long term, the institute intends to consolidate its role as a technological pole in the micro-nano-biotechnologies domain, facilitating a concentration of research efforts on national level, but also providing a direct and efficient interaction with companies and with educational activities, respectively (especially M.Sc. and Ph.D. studies). IMT intends to play a role at the regional level and become part of the system of technological centres at the European level. Therefore, the objectives are: *(a)* to become a centre of excellence in research and development related to the integration/ convergence of technologies (micro-nano-bio-technologies); *(b)* to function as a *"technological pole"*, by using the facilities such as *"clean room"* spaces and the whole complex of equipments and computing technique to provide a platform of interaction of the Romanian research with industry and education; *(c)* to pursue the *technology transfer and innovation*, by developing a "cluster" of organizations either providing or using the knowledge and the technologies in the domain; the main instrument will be represented by the Science and Technology Park, whereas the Centre for technology transfer will provide some services in the park, including brokerage activities. Services will be also provided to non-residents.

Human resources

Fig.1 (a, b, c) provides information about the number and distribution of researchers active in IMT in 2006 (72 persons). Half of them are senior researchers (a). More of 70% of them have the Ph.D. degree or are Ph.D. students (b). The average age is slightly above 40 years (c).

Researchers active in IMT (72)



Researchers and Specialists providing technical services (91)

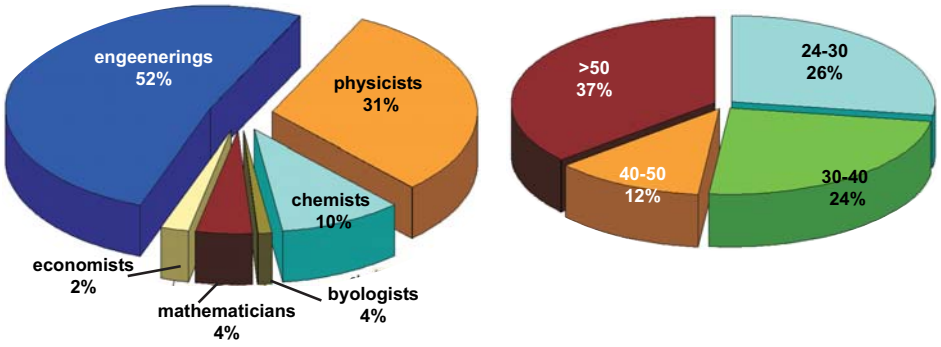
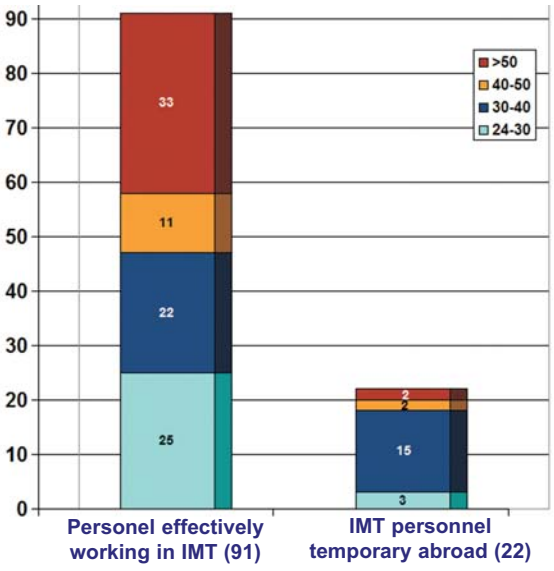


Fig.2 gives information about **the total number of specialists active in IMT** in 2006 (91 people): researchers and specialists providing technical services.

Their background is shown in Fig.2.a, whereas the age distribution occurs in Fig.2.b. The male (47) - female (44) number is balanced.

Age distribution of specialised personnel (91+22)

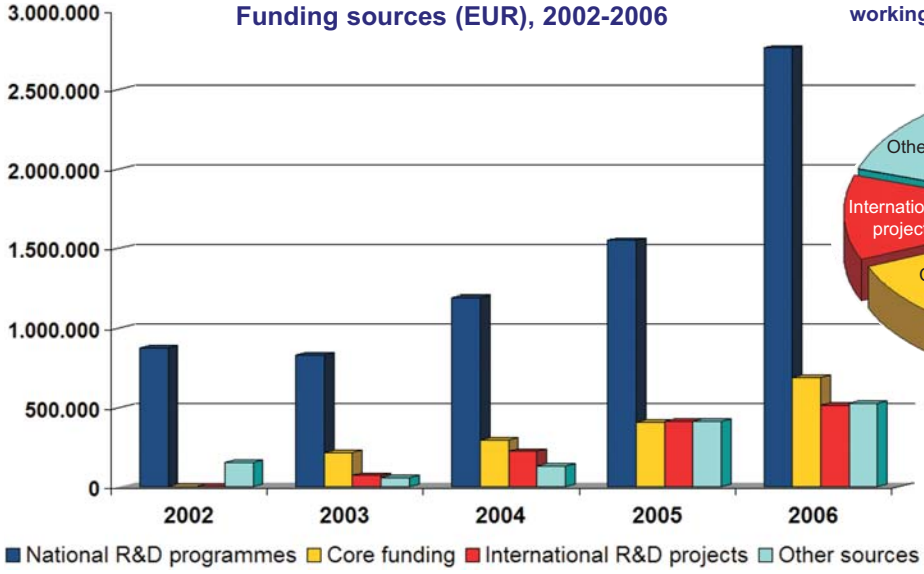
The number (and age distribution) of specialized IMT personnel temporarily working abroad (22) is shown in Fig. 3 in comparison with the personnel active in the institute (91).



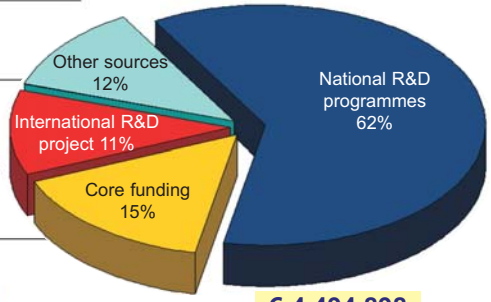
Funding sources.

Fig. 4 shows the **funding sources** in 2006 (a) as well as the evolution in the last five years (b). As the number of personal remained almost constant, **the substantial increase of funding** determined not only an increase in salaries but also acquisition of new equipments. In 2006, the majority of total funding (62%) comes from national R&D programmes (competitive funding, through open calls) and only **15% is provided by core funding** (public money available to national institutes for R&D, since 2003).

Funding sources (EUR), 2002-2006



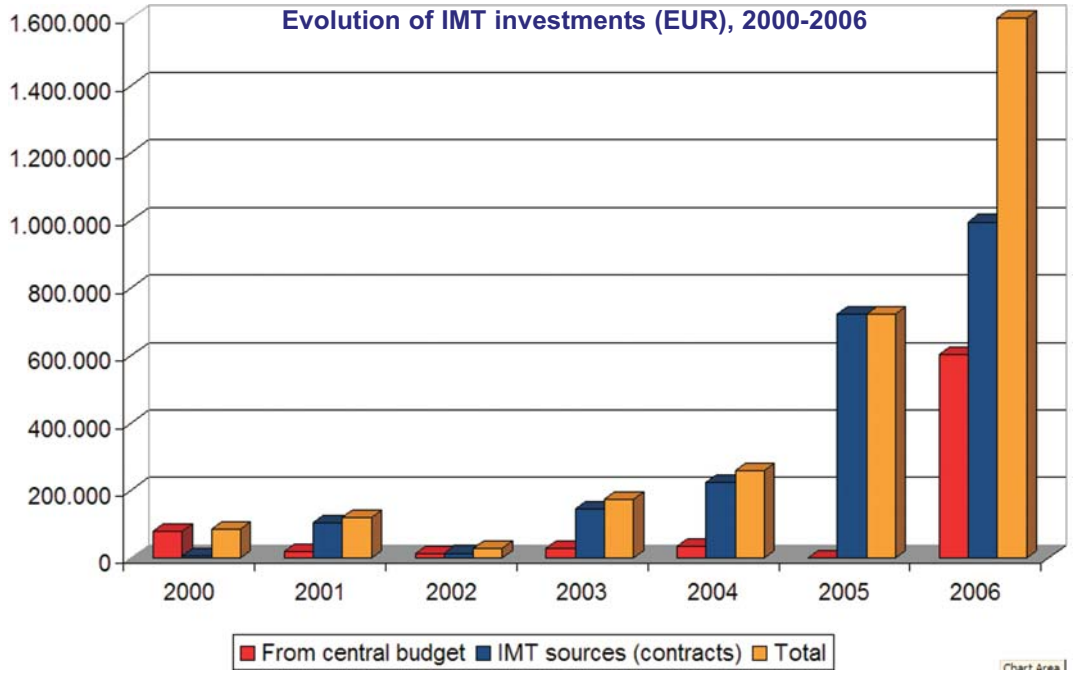
Funding sources (EUR), 2006



€ 4.494.898

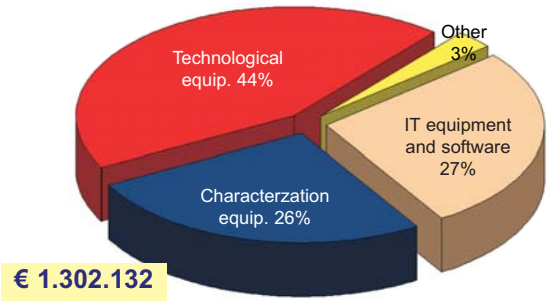
Investments: dynamics and structure.

The dynamics of investments during the ten years of existence of IMT as a national institute (2000-2006) is even more spectacular. Fig. 5 shows the evolution from 2000 to 2006. 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 the last year. The substantial increase in investments during the last three years was provided to a large proportion by **funding from R&D contacts financed from the national programmes.**



The structure of these investments is shown in Fig.6. For the time period (2001-2005) a substantial part of the money (44%) went into technological equipment (Fig. 6.a). The increase of the total amount of money in the last year was dramatic (**the total money invested in 2006** represent 135% from the money invested in the previous five years). The investments for technological equipments had increased by 150% in 2006, reaching 72.5% from the total (Fig. 6.b), whereas the characterization equipments maintains to a significant percentage (20%).

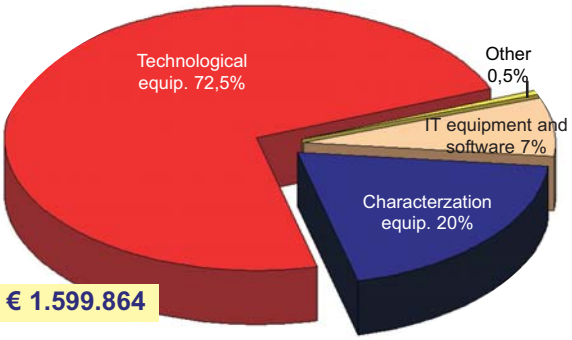
IMT investments, per category 2001-2005



€ 1.302.132

Note: The use of these new equipments will be shared with many partners in R&D projects financed by national programmes. The **number of these partners in the projects coordinated by IMT** is very high, as shown in Fig. 7. The partnership with many other research institutes provides the multidisciplinary character of research, whereas the orientation towards applications is certified by the presence of companies in these consortia.

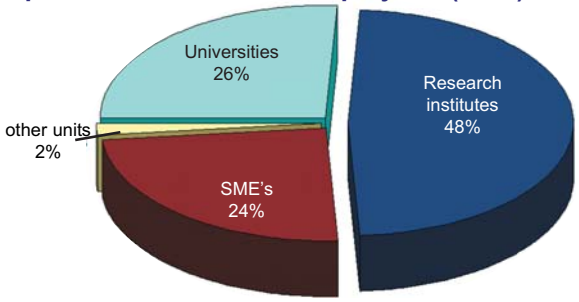
IMT investments, per category 2006



€ 1.599.864

Three S&T networks are focused on common laboratories already installed in IMT (NanoScaleLab and NanoBioLab). IMT is acting as a "technological pole" (providing also access of companies and Ph.D. students).

58 partners in national R&D projects (2006)



It is worth while to note that the presence of IMT in successful FP6 research proposals was certified before the substantial upgrading of equipments accomplished in the last two years. Today, IMT has much more to offer in this respect.

L1: Laboratory of Nanotechnology

Affiliated to the Romanian Academy (of Sciences)

- Mission
- Main areas of expertise
- National and International networks
- International research grants
- Research Team
- Instruments and equipment
- Awards

• **MISSION:** Nanomaterials and nanostructures: design, modelling/simulation and technological experiments.

• **MAIN AREAS OF EXPERTISE:** The research activities carried on in Laboratory of Nanotechnology can be divided into three areas which are: Functional nanomaterials, Nanobiosystems, 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 Bio-Microelectromechanical Systems (Bio-MEMS) area focuses on the design, modeling/ simulation and fabrication of new complex devices on silicon for applications in many interdisciplinary areas, and recently results in biochips, or microfluidic systems as laboratory-on-a-chip were obtained with applications in biomedicine and environmental monitoring.

• **NATIONAL AND INTERNATIONAL NETWORKS**

• *Partner in national networks:* RO-NANOMED, CEEX (2004-2006).

• *Partner in international networks* /projects: FP6-NoE: Nanostructured and Functional Polymer-Based Materials and Nanocomposites (NANOFUN-POLY) (2004-2008); FP6-ROManian inventory and NETworking for Integration in ERA (2004-2007); MIcro-NanOSystems European Network (2005-2008); S-E Europe Regional Network of Excellence Nanosciences and Multifunctional Materials (COSENT) (2002-2006);

• **INTERNATIONAL RESEARCH GRANTS**

• *Marie Curie Host Fellowships programme*: a young researcher from our group, Teodora Ignat, was involved in the project: Nanoelectrochemistry: from the synthesis of nanomaterials to functionality; job title: Functionalization of silicon surfaces for bioelectronics; Host Laboratory: PMC CNRS - Ecole Polytechnique France, 2005-2006.

• *NATO Collaborative Linkage Grant:* 'Novel optical nanosensors on the basis of organic nanofibers', 2005 -2006, coordinated by Prof. .Dr. Horst-Günter Rubahn from Physics Institute, Syddansk Universitet, Odense, Denmark

• "Drug delivery system based on microreservoirs array with porous silicon resorbable membrane caps", Romanian-Greece International Cooperation, December 2005-2007.

• "Nanostructured silicon for optical biosensors", Romanian-Italian International Cooperation, 2005-2007.

• **RESEARCH TEAM** has multi-disciplinary expertize and is composed by 4 senior researchers (with background in physics, chemistry, electronics), 4 PhD students (with background in physics, chemistry, computers and specializations in pharmacy and biochemistry), 1 student (physics).

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

One Ph.D. student from our group working on microarray

Electrical measurement unit

• **INSTRUMENTS AND EQUIPMENT** Computers for simulation; instruments and software for electrical characterisation of nanostructures; Keithley model 6487-picoammeter/ voltage source- 2004; VOLTALAB10 and Trace Master 5; AMMT: Wet etching system with software for 4' silicon wafers, potentiostat MC, silicon etching power supply; Fluorescence set-up for LEICA DMLM with images acquisition and measurement system. We have full access to IMT technological and characterisation facilities.

• **AWARDS**

1. Diploma of Excellence for participation in FP6 competition (Irina Kleps) ;
2. The Wipo Award for Woman Inventor, INVENTIKA 2006, for invention: „Bipolar Magnetotransistor with Enhanced Emitter Injection Modulation and Carrier Deflection", Geneva and Bucharest, October 2006; (Marioara Avram).
3. Best Paper Awards "Microfluidic dynamic system for biological fluid viscosity measurements", M. Avram, A. Avram, C. Iliescu, E. Manea and C. Voitincu, Proc. of Int. Semiconductor Conf. – CAS 28th Edition, vol. 1, pp. 223-226, Sinaia, Romania.

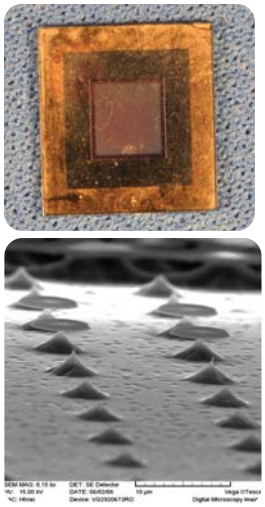
Laboratory Head - Dr. Irina Kleps (irinak@imt.ro)

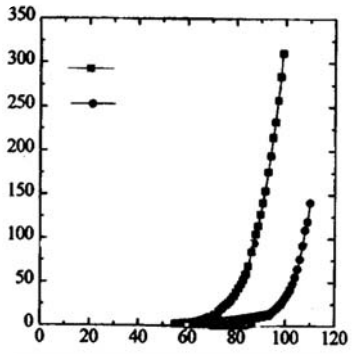
She obtained her MSc. in Chemistry Engineering, in 1973, and the PhD in chemistry in 1998 at Politehnica" University of Bucharest. *Her competence domains are*: nanomaterials, nanostructures, nanotechnology, new materials and technological development for bio-medical devices, microchemistry.

Dr. Kleps participated in several European projects: PATCOAT (hard coatings) (1994), NATO-CNR (LPCVD-TiO_2 and SNO_2 films) (1996), 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 expert* for project evaluation in the EC-FP5 (IST; Growth, Improving programmes), FP6 (NMP and Marie Curie) and MATNANTECH national program.

Other activities: Golden medal (2001), Salon International des Inventions-Geneve: Chapter „Electrochemical Nanoelectrodes", in „Encyclopedia of Nanoscience and Nanotechnology"; Co-editor of the „Nanoscience and Nanoengineering" (2002) and "Advances in Micro and NanoEngineering" (2004), (Romanian Academy); More than 100 papers published in international journals/conferences, 80 technical reports, and 4 Romanian patents.

INCREASE OF THE MICROPROCESSED SILICON TIPS FIELD EMISSION EFFICIENCY, BY LOCALIZED DEPOSITION OF THE NANO-STRUCTURED MATERIALS IN VACUUM THERMOIONIC ARC



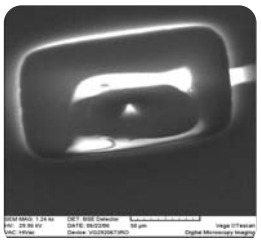


Field emission device and I-V characteristics

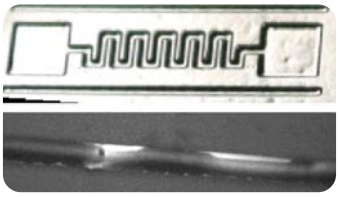
Achievements:
It was realized a demonstrator consisting in a silicon chip with an array of microprocessed tips (the square in the middle of the chip) as cathode, and a gold ring used for chip bonding with the cover conductive plate as anode of the device. Measurements were performed in a vacuum deposition tool, 10-6 torr level for vacuum.

MATNANTECH Project (2004-2006); Co-ordinator: IMT-Bucharest, Contact person Florea Craciunoiu:(floreac@imt.ro); Partners: National Institute of Materials Physics; ROMES SA.

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



DNA- Lab-on-a-chip for genetic diagnosis



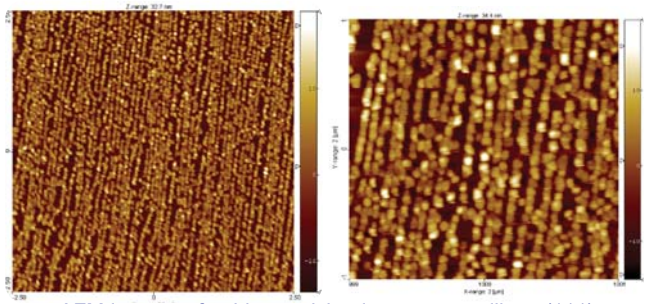
CELL-Lab-on-a-chip for in-vitro drug testing

The project scope is to design and fabricate two devices, tools for health applications, using microfluidics and microarray probes technologies: (i) CELL-Lab-on-a-chip for in-vitro drug testing and (ii) DNA - Lab-on-a-chip for genetic diagnosis.

The first type of device is dedicated to both optical and bio-electrochemical analyses of biological materials – different type of cells – subjected to external stimuli. The preliminary test structure contains an electrical circuit integrated in a microfluidic network, and fabrication of nano-electrodes on the reactor base determine the enhacement of sensitivity in electrochemical processes detection: The second type of device is designed to act as a micro-PCR (microreactor, resistor for thermal cycle, and temperature sensor) in connection with an microfluidic electrophoretic system for DNA separation (microchannel and microelectrodes).

CEEX Project (2005-2007), Co-ordinator : IMT-Bucharest, Contact Person: Irina Kleps (irinak@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

FUNCTIONALIZATION OF SILICON SURFACES FOR BIOELECTRONICS

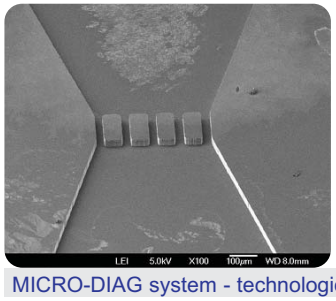


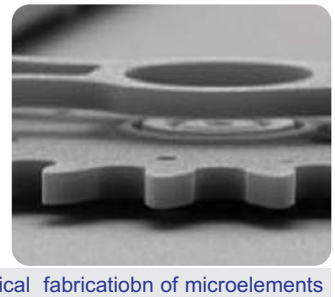
AFM images of gold-nano-islands on n-type silicon (111) substrates

Achievements:
Small metal islands were deposited on the surface of a semiconductor with the aim to obtain a particular arrangement which makes possible to increase the infra-red sensitivity by enhancement of the electromagnetic field on the surface. We have prepared by electrochemical deposition regular networks of gold nano-islands on silicon. Then we studied by IR spectroscopy the adsorption and the modification of thiol molecules on the surface of the nano-islands.

MARIE CURIE Host Fellowships programme (2005-2006), Contact person: Teodora Ignat (teodoran@imt.ro)

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





MICRO-DIAG system - technological fabricatiobn of microelements

The biodynamic analysis microsystem consists of two main modules. The first module is the microfluidic system consisting of the microgearing wheels system and microchannels system (for the determination of molecular transport coefficients in biological fluids), microchannels with high-doped walls and nanoelectrodes (for the detection, sorting and differentiating of suspended bioparticles) and heaters. The second module is the detection and measuring system.

CEEX Project (2005-2008), Co-ordinator : IMT-Bucharest, Contact Person: Marioara Avram (marioaraa@imt.ro)

MICROSTRUCTURES AND MICROGEARS WITH MAGNETIC DETECTION BASED ON GIANT MAGNETORESISTANCE NANOSTRUCTURES

A micromechanical system of gear-wheels was fabricated using silicon micromachining technology. The measurement principle is the detection of the rotation of a micromachining polysilicon gear wheels system combine the undercut and refill technique with pin-joint bearing permitting the fabrication of bushings that can be used to elevate the rotor away from the silicon surface.

Micromechanical system of gear-wheels microfabricated on polysilicon

MATNANTECH Project (2004-2006); Co-ordinator: IMT-Bucharest
Contact person: Marioara Avram (marioaram@imt.ro);
Partners: ICPE-CA, Universitatea Transilvania Brasov

ISOLATED GATE BIPOLAR TRANSISTOR (IGBT) FABRICATION TECHNOLOGY FOR HIGH POWER AND HIGH TEMPERATURE APPLICATIONS

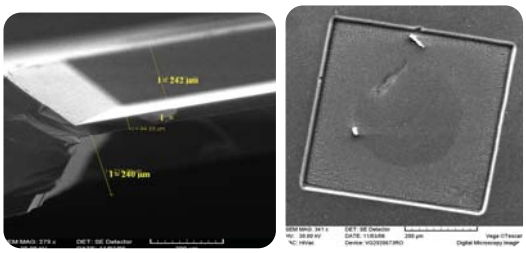
Achievements: The SiC-IGBT is used for applications that require a high breakdown voltage of 5 kV and more. The SiC devices reduce power loss and equipment size, and drastically reduce ON – resistance, too. A problem that is common to silicon carbide is that its manufacturing cost is higher than that of silicon. The proposed IGBT has one epilayer (cheaper), an buffer layer between substrate and epilayer to improving the dynamic characteristics and a guard ring / epilayer junction to increase the saturation current. The SiC – IGBT is used in applications that require: higher current conduction capability, power losses efficiently dissipated, operation at higher temperatures, up to 600^0C, and in very harsh environment.

RELANSIN project (2004-2006); Co-ordinator: IMT Bucharest, contact person: Marioara Avram (marioaraa@imt.ro);
Partners: Politehnica University of Bucharest; ROMES SA

FABRICATION TECHNOLOGY OF NANOSTRUC-TURED SILICON MEMBRANES WITH APPLICATIONS IN SENSORS AND BIOMEDICAL DEVICES

The project scope is to obtain a versatile fabrication technology for silicon nanostructured membranes that can be integrated in a complex process flow to realize devices with improved characteristics. Two wet etching processes were used for fabrication: chemical etching for crystalline Si membrane fabrication and electrochemical etching for membrane porosification. The experimental structures were characterised from morphological point of view using microscopic techniques:

The future work in this project will be dedicated development of devices based on proposed technology: humidity sensor, fuel cell and respectively biomedical system for controlled drug delivery.

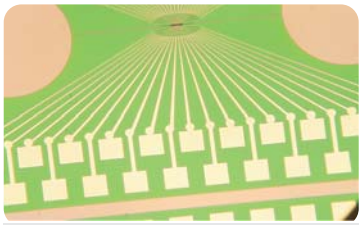


SEM images: (a) cross-section of membrane suspended at the middle of microreservoir;
(b) plan-view of membrane on the bottom of microreservoir.

MINASIST-program (2006-2007); Co-ordinator: IMT-Bucharest, Contact person: Mihaela Miu (mihaelam@imt.ro).

MICROSYSTEM FOR DNA MACROMOLECULE SEPARATION

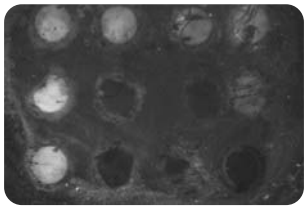
Achievements:
Microsystem realized on a silicon chip, which contains two reservoirs (for supply or collect DNA macromolecules) connected by microchanels and a line of 23 micro-electrodes. The microelectrodes are polarized in traveling wave, by a specific power supply containing 3 microcontrollers, special designed. Testing is performed using fluorescent markers, in order to control flow of the substance by the microchanels.



Silicon chip for DNA macromolecule separation

MATNANTECH Project (2004-2006) Co-ordinator: IMT-Bucharest,
Contact person Florea Craciunoiu: (floreac@imt.ro); Partners: Academy Biochemistry Institute; ROMES SA.

SILICON AND GLASS SURFACE FUNCTIONALIZATION IN ORDER TO OBTAIN BIOCHIPS FOR PRINTING MICROARRAY

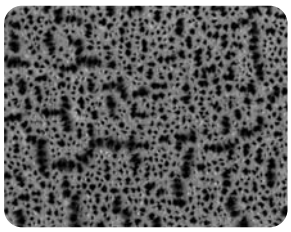


Fluorescence microscope image of the DNA/polipyrol spots

Glass functionalization with polipyrol: it was tested a structuring method with the aim to obtain conductive surfaces which are containing biological probes arrays (active bio-molecules as oligonucleotides). The process is about the immobilization of the biological probes after the electrochemical polymer film deposition on surface.

Silicon functionalization. For silicon substrate, the best results were obtained by using silanizated wafers, but it can be observed good adherence of the poly-L-lysine on silicon surface, also.

MINASIST-program (2006-2007); Co-ordinator: IMT-Bucharest, contact person: Monica Simion (monicas@imt.ro)



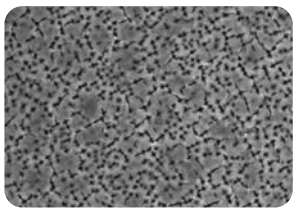
SERVICE OFFER:

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 mm) on n+ or p+ Si, 4inch diameter.

Contact person: Mihaela Miu (mihaelam@imt.ro)



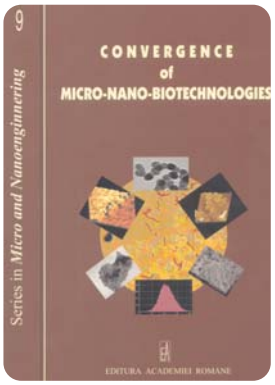
MICROARRAY BIOCHIPS:

Microarray technology includes applications for functional genomics, pharmacogenomics, SNP genotyping, proteomics and cell signaling. We have expertise for microarray manufacturing, processing, surface chemistry, detection reagents, scanning and analysis. Specific preparation protocols and probe design workflow can be developed in function of requested application. We are working using the new facilities, nano-plotter and micro-array scanner from NanoBioLab.

Contact person: Monica Simion (monicas@imt.ro)

CONSULTANCE ACTIVITIES: • nanostructures/ nanomaterials integration into the microsystems structures; • technological processes on silicon; • luminescent properties of the porous silicon; • nanostructured bioactive silicon for biomedical applications; porous silicon biocompatibility; • functionalization of silicon surface; • micro-systems for drug delivery; • magnetic sensors and magnetic nanostructurated nanomaterials; • CVD processes using liquid precursors; • project evaluation for national/international competitions.

Editing activities: "Convergence of MICRO-NANO-BIOTEHNOLOGIES" Volume 9 from the "Micro and Nanoengineering" series (edited by the Publishing House of the Romanian Academy) and includes a selection of extended and up-dated papers presented at the 5th Seminar of Nanoengineering and Nanotechnologies organized in 2 March 2006 by the Romanian Academy, Council for ERA (coordinator IMT-Bucharest). Among the editors are Irina Kleps PhD, senior research and head of the Center of Nanotechnology from IMT-Bucharest and Professor Dan Dascalu, member of the Romanian Academy, General Manager of the IMT-Bucharest.



Due to the breakthrough of nanoscience and nanotechnology in all science, the topics of the papers in this volume are various. The papers present novel results in different inter- and multidisciplinary fields, obtained in the frame of the Romanian Research Programs MATNANTECH and CEEX. Some of the papers presents results obtained in large consortiums, involving also partners from Porto University, Tor Vergata University – Rome, Glasgow University or Royal Institute of Technology – Stockholm.

The papers refers to fabrication, physical and chemical properties of nanoscale materials, atomic and nanoscale characterization including theory, modelling, simulation and experimental methods, application of functional nano-structures and nanoprocesses.

A group of seven papers from bio/nanotechnology field contributes to join the latest news related to topics such as controlled drugs delivery, nanostructure formation of seed storage protein, artificial chaperones, template nano-materials in obtaining bioconjugated for medical applications, etc .

This publication is addressed to all interested people from research institutes, universities and companies and will be distributed to the university libraries.

L1: Participation to NoE's in FP6

NANOSTRUCTURED AND FUNCTIONAL POLYMER-BASED MATERIALS AND NANOCOMPOSITES

Acronym: NANOFUN-POLY

Coordinator: Prof. José M. Kenny; Italian Consortium for Science and Technology of Materials (INSTM);
E-mail: kenny@unipg.it; Fax: 39 0744 492925, Tel: 39 0744 492939 / 39 3292332268

IMT collaboration proposals for nanobiomaterials internal projects in the frame of NANOFUNPOLY

1. Complex nanostructured matrix based on meso/ macro porous membranes or microparticles for drug delivery or tissue engineering applications

2. Investigation of hybrid (biohybrid) interfaces for biosensors.

3. Microarray technology.

4. Surface engineering techniques to investigate inorganic-biomolecular interfaces

Information on mobility

• PhD Adina Bragaru: Third Short Course on ADVANCES IN POLYMER CHEMISTRY AND PROCESSING OF NANOSTRUCTURED POLYMER MATERIALS Modelling and Simulation in Nanopolymer Processing Nanostructure by Polymer Chemistry, Florence, Italy, February 9th and 10th, 2006;

• Dr. Irina Kleps: Fourth Workshop on "NANOFUN Research Internal Projects"
Donostia-San Sebastian, Spain, September 15th and 16th, 2006;

• Dr. Florin Craciunoiu to "2nd Annual NANOFUN-POLY Meeting", Florence, Italy, June 26th and 27th 2006;

L2: Laboratory for Microsystems in biomedical and environmental applications

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

• The **Mission** of the laboratory for microsystems in bio-medical and environmental applications is research, focused on the development of microsensors (chemo resistive and resonant gas sensors), electrodes for biological sensors, micro-probes for recording of electrical activity of cells and tissues, 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. Our team was working in 20 national projects during the last 5 years, and is currently involved in 10 FP6 projects (Networks of Excellence, Integrated Projects, Concerted Actions and Specific Support Actions).

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

• **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; networks: PATENT-DfMM ("Design for Micro and Nano Manufacture") – FP6 IST NoE, 2004 – 2007, 4M ("Multi-Material Micro Manufacture: Technologies and Applications") – FP6 NMP NoE, 2004 – 2008.

• **National projects:** RO-NANOMED ("Integrated Research Network Devoted to Nanobiotechnology for Health – Romanian Nanomedicine Network); RTN-NANOEL ("Romanian Technological Network for integration in the European Platform for NANOELectronics ENIAC") – both are CEEX complex projects – technological networks.

• **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 (cmoldovan@imt.ro)

Dr. Carmen MOLDOVAN, the head of the laboratory, is also the Head of the Microtechnology Department within the National Institute for R&D in Microtechnologies 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 (FP6 project) within EUROPRACTICE. Dr. Moldovan is the vice-coordinator of the FP 6 SSA "Micro and Nanotechnologies going to Eastern Europe through Networking (MINAEAST-NET)" and "ROManian Inventory and NETworking for Integration in ERA (ROMNET-ERA)". She is involved in the **4M** NoE (NMP), working on demonstrators, in Ceramic cluster, having the goal to integrate a non-standard micromachining processes to a ceramic substrate and in the Sensors and Actuators cluster, in the **PATENT-DfMM** NoE (IST), in **INTEGRAMplus** IP (IST), dealing with technology convergence and integration and virtual design and manufacturing and **TOXICHIP** STREP (IST), as responsible for the development of temperature and pH sensors.

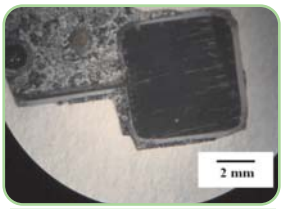
She is a **member of: IEEE and Science and Technology Commission of the Romanian Academy** and **NEXUS-PLUS** and **BRIDGE** subcontractor (and also a *member of the NEXUSPLUS Steering Committee*). The scientific activity is published in more than 55 papers in journals, books and communications in Proceedings.

E-mail: cmoldovan@imt.ro

DIAMOND-LIKE CARBON BASED BIOMEDICAL MEMS

An implantable probe for electrical activity monitoring of the living tissues was engineered and fabricated on a silicon chip. In order to improve the mechanical resistance and the biocompatibility of the device, an original technology was used for coating the implantable parts with diamond like (DLC)/carbon zero stress (CS0) films.

The microprobe was packaged using copper wire bonding, in order to allow the electrical signals reading and processing. The electronics accomplish the separation and reduction of the biological noise recording. Packaging in "pen" shape allows the device handling in biological environments, respectively insertion of small quantities of liquids in tissues and cells.

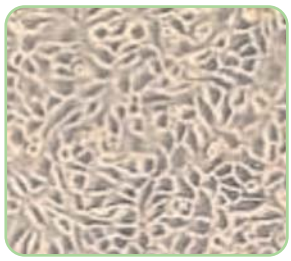


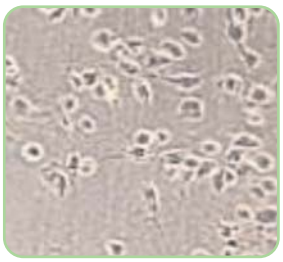
SEM picture of the device


Pen-shape microprobe mounted on an electrical board

The microprobe functionality was tested in vivo and in vitro, in specialized laboratories, by recording electrical signals from cells cultures and mice organs. The impedance measurements revealed different values for different tissues and organs, but reproducible at the same tissue/organ level.

Biocompatibility tests were performed at the National Institute for Chemical-Pharmaceutical R&D on implantable microprobes, coated with DLC/CS0, introduced in cells cultures. The standard procedure was based on citotoxicity tests in vitro, using fibroblasts cells L929. The cells viability was estimated by functional tests (evaluation of cells breath, MTT and MTS tests, protein synthesis, DNA quantification) and permeability tests.


Cells culture L929
untreated reference sample

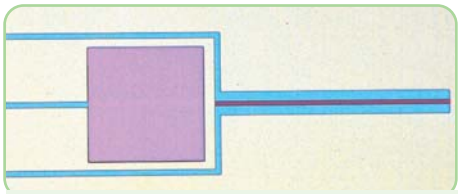

Cells culture L929
citotoxicity control

An improvement of cells adhesion and growth was observed for microprobes coated with DLC films. The extracting and contact methods proved that no significant differences exist between the viability of the treated environment and the control one, therefore no citotoxic products from the tested materials are released into the growing cell environment.

MATNANTECH project "Advanced technologies for MEMS devices with biomedical applications, based on Diamond-Like Carbon layers" – BIOMEMS-DLC.
Project coordinator: Dr. Carmen Moldovan, IMT-Bucharest

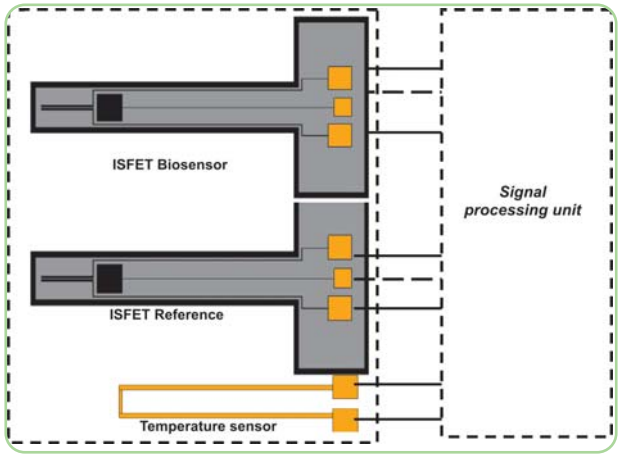
TECHNOLOGY FOR OBTAINING BIOSENSORS FOR BIOTERRORISM TOXINS DETECTION

The project aims to develop the technology for manufacturing a micro-system to monitor and detect toxins from natural environments (water, air, food). The integrated microsystem includes the biosensor that permits electrical measurements of several toxins and electronic circuits for signal processing.


Optical picture of the ISFET structure (source-drain and gate)

Field effect gas sensors are based on metal-insulator-semiconductor structures in which the enzyme deposited on the gate is detecting the toxins presence. ISFET sensors use the field effect transistors to detect very small quantities (10-3 g). Examples are biological and medical applications. The ISFET is essentially an extended gate field effect transistor with the surface of the transistor and the reference electrode.

SECURITY project Technology for obtaining biosensors for bioterrorism toxins detection" – TOXISISTEM.
Project coordinator: Dr. Carmen Moldovan, IMT-Bucharest



BIOSENSORS FOR NEUROTOXIC SUBSTANCES DETECTION

The biosensors for neurotoxic substances will be developed as ISFET-type biosensors. The ISFET structure is represented by a concentration-potential transducer, with a biosensitive layer deposited on the gate (acetyl-cholinesterases, immobilised on chitosane), which generates an interface potential on the gate.

The enzymatic ISFET structure is developed in CMOS technology and the sensor's response characteristics depend mainly on the AChE enzyme immobilisation mode.

L2: Participation to NoE's, IP's, STREP's in FP6

MULTI-MATERIAL MICRO MANUFACTURE: Technologies and Applications

Acronym: **4M**; Priority: 3- **NMP**; Instrument: Network of excellence **NoE**; 2004-2008
Coordinator: Dr. Stefan Dimov; Cardiff University; **e-mail: dimov@cardiff.ak.uk**; **http://www.4m-net.org/**

Within **4M**, IMT has an important role in several 4M clusters: *Polymers, Ceramics, Micro-Optics, Micro-Sensors and Actuators*, and also in integrating activities (assembling a critical mass in different research domains).

IMT's SPECIFIC ACTIVITIES in 4M:

• polymer and ceramics processing
• micro-fluidics – micro-manufacture platforms for high pressure & high temperature applications; micro-fluidic manufacturing operations: compatible tooling and machining processes
• micro-optics – manufacturing of micro-moulds with free form surfaces in different kind of materials; assembly and testing of micro-optical systems
• micro-sensors and actuators – simulation and design (COVENTOR, IE 3D Fidelity, ANSYS, OptiFDTD), micromachining, thin layers deposition, photo-lithography, masks fabrication, SEM, AFM, electrical characterization, packaging
• micro-components produced in different materials including IC-compatible ones

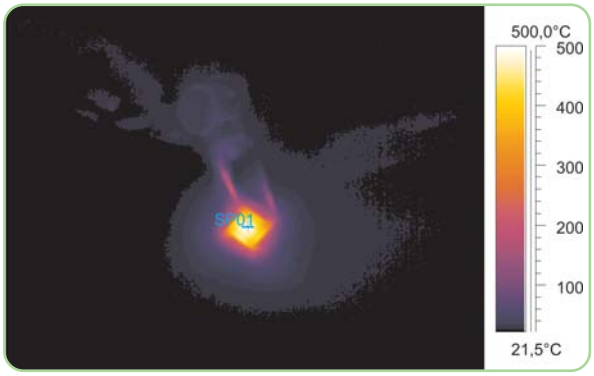
RESULTS in 4M:

Mixed technologies for gas sensors microfabrication

The main goal was developing a novel class of chemoresistive gas sensors, miniaturized, low cost and with low power consumption, by using mixed techniques such as: laser milling techniques, conductive ceramic technology, thin film technology, bulk micromachining techniques.

The sensor's operating principle is change in conductivity due to the chemisorption of gas molecules at the sensitive layer surface. Small quantities of gas can be detected by measuring the resistance of an interdigitated capacitor with a sensitive film deposited on top.

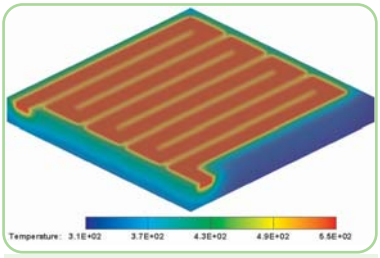
• **Ceramic Micro Heater Technology for Gas Sensors**



Heat distribution from the released heating element

The micro heaters are designed and fabricated by combining laser milling techniques and conductive ceramic technology. Trenches are created in the ceramic substrate in order to define the geometry of the heater using laser processing of the substrate. The heater is completed by filling the trenches with conductive ceramic paste and then baking to remove the solvent from the paste.

The temperature of the heater element was measured with a heat camera from FLIR 40 system comparing the case of the heater positioned on top of a released membrane and that of the non-released membrane. The heater reaches about 490° C in 5 seconds.


Thermal distribution after 0.02s at 550^{0}C

The results indicated a very uniform thermal distribution in the sensor substrate to be used in gas sensors microfabrication.

Results obtained in cooperation with 4M Ceramic Cluster.

Multi-domain platforms for integrated micro-nano technology systems – *Service Action*

Acronym: **INTERGRAMplus**, **IP**, Priority 2 -**IST**, Contract no.: 027540; 2005-2007
Coordinator: Chris Pickering; **e-mail:** cpickerig@qinetiq.com; **QinetiQ Ltd**, UK.; **http://www.integramplus.com**

Within INTEGRAMplus, IMT is involved in different ACTIVITIES, corresponding to different project tasks:
Related to Design and virtual manufacture, IMT deals with modelling and simulation for MEMS, optical and microfluidic devices as well as Silicon-Polymer hybrid simulation. Different tools will be used and analysed in order to provide complete and comparative modelling for multi-domain design and simulation.

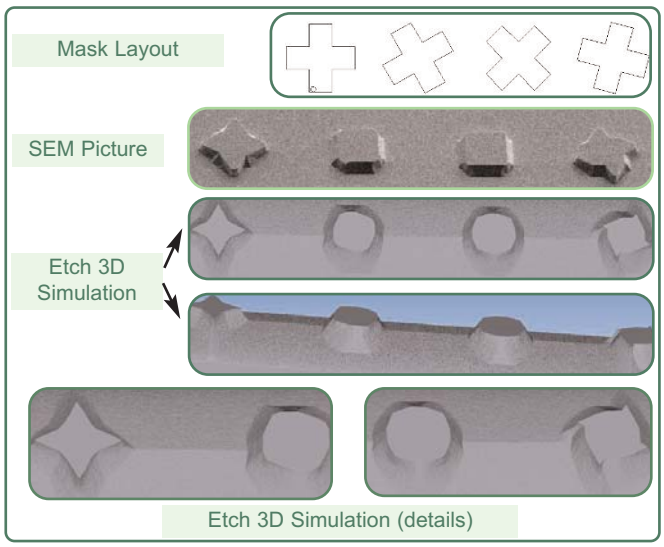
IMT is involved also in the Technology convergence and integration activities, acting in microfluidic simulation (3-D models and fluidic functions), developing methodologies for integration of bio-materials into micro and nanosystems, including new processes for biomaterials deposition, packaging and measurement.

Due to it's previous experience from FP6 SSA projects, IMT has also training and educational activities, developing new training modules for the INTEGRAMplus portfolio, preparing and delivering courses, training visits (presenting and visiting the technological facilities), organizing regional events for Eastern participants to attract industry as potential users of the project services.

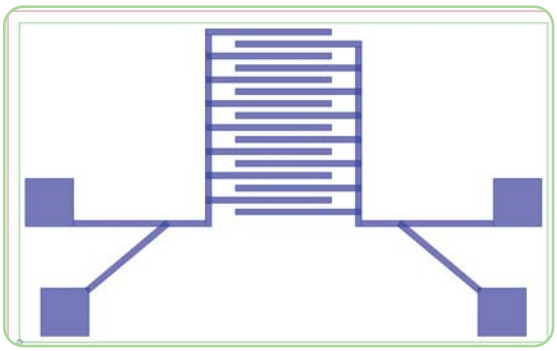
RESULTS in INTEGRAMplus:

IMT worked on calibrating a CAD tool (Etch 3D, from Coventor, Inc.) for simulating the silicon anisotropic etching. This was done by etching silicon wafers with a test mask (containing very "sensible" shapes) and comparing the results with the simulations.

The simulations were performed by modifying the internal program parameters in such a way to tune them for the maximum precision compared to the real silicon wet etchings performed in the lab. The simulations were performed using both KOH and TMAH as etchants.
Examples of simulations vs. real etchings, for KOH, 80ºC, 40% concentration:



Etch 3D Simulation (details)


Interdigital electrodes for biomaterials deposition

Also, IMT was responsible for the interdigital electrodes design and fabrication, for biomaterials deposition. Corresponding masks were fabricated and the wafers were processed. The chip will have bio-materials deposited on the inter-digital electrodes area and it will be integrated in a microfluidics module, for the biomaterials characterization. Two dimensions are available for the microelectrodes: 4.6 mm x 2.8 mm and 2.7mm x 1.7 mm. The microfluidic channels are covering the interdigitated microelectrodes, leaving the pads for electrical connections outside the channels.

Development of a toxin screening multi-parameter on-line biochip system

Acronym: **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

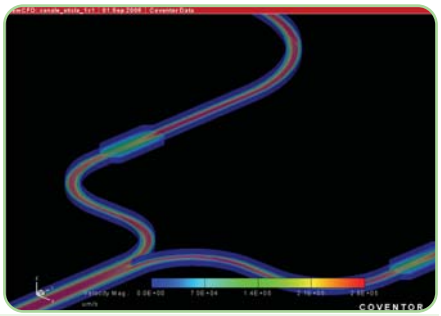
Within **TOXICHIP**, IMT is responsible for the **development of a temperature sensor, as well as a pH sensor, that will be integrated with the micro-fluidic platforms.** This objective will be carried out within WP4 (Development of Sensor Platforms), led by IMT. It will also include the development of the data acquisition system to be used with these platforms.

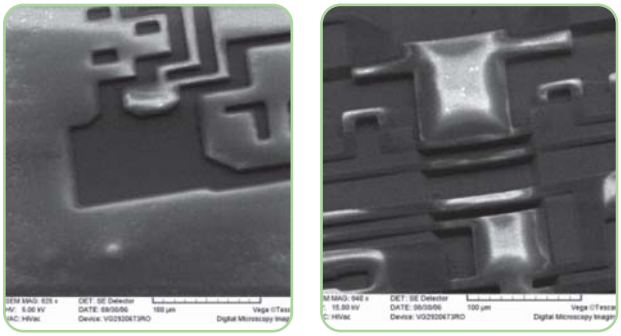
IMT's SPECIFIC ACTIVITIES in TOXICHIP:

- ***Development of temperature sensor integrated with the microfluidic platform:***
  - Simulation and design of the temperature sensor together with the microfluidic part where the sensor is integrated;
  - Study of the compatibility of the sensor with the chemical aggressive working environment;
  - Biocompatibility of the microsensor materials with the biological media;
  - Experiments, manufacturing design and testing;
- Development of pH sensors integrated with the microfluidic platform:
  - Simulation and design of the pH sensor together with the microfluidic part where the sensor is positioned;
  - Development of materials, manufacturing steps, experiments and testing;
- ***Development of the data acquisition system:***
  - Methodology on the data acquisition system;
  - Design and implementation of the data acquisition system

RESULTS in TOXICHIP:

IMT has provided microfluidics simulations (using CoventorWare), in order to analyse the designed microchannels behaviour at specific fluid flow rates. Also, IMT has developed the initial layout of the microchannels platform and worked on partial experiments for the technological implementation of the sensors platform.


Microchannels simulations (fluid flow detail)


SEM pictures: integrated sensors experiments

L3:Laboratory of micro/nano photonics

- Mission
- Main areas of expertise
- International co-operation
- Research Team
- Specific facilities

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

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

• Main areas of expertise

- modelling and simulation of micro and nano photonic structures ;
- new materials for micro/nano opto-electro-mechanical systems integration (e.g. compound semi-conductors, functional polymer, hybrid organic-inorganic nano-compozites and glasses), and related fabrication processes (including mixed technologies);
- passive and active micro-nano-photonic structures for integrating in MOEMS for bio-medical and environment applications.
- hybrid or monolithic integrated photonic circuits and optical-MEMS (including heterogeneous platforms) for optical communications, interconnects and optical signal processing;
- Optical and electrical characterization of materials and optoelectronic and photonic components.

• International co-operation

- Partener in international networks: ASSEMIC - Advanced Handling and Assembly in Microtechnology (2004-2008), EC FP6 - Marie Curie Research Training Network; 4M - Multi-Material Micro Manufacture: Technologies and Applications , NoE FP6 – priority 3, NMP;
- Bilateral co-operation with LAAS-CNRS Toulouse, France, and with University of Athens- Department for Optical Communications, Athens, Greece
- European Projects: Waferbonding and Active Passive Integration Technology and Implementation in Photonics (WAPITI), STREP- FP6, Priority 2 (IST), Thematic area:- Optical, opto-electronic, photonic functional components.

• **Research team** has multidisciplinary expertise and is composed of 5 senior researchers (4 with PhD in optoelectronics, materials for optoelectronics, microsytems, physics, chemistry), 2 PhD students (with background both in physics and photonics), 1 master student and an early stage researcher from Moldavia and 1 experience researcher from Bulgaria (trained in the frame of ASSEMIC network).

• Specific facilities:

Modelling 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 characterisation in UV-VIS-IR spectral range of optoelectronic and photonic components, circuits.

New: Research and High Resolution Raman Spectrometers LabRAM HR. High resolution confocal Raman microscope, offers unique spectral resolution and sensitivity on a bench-top microscope system.

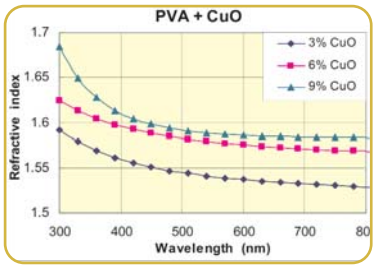
Applications: microscopy and analysis into semiconductors, nano-materials , polymers .

Laboratory Head – Dr. Dana Cristea (danac@imt.ro)

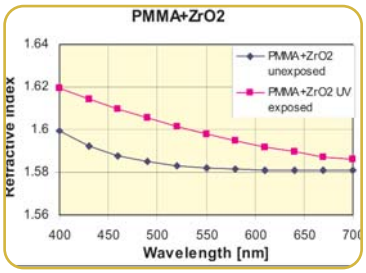
Dr. Dana Cristea obtained the MSc in Electronics (1982) and PhD in Optoelectronics and Materials for Electronics from "Politehnica" University, Bucharest, Romania. From 1982 until 1994 she was a research scientist in the Department of Optoelectronics and Sensors from the Research & Development Institute 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 has also Associate Professor at "Politehnica" University, Bucharest, Faculty of Electronics.
Her main research activities are in the fields of optoelectronics and photonic integrated circuits, optical MEMS for communications, chemo and bio-sensors with optical read-out.

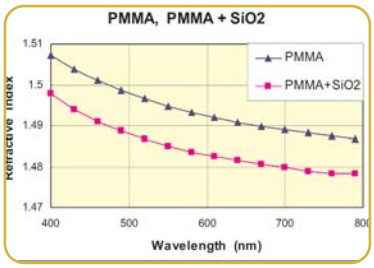
She has been more than 75 publications in international scientific journals and conference proceedings. She is also a reviewer in Romanian and international scientific journals and evaluator of European projects (FP6). She is project manager for more than 10 national and European projects.

POLYMERIC AND HYBRID NANOCOMPOSITES FOR MICROPHOTONICS



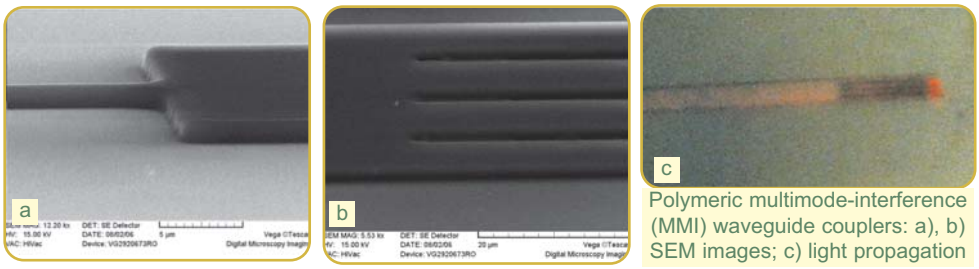
Refractive index spectra of doped PVA





Refractive index spectra of doped PMMA

Nanocomposites for photonics app-lications, with controlled refractive index in the range 1.46-1.7 were prepared by chemical route or sol-gel process, starting from polymethylmethacrylate (PMMA), hydroxyethylmethacrylate (HEMA), polyvinyl alcohol (PVA) and metal oxides from alkoxides or inorganic compounds.

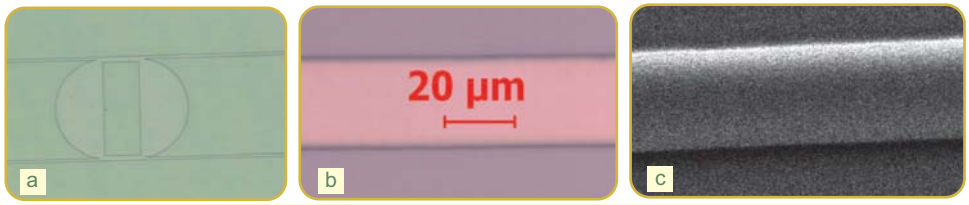


Polymeric multimode-interference (MMI) waveguide couplers: a), b) SEM images; c) light propagation

PVA was doped with CrO_3 to induce the photosensitivity, and with CuO to tune the refractive index. The refractive index of PMMA was either decreased or increased by doping with SiO_2 and ZrO_2 respectively. The optical transmission is not influenced by the dopants. These polymers can be used to fabricate waveguides and photonic circuits with the desired refractive index contrast between the core and the cladding.

MATNANTECH Project (2004-2006), Technologies for microstructures based on polymeric and hybrid composites, Coordinator: IMT Bucharest, Project manager: Paula Obreja (paulao@imt.ro)

MIXED TECHNOLOGIES FOR MICROPHOTONICS



a) Microring resonators based on SiO_2-TiO_2 thin films doped with Er_2O_3

Silicon optical waveguides on SOI wafers: b) optical magine; c) SEM imagine Si thickness: 2 µm; SiO2 thickness: 2 µm

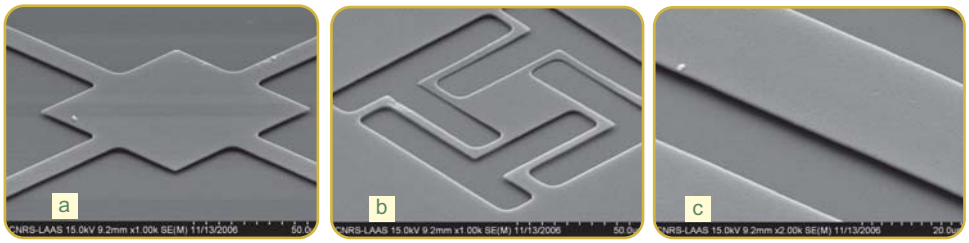
Sol-gel technology

Achievements:

- Er doped SiO_2-TiO_2 obtained using sol-gel technique - Microring resonators based on Er Er doped SiO_2-TiO_2 layers.

SOI – based microphotonic components

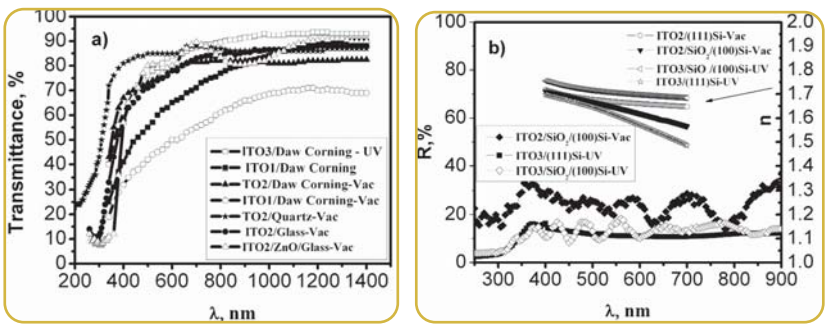
Microphotonic structures (movable micro-mirrors, optical waveguides) have been obtained on silicon-on insulator (SOI) wafers. Process steps: (i) Si etching (RIE); (ii) SiO_2 etching in HF solution.



SEM images of suspended SOI-based microstructures: a) movable micromirror 100x100 µm^2 b) movable micromirror 50x50 µm^2; c) bridge. Si thickness: 2 µm; air gap: 2 µm

Thin transparent conducting layers with optical and electrical properties suitable for micro/nanophotonic applications.

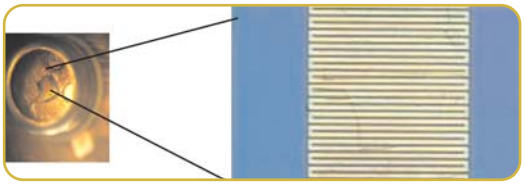
Achievements: Thin transparent conducting layers of ITO, ZnO, undoped CdS and doped with Mn, Se, Sb



The transmitance, reflectance and refractive index of TCO thin layers deposited on different substrates as a function of wavelength.

CEEX Project 2006-2008,
Co-ordinator: IMT-Bucharest,
Co-operation with Institute of Physical Chemistry "I.G.Murgulescu" of Romanian Academy, LAAS CNRS Toulouse, France, "Al.I. Cuza" University , Iasi,
Project manager: Dr. Dana Cristea (danac@imt.ro)

SILICON METAL-SEMICONDUCTOR-METAL PHOTODETECTOR (MSM-PD) WITH ZnO TRANSPARENT CONDUCTING ELECTRODES

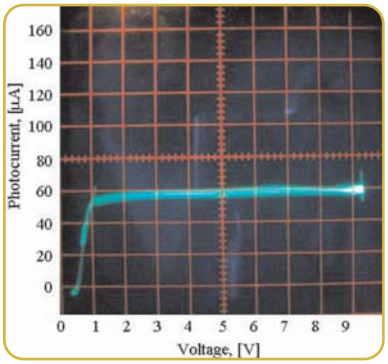


Optical image of a MSM-PD with transparent interdigitated electrodes of ZnO

MSM type structure is a fast photodetector useful in applications such as optical communications, optical interconnects, sensors by integrating with optical waveguides from polymer or other dielectric materials. Advantages compared with other high speed photodetectors like PIN or APD photodiodes: - **high frequency bandwidth** due to a lower intrinsec capacitance for the same area as PIN junction photodiode due to its planar lateral structure;

- **simple planar technological process**, compatible with silicon IC technology;
- **low voltage operation;**
- **high responsivity** due to transparent interdigitated electrodes;

An MSM structure of 0.143 mm^2 active area and finger spacing and width of 6 μm was achieved using ZnO thin films as transparent conducting electrodes. The thin layer of $Zn_{0.97}Al_{0.015}Sn_{0.015}O$ deposited on p-Si by thermal evaporation exhibits high transparency (T>85%) over a large spectral range and low electrical resistivity ($\rho \sim 10^{-4}\Omega$cm). The opto-electrical mesurements revealed an improved responsivity of 0.2 A/W in UV region (λ = 375 nm), a low capacity of 1.4pF at 10 V bias voltage and a flat response with the bias voltage for obtained MSM-PD with transparent conducting ZnO Schottky electrodes.



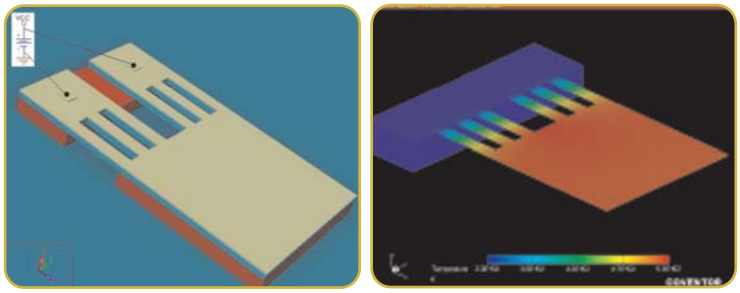
Photocurrent versus reverse bias voltage at λ = 475 nm for obtained MSM-PD structure.

MATNANTECH project 2004-2006: New processes and photonic microstructures based on Si and AIIIBV semiconductor compounds with transparent conductive thin films. Co-ordinator: IMT-Bucharest. Project manager: Elena Budianu, elenab@imt.ro

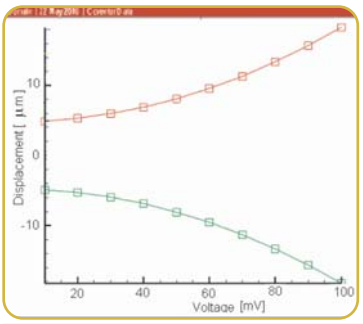
MOVABLE MICROMIRRORS ON SILICON-ON-INSULATOR

Movable micromirrors are an expending area of applications such as as miniature scanning devices, optical spectroscopy, adaptive optical systems, communication and cross connects and switches in optical systems and sensors applications. These devices can be actuated by different means, such as: electrothermal, electrostatic, piezoelectric, electromagnetic, bimorph, etc.

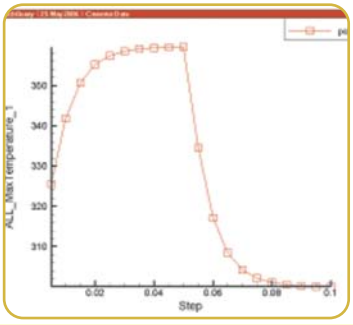
Achievements: Design and simulation of movable micromirrors on silicon and silicon-on-insulator substrate, thermally actuated based on bimorph layer . The response of the micromirrors, consisting in the displacement along z axe was investigated in static and dynamic regime using Coventor taking into account the material properties, structure geometry and dimensions and actuation conditions such as dc and pulsed voltage applied on device. The simulated micromirrors structures are based on two layers, one layer is gold and the other one is thermal silicon dioxide grown on silicon with rectangle and circular reflective surface sustained by to arms on silicon wafers.



Photocurrent versus reverse bias voltage at λ = 475 nm for obtained MSM-PD structure.



Vertical displacement of the micromirror vs. applied voltage



Thermal transient response for a period of 50 ms

MINASIST + project (2006-2008), Contact person: Dr. Munizer Purica (munizerp@imt.ro)

NUMERICAL INVESTIGATION OF LEFT – HANDED METAMATERIALS

Metamaterials are novel periodic systems, patterned at micro and nanoscale, for which the effective electromagnetic properties like electric permittivity and magnetic permeability can be artificially engineered. A very interesting class of metamaterials are the left – handed metamaterials (LHM) which present simultaneously a negative permittivity and permeability, and implicitly, a negative refraction index. Besides the interesting electromagnetic and optical phenomena occurring in LHMs, there is a plethora of novel applications in imaging (perfect lens), invisibility, waveguiding, etc. We use a combination of theoretical methods and numerical algorithms to investigate and design various LHM at microwave, infrared and optical frequencies.

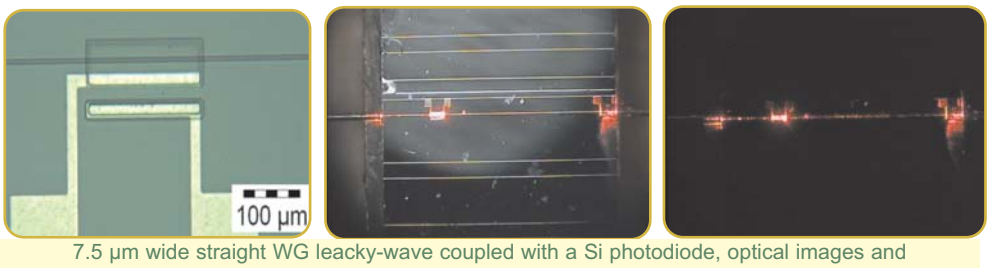
CEEX Project (2006 – 2008) Optical properties of nanostructured materials. Coordinator: IMT Bucharest , Project manager: Cristian Kusko (cristiank@imt.ro)

L3: International participation to research projects

INTEGRATED BIOPHOTONICS POLYMER CHIP

The goal of this project is to analyse the possibility of realizing compact biophotonic sensors for living cells by heterogeneous integration of optical waveguides, photodetectors and electronics within a polymer microfluidic chip.

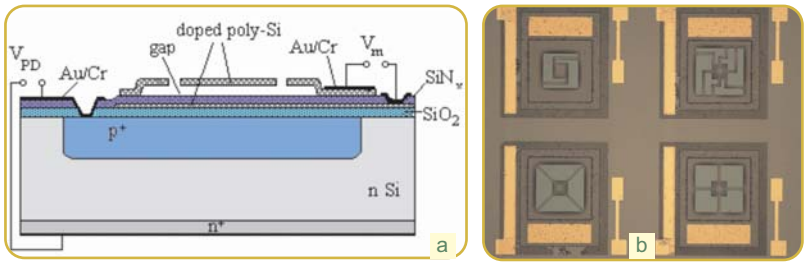
Preliminary results: heterogeneous integration of PMMA waveguides with silicon photodiodes.



7.5 µm wide straight WG leacky-wave coupled with a Si photodiode, optical images and light propagation

Joint research in the frame of the FP6 NoE MULTI-MATERIAL MICRO MANUFACTURE: Technologies and Applications (4M); Co-operation with Institute for Microstructure Technology (IMT), Forschungszentrum Karlsruhe (FZK), Germany

DEVELOPMENT OF PHOTODETECTORS INTEGRATED WITH MICROMECHANICAL AND PHOTONIC COMPONENTS FOR MOEMS

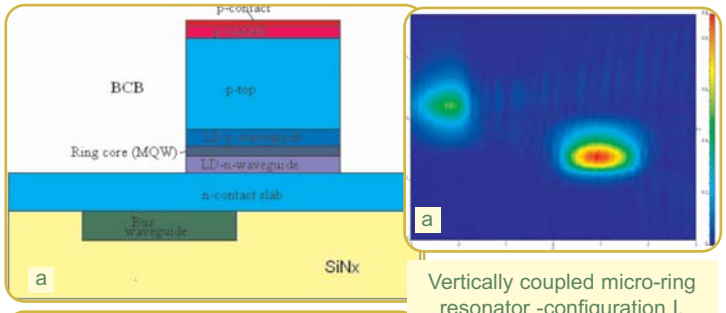


Tunable optical filter: a)structure; b)optical image

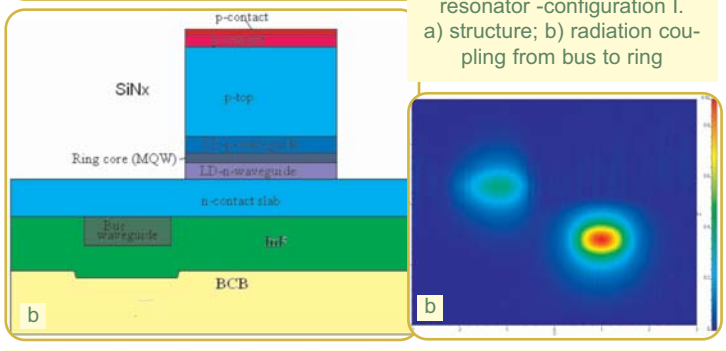
Tunable optical filter composed of a Fabry-Perot Interferometer (obtained by surface micromachining) integrated with a silicon photodiode.

Bilateral co-operation with LAAS CNRS Toulouse, France (Brâncusi project)

WAFERBONDING AND ACTIVE PASSIVE INTEGRATION TECHNOLOGY AND IMPLEMENTATION



Vertically coupled micro-ring resonator -configuration I. a) structure; b) radiation coupling from bus to ring



Vertically coupled micro-ring resonator -configuration II: a) structure; b) Radiation coupling from bus to ring

Acronym: (**WAPITI**) Instrument: STREP FP 6, Priority 2, IST *Coordinator* - Fraunhofer Institute for Telecommunications, Heinrich Hertz-Institut, Berlin, Germany; Dr. **Helmut Heidrich** (Helmut.Heidrich@hhi.fraunhofer.de).
Partners: National Kapodestrian Univ. of Athens (GREECE); Cambridge Univ., Engineering Depart.(UNITED KINGDOM); EV Group, E. Thallner GmbH, Scharding (AUSTRIA); Max Planck Institute of Microstructure Physics, Halle (GERMANY);National Institute for R&D in Microtechnologies, Bucharest (ROMANIA)

Recently, optical micro-ring resonators have received considerable attention since they provide a promising route towards very large-scale-integrated photonics. The key WAPITI structure for the miniaturisation of the optoelectronic GaInAsP/InP laser circuits is the active microring resonator which is vertically coupled to one or two transparent bus waveguides. Major advantages associated are compactness of the ring cavity (diameter of a few 10 µm), the realisation of ultra short couplers (order of 10 µm), precise control of the coupling strength with epitaxial growth accuracy, flexibility in the optimum choice of the material composition and pattern of the passive and active waveguides (optical I/O ports are located in a passive, transparent optical waveguide layer vertically coupled to an active, highly confined second waveguide layer in which microring cavities are formed).

Two configurations for of the active devices (ring lasers and wavelength converters) have been studied. The ring and bus waveguides are based on the InGaAsP material system with bandgap wavelengths smaller than 1550 nm –typically in the range from 1300 to 1400 nm. The two waveguides are grown on different substrates which are subsequently bonded to produce the micro-ring structure. All InP/GaInAsP epitaxial layers necessary for the fabrication of microring resonator devices are fabricated in a single epitaxial growth step on InP substrates.

We calculated the bus-ring and the ring-bus coupling efficiency as a function of the lateral offset necessary for optimal working properties. Our theoretical and numerical results were confirmed by the experiments done upon the passive ring resonators realized by WAPITI consortium.

L4: Laboratory of micromachined structures, microwave circuits and devices

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

The laboratory has coordinated one of the first European founded projects in **RF MEMS "MEMSWAVE"** (1998-2001). The project was nominated, in 2002 between the first ten European projects for the Descartes Prize (awarded for the best European co-operative research projects). The laboratory is one of the promoters of the RF – MEMS topics in Europe, The laboratory is participating in the FP6 network of excellence **"AMICOM"** (2004 -2007). The laboratory was recognized at national level as RF-MEMS Center of Excellence, financed by the National Programme MATNANTECH (2002-2005).

• **Mission:** scientific research and technological development of micromachined microwave and millimetre wave devices and circuits, contributions to the developing strategy of the domain. The new RF MEMS technologies including the "membrane supported circuits" represents a solution to manufacture high performance microwave and millimeter wave devices and circuits devoted to the emerging communication systems.

• **Main area expertise:**

♦Development of a new generation of circuits devoted to the millimeter wave communications based on the semiconductor (Si, GaAs, GaN) micromachining and nanoprocessing materials;

♦Design and manufacturing of micromachined, passive circuits elements: inductors, capacitors, filters and antennae (endfire and broadband);

♦Design and manufacturing of monolithically and hybrid integrated receiver front-ends based on silicon and GaAs micromachining;

♦Design, modelling and manufacturing of reconfigurable millimeter wave circuits for wireless communication systems;

♦Electromagnetic modelling of RF switches;

♦Studies on magnetostatic wave resonators in microstrip and CPW configurations;

♦Design, modelling and manufacturing F-BAR resonators on GaN membrane;

♦MEMS and NEMS technologies development.

• **International network:** Partner in the international network FP6 Network of Excellence "Advanced MEMS for RF and Millimeter Wave Communications" coordinated LAAS-CNRS Toulouse/ Univ. Perugia

• **International bilateral cooperations:** The laboratory has bilateral governmental cooperation with ITC-irst Trento, Univ Tor Vergata , Rome and CNR Rome. FORTH Heraklion, KERI Chanwong, Koreea,

• **National projects:** The national projects contributes to the development of a new generation of circuits based on MEMS and NEMS technologies, devoted to the millimeter wave communications. The laboratory had 6 projects in the MATNANTECH Programme, one in the MINASIST project, three CEEX projects (INFOSOC and RENAR programme) as coordinator, two CEEX projects as partners and three projects in the MINASIST+. National partners in these projects are: "Polytechnica" Univ Bucharest, Nat. Inst in Mat. Physics, Military Tech. Academy, "P. Poni" institute Iasi, Valahia Univ. Targoviste.

• **Research team:** has multidisciplinary expertise in physics and electronics of microsystems and is composed of 7 senior researchers (5 of them with PhD in physics, electronics, microwave and chemistry), 1 early stage researcher (PhD in electronics), two PhD students in physics and one Master Student.

Team from left to right: Dan Neculoiu; Cristina Buiculescu; Dan Vasilache; Alexandru Muller; Ioana Petrini; Gheorghe Sajin; Alexandru Takacsi; Cornel Anton; Andrei Muller; Alina Cismaru;

• **Specific facilities:** Computers and 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; Access (by international cooperation) to millimeter wave on wafer measurements. At the end of 2006 the laboratory has obtained through a successful CEEX project (Module 4) acquisited an and network analyzer with "on wafer" measurement system in the 0.1 -65 GHz range

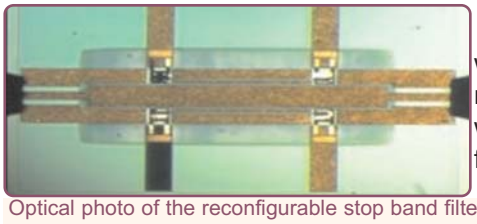
Laboratory Head – Dr. Alexandru Muller (alexm@imt.ro)

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, modelling and manufacturing of microwave passive membrane supported circuits (1997-European priority), micromachined inductors, filters and antennae, monolithically as well as hybrid integrated receiver front end modules.

Dr. Müller has coordinated the European Project FP 4 MEMSWAVE (1998-2001), and is 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. Dr. Müller is finalist of the Descartes Prize competition 2002 of the European Community with the MEMSWAVE Project, Romanian Academy Prize "Tudor Tanasescu" for "Micromachined circuits for microwave and millimeter wave applications" project); second prize for the MATNANTECH project, SIRMEMS (at CONRO 2003). He has more than 150 contributions in books and international journals/conferences.

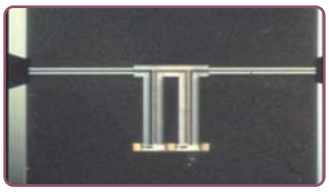
RECONFIGURABLE FILTERS FOR MOBILE COMMUNICATION



Optical photo of the reconfigurable stop band filter

New reconfigurable micromachined filters for millimeter wave applications were designed and manufactured on silicon substrate or on dielectric membrane on silicon. For the second version, two levels of micromachining were processed. Demonstrators of reconfigurable band pass and band stop filters were manufactured and characterized. Original architecture for the two cantilever shunt switch was designed.

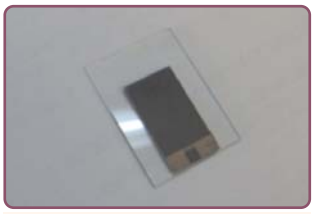
Achievements: Design and manufacturing and characterisation for cantilever type switch; design, modelling and simulation for stop band and band pass reconfigurable filters for 38 GHz.



Optical photo of the reconfigurable band pass filter

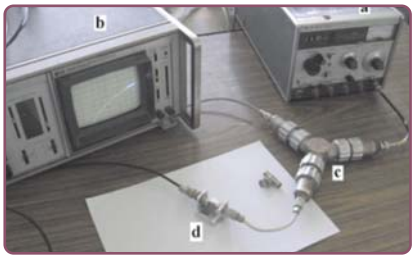
MATNANTECH Project "Silicon based reconfigurable filters for millimeter wave applications"- FIREMEMS, (2004-2006), Co-ordinator, IMT-Bucharest, Project Manager: Dr. A Müller (alexm@imt.ro)
Partners: Institute of the Macromolecular Chemistry "Petru Poni", Iasi, Military Technical Academy Bucharest

ACOUSTIC WAVE DEVICES – SAW-BAW



Micromixing SAW device glued on a microscope glass slide ready to be mounted in functional holder.

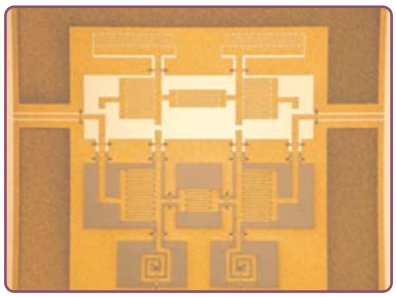
Manufacturing of a micromixer using SAW type resonators as mixing element for use in bio-medical applications, mainly in DNA in situ hybridization is in progress. Also, a BAW resonator as detecting element for environmental pollutants will be manufactured.
Achievements: Manufacturing of SAW and BAW resonators test structures; preliminary electrical characterization of these structures; experiments concerning biological compatibility of the used materials (piezoelectric ceramics used in SAW fabrication); experiments for obtaining the piezoelectric polyimides in collaboration with ICM "Petru Poni" Iasi



MATNANTECH Project: "Surface and bulk acoustic waves devices for biomedical applications and environment pollution monitoring", (2004 – 2006).
Co-ordinator, IMT-Bucharest, Project Manager, Dr. Gheorghe Ioan Sajin (gsajin@imt.ro).
Partners: INCD ICPE CA Bucharest; "Carol Davila" Medical University, Bucharest; Institute of the Macromolecular Chemistry "Petru Poni", ICM, Iasi.

Test setup for functional characterization of SAW device:
a) High frequency sweep generator; b) Network analyzer; c) High frequecy power splitter; d) Device under test in a dedicated test fixture.

MICROMACHINED FILTERS FOR DCS 1800 RANGE



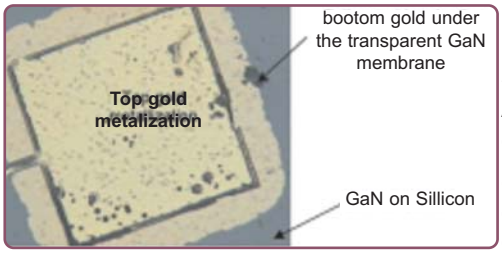
Optical photo of the DCS 1800 filter

New topology for L-C type filters based on membrane suspended inductors and interdigitated capacitors manufactured by silicon micromachining are processed. L-C type filters using MEMS technology, are key elements in microwave and millimeter wave applications such as mobile communication systems.

Achievements: Two level of micromachining for manufacturing membrane suspended inductors; new topology for micromachined L-C type filters

MINASIST + project "High selectivity filters for Rf and millimeter wave communications" (2006-2008)
Contact person Master student: A A Müller (andreim@imt.ro)

EXPERIMENTAL PROCESSES FOR GaN MEMBRANE SUPPORTED FBAR STRUCTURE



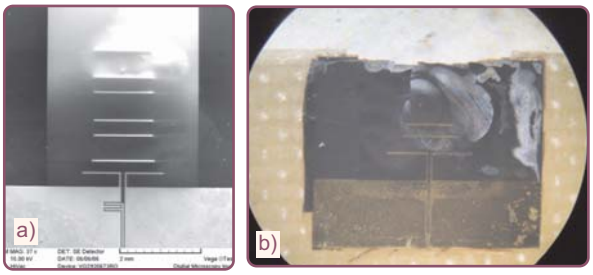
The experiments regarding membrane supported GaN FBAR structures were performed using a 2μm thin GaN layer, grown by a Riber MBE system, on a high resistivity silicon substrate (ρ>10kΩm) was used as active region of the device. The thickness of the silicon wafers was about 500μm. The grown epitaxial layer includes thin AlN layers in order to reduce the stress in the GaN layer and avoid cracking.

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 (alexm@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.

ENDFIRE MICROMACHINED ANTENNAE ON SILICON AND GaAs

Yagi-Uda antennae suspended on GaAs membrane for 60 GHz were manufactured by surface and volume micromachining using reactive ion etching. Micromachined 77GHz Yagi-Uda antennae were manufactured by anisotropic etching of high resistivity <100> silicon. Microwave characterization of the antennae was performed by "on wafer" measurements.

Achievements: Design, modelling and manufacturing of millimeter wave endfire antennae for 60 GHz and 77 GHz



a) SEM photo of 77 GHz Yagi-Uda antenna micromachined on silicon; b) Optical photo of 60 GHz Yagi-Uda antenna suspended on GaAs membrane)

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 (alexm@imt.ro);
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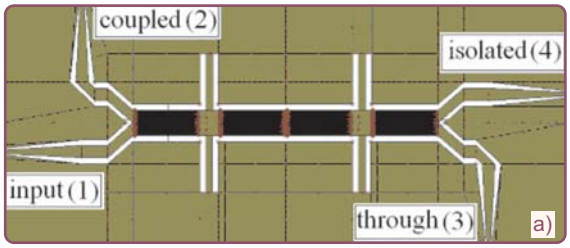
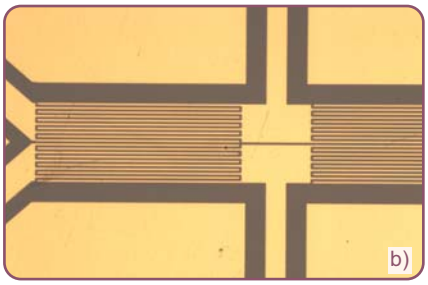
METAMATERIAL MEDIA AND DEVICES IN MICROWAVE FREQUENCY DOMAIN

Metamaterials are media with special propagation properties and applications in the entire electromagnetic domain. These materials are periodical structures obtained by microprocessing / micro-machining of ceramics, semiconductors or metals up to sub-micronic levels, (depending on substrate, frequency, and the desired application). Applications are non-conventional microwave devices (filters, resonators, miniature antennas, etc.) with different characteristics from those of similar classic devices.



Achievements: Analysis of the correlations between dimensions and geometry of these transmission media and the frequency band gaps; the function modeling of these structures and design of non-conventional microwave devices.



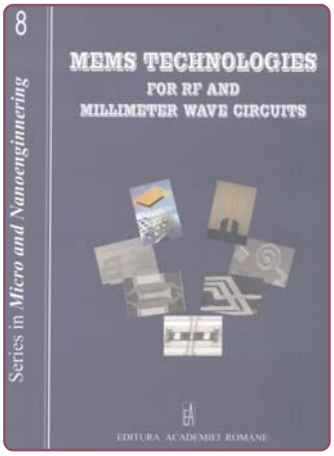
CEEX INFOSOC Project "Microwave structures and devices on microprocessed media with frequency selectivity"-ELMAG_SF (2005-2008),
Co-ordinator, IMT-Bucharest, Project Manager: Dr. George Sajin-(gsajin@imt.ro);
Partners INCDIE ICPE CA Bucharest; Politechnica University Bucharest, INCD-FM Bucharest.

CLRH directional coupler layout (a) and details from the region of the interdigitated capacitors and CPW stubs (b).

THE VOLUME "MEMS TECHNOLOGIES FOR RF AND MILLIMETER WAVE CIRCUITS"

The volume "MEMS technologies for RF and millimeter wave circuits" - editors A. M. Ionescu (EPFL), Anja Skrivervik (EPFL), A. Müller (IMT), D. Dascalu (IMT) - was launched at Orvieto in June 2006, during the **7th edition of the international Workshop 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 6th MEMSWAVE Workshop, Lausanne, 2005.

The international MEMSWAVE workshop was generated by IMT Bucharest in 1999, in the frame of the MEMSWAVE project.



L4: Participation to NoE in FP6

Results obtained by the Laboratory team in the FP6 Network of Excellence

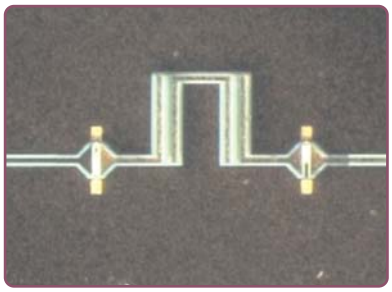
Results obtained by the Laboratory team in the FP6 Network of Excellence "Advanced MEMS for RF and Millimeter Wave Communications" (**AMICOM;** 2004-2007) – ***http:\\www.amicom.info***, coordinator LAAS-CNRS, Toulouse/ Univ Perugia. IMT contact person for **AMICOM**: Dr. Alexandru Müller, member of Board of Directors (**alexm@imt.ro**)

The research work in **AMICOM** in 2005-2006, was performed in the second year via two "North Star" Projects: "MMID – Millimeter Wave Identification" and "ReRaFE – Reconfigurable Radio Front-End". The technological research is developed together with partners from FORTH Heraklion, TU Darmstadt, LAAS Toulouse, VTT Helsinki, IMEC Leuven and ITC-irst Trento.

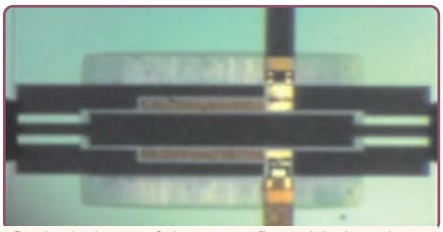
L2 - Results obtained in AMICOM project

Achievements:

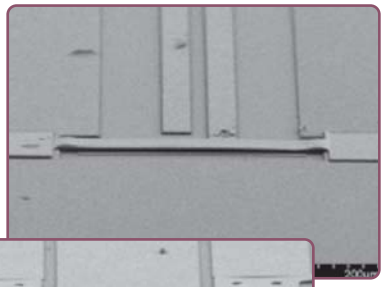
- Design, modelling and manufacturing of a membrane supported Yagi-Uda antenna for 45 and 77 GHz,
- Monolithically integrated receiver front end with a membrane supported Yagi Uda antennae
- Design, modelling and manufacturing of advanced F-BAR test structures;
- Switches for 60 GHz on GaAs substrate;
- Lumped elements filter structure manufactured by bulk and surface of micromachining;
- Architecture for the 60 GHz membrane supported reconfigurable filter;
- Diplexer filters based on FBAR resonators;
- Design of tunable bandpass and bandstop reconfigurable filter for MMID applications;
- Millimeter wave identification (MMID) system
- 60 GHz Band-pass and band-stop tunable filters using surface and bulk micromachining
- 60 GHz radiating elements (Yagi-Uda antenna)
- FBAR resonators
- Tunable band-pass filters for 1-6 GHz frequency range
- 60 GHz receiver for the MMID tag
- Demonstration of the MMID concept

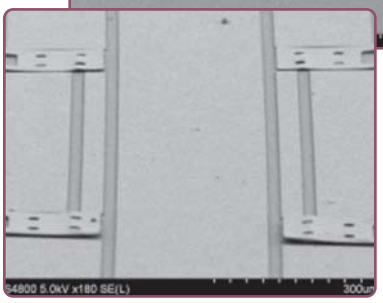


Optical photo of the reconfigurable bandpass filter for 60 GHz (IMT, LAAS)

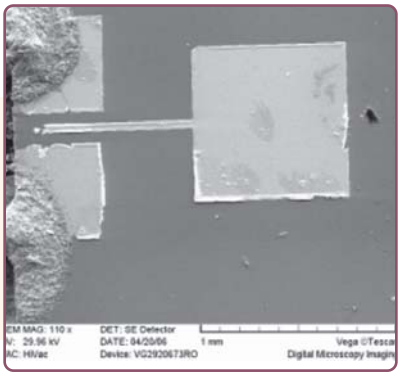


Optical photo of the reconfigurable bandstop filter for 60 GHz (IMT, LAAS)

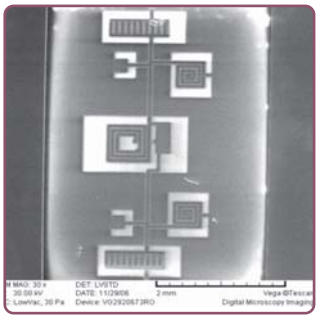


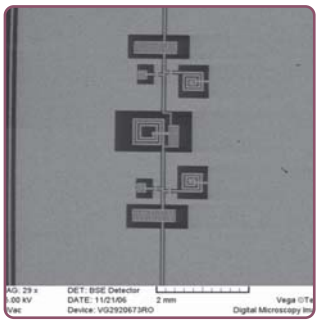


SEM photo with detail of the cantilever type switch

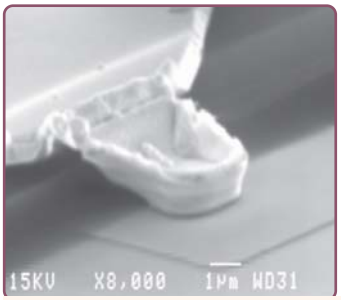


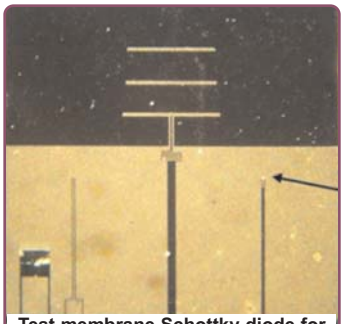
SEM photo (top side) of the GaN membrane supported F-BAR structure. The silver epoxy on the left side is used in order to provide a connection of the ground electrode to the bottom metallization of the FBAR membrane and allow measurements with GSG probes (IMT, FORTH, TUD)- Superlatices&Microstructures, 40, 2006, pp. 426-431





SEM photos of WLAN 5200 band-pass filter (top and bottom view) (IMT, LAAS) - Proc of Micromechanics Europe MME 2006, Southampton, Sept 2006, pp 125-128

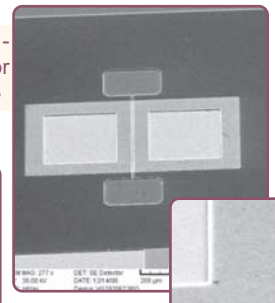


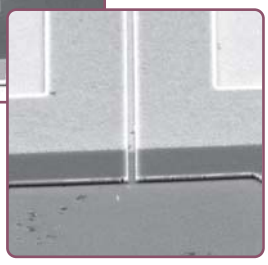


Test membrane Schottky diode for parameter extraction

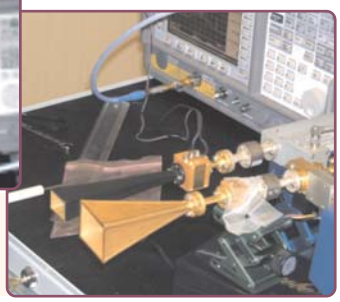
Photo of the manufactured 60 GHz receiver structure for the MMID tag and a SEM detail with of the Scottky diode (IMT, FORTH) - Proc of the SPIE Conf on Smart Materials Nano and Microsystewms 10 -13 December Adelaide 2006

SEM photos nano-oscilator based on carbon nanotube (CNT) - micromachined structure on GaAs metalized on the bottom for CNT support; trench structure 1.5x1.5μm -IMT, FORTH, LAAS





Millimeter wave TAG-experiments performed at VTT Helsinki by the IMT and VTT scientists



Millimeter wave TAG-experiments performed at VTT Helsinki by the IMT and VTT scientists

L5: Simulation, Modelling and Computer Aided Design Laboratory

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

• ***Mission:*** research, simulation and modelling activities oriented to collaborative research projects, education (short courses, seminars, workshops), services (offering access to hardware and software tools) and consulting (design/ optimization) in the field of micro/bio/nanotechnologies.

• ***Main areas of expertise:*** simulation and design of microfluidic components for biomedical applications, structural analysis, mechanical, thermal analysis, electric and magnetic field analysis, coupled field analysis of MEMS and MOEMS; design development and optimization of MEMS/MOEMS components and device (switches, microgrippers) modelling of opto-electronic devices, neural networks.

• ***Research Team:*** The team has a multidisciplinary expertise in: mathematics, physics, electronic and mechanics (5 senior researchers: 3 PhD, one physicist and one mechanical engineer, 4 PhD students.

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

• ***Specific facilities:***

• Finite element method software COVENTORWARE 2006; • Finite element method software ANSYS 5.4 • Programming tool MatLab 7.0; • Multiprocessor workstation; • Training room equipped with a computer network, used also for design and simulation with specific software packages.

• ***Research interest:*** • modelling and simulation of contact phenomena in MEMS microdevices; • determination of material parameters using FEM simulation for micro and nano materials, modelling and simulation of hard biological tissues, development of new simulation techniques, simulation and optimization of specific technological processes, evelopment and modelling of structures and assemblies for optical computers, modelling, simulation and realization of elastomer based microstructures; • application of simulation techniques to the Design for Manufacturing concept (DfM) in the field of microsystems; • diffusion of mixed fluids in microchannels and study of separation effect, modelling, simulation and characterisation of microfluidic structures as micropumps, microvalves, microchanels; • microliquid handling by electrokinetics; developing nanofluid structures for cooling microsystems obtained by plasma and laser technologies; developing silicon microchips for ADN identification; • modelling, simulation of microfluidic components for lab-on-chip structures; parameter optimization of microsystems design by genetic algorithms analysis;

• ***International networks and projects:*** the laboratory is involved in international projects as: FP6:

- **MI-Lab on chip**- "Lab-on-a-chip implementation of production processes for new molecular imaging agents- STREP (2005-2008), NMP-No 516984
- **ASSEMIC** - Advanced Handling and Assembly in Microtechnology (2004-2007), 2003-504826, Marie Curie Research Training Network - WP 2- Microhandling (Computational fluid dynamics);
- **PATENT** - Design for Micro & Nano Manufacture (Packaging, Test and Reliability Engineering in Micro & Nanosystem Technologies)- NoE No.507255, (2004-2008), - priority 2, IST: WP 2 Modelling and Simulation; Micro Electronic Fluidics Service Clasuter.
- **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)
- **Microteaching** - New teaching and learning methods and basic qualifications in job education Leonardo da Vinci- Microteaching (Contract nr. 146157, 2004-2007)

The laboratory offer simulation, consulting and training services in micro and nano domains; Application areas: microsensors, MEMS, MOEMS, microfluidics, RF MEMS.

Laboratory Head – Dr.Raluca Muller (ralucam@imt.ro)

Raluca Müller received the M.Sc and PhD in Electronics and Telecommunications from "Polytehnica" University of Bucharest. From 1978-1994 she was research scientist with ICCE Bucharest; since 1994 she is with IMT Bucharest.

Currently she is Head of Development in Information Technologies Department and Coordinator of the **Simulation, Modelling and Computer Aided Design Laboratory.**

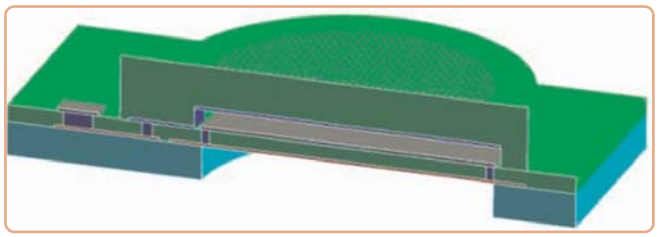
Her main scientific interests include design, modelling and technological processes for micro-electronic devices, integrated optics, microsensors and microsystems. She was involved in teaching activities as associated professor at University "Valahia Targoviste".

She is leader of national research projects and scientist in charge from IMT in international projects as: *IMPACT Project* (FP5) with CNRS – LAAS Toulouse (2003-2004), FP 6: *ASSEMIC- Marie Curie Training Network* (2004-2007)- FP6- *PATENT (Modelling and Simulation cluster)* and *Leonardo da Vinci – Microteaching Project*. She is author of more than 55 scientific papers presented at conferences and published in journals (Sensor&Actuators, J. of Micromechanics and Microengineering, Optical Materials, J. of Microsystem Technologies, etc).

L5: Participation in FP6 projects

Design for Micro & Nano Manufacture

Acronym: **PATENT-DfMM,** NoE-FP6**,** Priority 2 **IST,** Contract No. 507255,
Coordinator – University of Lancaster, UK; **Dr. Andrew Richardson (A.Richardson@Lancaster.ac.uk)**

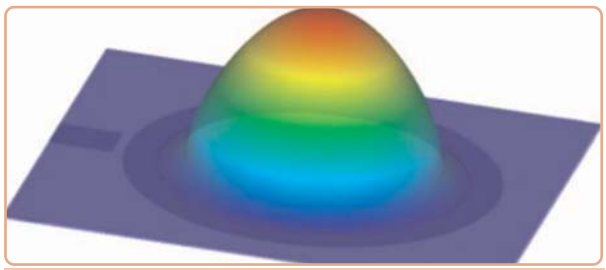


Device modelling-Cross section through the microphone structure

L5 was involved in WP2 - Modelling and Simulation in different proposal Round Robin, Flagships as BioDrop and Hermecity.

Modelling Effects of Packaging on MEMS - Round Robin Modelling Study

Partners: Tyndall National Institute and QinetiQ - leaders, University of Lancaster, HWU - Edinburgh, IMT – Bucharest, BUTE, POLIMI, ULG, WUT, IZM-Berlin



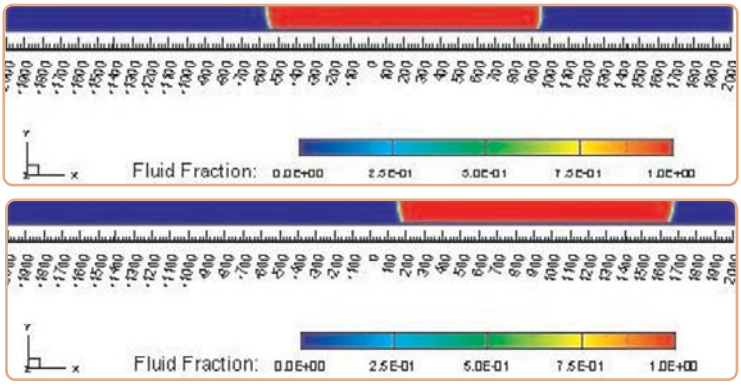
Mechanical simulation-Displacement of the membrane under acoustic pressure (120 dB) (exaggerated displacement)

Objectives: • Compare simulation results across a range of modeling tools and modeling approaches
• Fabrication, test and characterization of three micro-mechanical test structures

Results: Modeling the structures; Simulation of the residual stress effect on the test structures; Simulation of mechanical and electrical behavior under working conditions. **Example** of Capacitive microphone structure.

Contact Person IMT: Phys. Catalin Tibeica, PhD Student, catalint@imt.ro;

Droplet-Based Micro-Electronic Fluidic Operations for Production and Evaluation Platform BioMEMS (BioDrop)

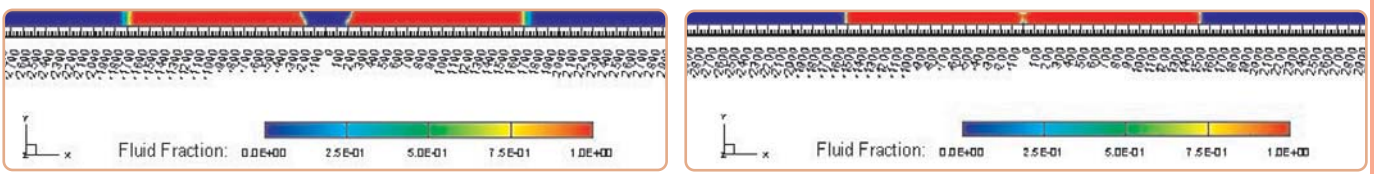


Various steps during the simulation of droplet transportation.

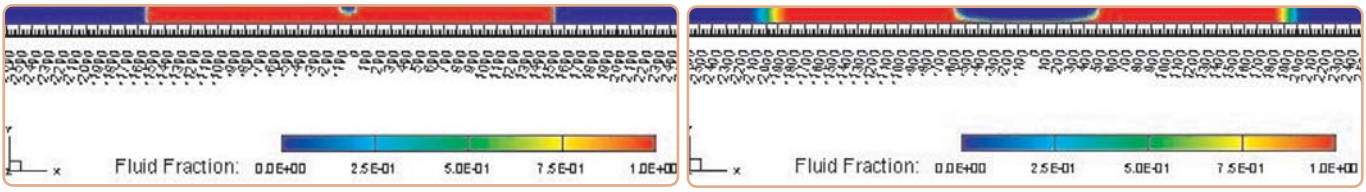
Partners: CTIT University of Twente (NL), CCLRC Daresbury (UK), QinetiQ Ltd, Winfrith (UK), MESA+ Enschede (NL), MultiSynTech GmbH, Witten (G), University of Lancaster (UK), Pepscan Systems BV, Lelystad (NL), LIRMM, Montpellier (F), **IMT-Bucharest** (RO)

The role of IMT-Bucharest, in the frame of the **BioDrop project** consists in study and simulations of simple test structures for droplet fluidic operations, like transportation, merging of droplets and splitting of droplets. The electrical control of small volumes of liquids was performed by electrowetting, which can be used as a very fast and efficient mechanism to deliver and mix micro- or nanoliter volumes of liquid droplets with a relatively low electrical potential and power consumption. We have used the **Bubble-DropSim Module** of the **CoventorWare 2006** simulation software.

We also succeeded to perform simulations for merging two droplets and for splitting a droplet.



Various steps in the simulation of mixing of two droplets.



Various steps in the simulation of the splitting of a droplet in two.

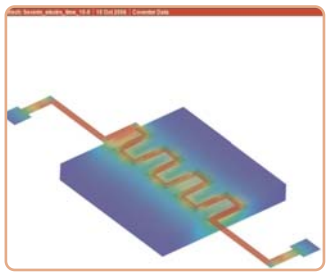
Contact Person IMT: Mat. Irina Codreanu- PhD Student, irinac@imt.ro

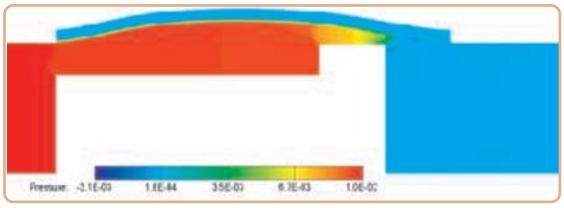
MI-lab on chip-Lab-On-A-Chip Implementation of Production Processes for New Molecular Imaging Agents

Acronym: **MI-lab-on-chip,** STREP-FP6**,** Priority 3 **NMP,** 2005-2008**,** Contract No. 221105

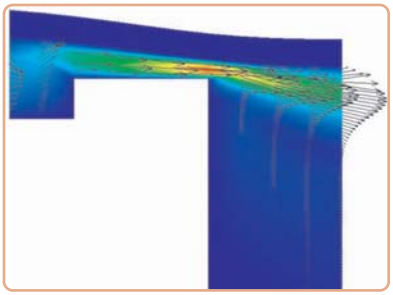
Partners: ***Liege University, Belgium – Leader***; Trasis S.A., Belgium; Bartels Microtechnik GmbH, Germany; IMT-Bucharest, Romania; University Henry Poincare – Nancy I, France.
Objective: Developing multiple steps radio-pharmaceutical chemistry processes at the micro molar scale.

The purpose of this project is to develop multiple steps radio-pharmaceutical chemistry processes at the micro molar scale in disposable, automated and miniaturized systems to be used at the time the products are injected to the patients. The platform will include a smart, single use "lab-on-a-chip" component, in which the process for a given compound is carried out. The chip will integrate and combine microfluidic function and specific chemical functions.
IMT contribution: Workpackage 2: Micro-engineering: Design of the chip functionalities; Validation of performances as function defined specification; **Workpackage 7**: Simulation: Modeling/simulation of functionalities to improve working and performances parameters; **Workpackage 8**: Project Management. **Tool:** *Software package COVENTORWARE 2006 dedicated to MEMS and microfluidic design and simulation.*
Result: • Characterization of pneumatic micopump behaviour; • Characterization of thermal components;

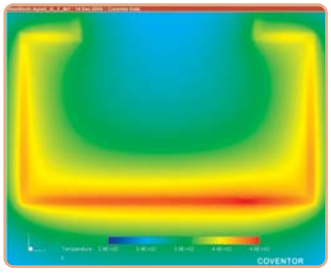




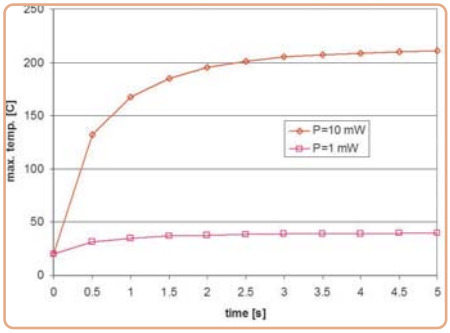
Fluid pressure distribution in the chamber (MPa)



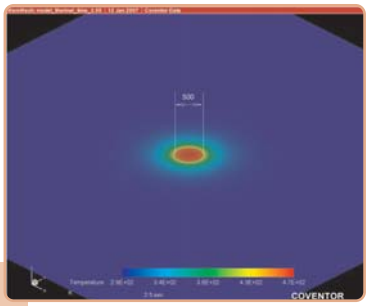
Relative representation of velocity vectors



Fluid-Structure Interaction between fluid and check valve in the pneumatic micropump

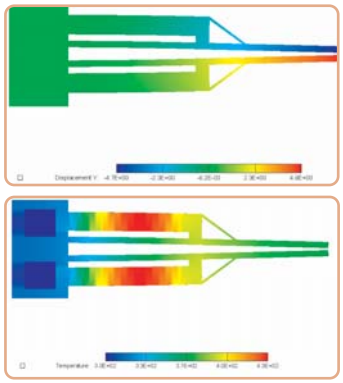


Electrothermal heating: simulation for various resistor geometries - Heating by laser beam



Contact Person IMT: Mat. Oana Tatiana Nedelcu - PhD Student, oanan@imt.ro

Oana Tatiana Nedelcu is mathematician and work in Modelling and Simulation Laboratory as Scientific Researcher. She is also PhD student at "Polytechnica" University of Bucharest. Her scientific expertise refers to computer aided design and simulation for microfluidic structures. She is involved in training activities and technical support in this area.



SENSORS AND ACTUATORS MICROSTRUCTURES FOR MICROROBOTIC POZITIONING, MECHANICAL AND BIOLOGICAL MANIPULATION- MEMSAS

The project will contribute to solving problems of micro-assembling, positioning and manipulation. It requires an **interdisciplinary** research, in the area of **micro- and nano- technologies**, focused on the development of some mobile micro-mechanical structures, of optical positioning sensors and of microstructures usable in **biologic material manipulation.** Preliminary results of the simulations for a SU8 polymeric micro-gripper, electro-thermally actuated, using COVENTORWARE 2006 are shown.

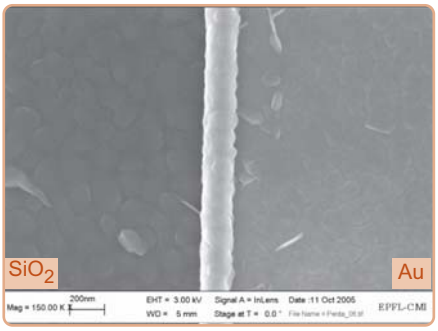
FEM simulation: of the closing arms of the microgripper, when a voltage of 0.2V is applied (scale in μm - top); of the temperatures in the arms of the microgripper when a voltage of 0.2V is apply (rigth)

CEEX (2005-2008); Project coordinator: Dr. Raluca Müller – IMT Bucharest (ralucam@imt.ro)
Contact person: Mat. Rodica Voicu - PhD. Student (rodicav@imt.ro)

UNIT OF ANALOGIC OPTICAL PROCESSING OF IMAGE TYPE INFORMATION

The project continues the previous original research of the project coordinator in the field of optical neurons. The project scope is developing novel algorithms for optical information processing of information and designing the architecture of a such an optical processing unit. What is important is the fact that images are processed by all optical means. The consortium comprises, excepting IMT-Bucharest, two companies and an university.
Project type: CEEX; Project coordinator: Dr. Gabriel Moagar-Poladian – IMT Bucharest (gabim@imt.ro)

ADVANCE STUDIES IN OPTICAL CHARACTERIZATION OF SEMICONDUCTOR NANOMATERIALS AND MANODIVICES



SEM image of the pentacene layer deposited on SiO_2 and the Au contacts. Grains with average size of 150 nm were formed at a deposition rate of 3 Å/min.
Dark output characteristics of (organic FET transistors) OFETs. The channel parameters are: W=500, L=20 and 50 μm. Vg= +15V,-15V. *CAS Conference Proceedings, p. 315.*

The aim of the present project is the theoretic and experimental investigation of optical phenomena in complex inorganic and organic nano-structured systems. Photoluminescence spectroscopy will be used as the most important characterization tool for optical properties investigation.

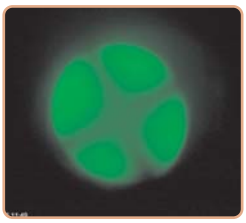
The physical mechanisms of carrier generation and recombination for photoluminescence emission will be investigated in the visible range (200-700 nm) and in the infrared range (800-2200 nm). For spectral analysis of emission in the infrared region acquisition of a photospectrometer working in this range is scheduled in the frame of the project. Experimental measurements will be carried out on Er doped nanocrystalline Si/SiO_2 (nc-Si/SiO_2:Er) films and on organic (pentacene) thin films. The objective is to investigate optimum excitation bands and the energy transfer processes in nanocrystalline semiconductors and organic semiconductors. The impact of light excitation on the characteristics of thin films transistors with organic active layers will be also studied.

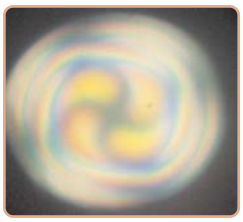
Project type: CEEX II Research projects for researchers reintegration
Project coordinator: Dr. Rodica Plugaru – IMT Bucharest (rodicap@imt.ro)

NON-CONVENTIONAL MATERIALS FOR MICROTECHNOLOGY – RESEARCH AND EXPERIMENTATOPN OF ELASTOMER -BASED MICROSTRUCTURES FOR APPLICATIONS IN THE FIELD OF MICROSYSTEMS

Photo of an experimental model of the reflective conoscope, developed in cooperation by IMT-Bucharest and S.C. ProOptica S.A.

In 2006 it was made and tested successfully the experimental model, in cooperation with S.C. ProOptica S.A. It is based on an idea developed by dr. Gabriel Moagar-Poladian and patented by IMT-Bucharest, the invention receiving the Silver Medal at the Bruxelles Fair of Invention in 2004. The reflective conoscope prototype is made under a national project aimed at realizing elastomer based microstructrures, project led by dr. Gabriel Moagar-Poladian from IMT-Bucharest. Attached are some images of the experimental model as well as of some reflective conoscopic images obtained with the experimental model. Now is under realization and certification **a prototype of a reflective conoscope.** Attached is also a brochure regarding the reflective conoscope and its applications. We succeeded in obtaining the reflective conoscopic image of a 190 microns thick quartz sample, quartz being known as having a small birefringence.





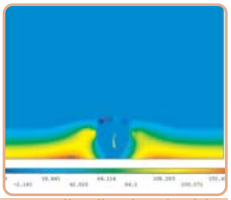
Main application domains: Integrated optics and optoelectronics, integrated ferroelectrics and piezoelectrics, materials science and engineering, process monitoring in optoelectronics and integrated optics technology , -geology and mineralogy gemology.

Project type: CEEX No.15I/2005, (2005-2008); IMT-Bucharest (coordinator), S.C. ProOptica S.A. (Laboratory of Optical Measurements) . Project coordinator: Dr. Gabriel Moagar-Poladian – IMT Bucharest (gabim@imt.ro)

KNOWLEDGE BASED ECOLOGICAL MATERIALS FOR FIRE PROTECTION, WITH SECTORIAL AND INTERSECTORIAL APPLICATIONS–ECOMAF

Experiment for measuring the insulating effects of paint; the foaming of the paint exposed to high temperature

Objective: The aim of this project is to develop a highly protective paint against the heating of fire. This paint will cover structures like metallic reinforcements for buildings, walls, gas tanks, etc. providing enough thermal insulation for certain time (until the fire is extinguished). The principle of this protectiv paint is to develop bubbles of gas when the paint is exposed to the fire. This way the thickness of the layer will become considerable, and the thermal conduction will be reduced due to its porous structure. Due to the complexity of phenomena, the ANSYS simulation was carried out by IMT with only one bubble of gas in the layer of protective paint.



Pressure distribution inside the gas bubble (ANSYS)

CEEX project (2005-2007). Coordinator ICEMENERG, IMT-Bucharest partner, Eng. Phys. Victor Moagar-Poladian (victorm@imt.ro)

COMPUTER AIDED DESIGN OF MICROFLUIDIC COMPONENTS

Main Objectives 2006: • Design of actuating microcomponents to optimize the fluid handling: microvalves and micropompes; • Study of ionic liquids to be used in biomedical applications

Main Results: • Design of actuating microfluidic components with various actuation principles; • Studies on Multilayer Soft Litography technology to obtain microfluidc components; • Studies on ionic liquids: properties and applications in biomedical applications;

National basic funding project-2006-2008; Coordinator: Mat. Oana Tatiana Nedelcu- PhD Student- oanan@imt.ro

L6: Microphysical characterization laboratory

Mission
Main areas of expertise
Research Team
Specific facilities
National networks
Awards

• **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.

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

• ***Research Team:*** is composed of 3 senior researchers with background in Physics, Chemistry and Electrical Engineering and a research assistant.

• **Specific facilities:** home-built non-commercial Atomic Force Microscope (maximum scan area: 20 μm x 20 μm, vertical resolution: 2 nm, lateral resolution: 20 nm). (A state-of-the-art **Scanning Probe Microscope** will be acquired in 2007 within the CEEX project **Nanomorph**).


Electro-thermal characterisation unit

TESCAN VEGA II LMU **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), **Raith Elphy Plus** pattern generator for Electron Beam Lithography, professional software for advanced image processing **SPIP™ - Image Metrology** (contains specialized tools for analysing and correcting AFM data: *visualization*, including a 3D visualization studio, *measure and analysis* (roughness analysis, grain and particle analysis), *reduce noise and enhance features* (correlation averaging, filtering and extended Fourier filtering), *calibration, tip* characterization).


TESCAN VEGA II LMU **Scanning Electron Microscope**

On-wafer electro-thermal characterization equipment for micro and nanostructures.

• **National networks:** Network of scientific services for nanoscale structuring and characterization, with applications in the development of convergent technologies NANOSCALE-CONV, Romania - Scientific Network of Services, CEEX Programme starting 2005

• ***National Projects:*** Our lab is the coordinator of **NANOMORPH** (Accredited laboratory for morphological analyses at nanometric scale) - CEEX/INFRAS project, 2006-2007 and a partner in other three national projects: „New methods for controlling the molecular anchoring of liquid crystals on polymeric surfaces for display cells using in-plane-switching" - CERES project, 2004-2006, **SIDISANIZ** (Surface and organization phenomena in disperse systems containing anisotropic fluids), CEEX project, 2005-2007, **MATNANOGRAN** (Production and characterization of some nanocrystalline metallic materials), CEEX project, 2006-2008.

Acting Laboratory Head – Phys. Adrian Dinescu (adriand@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 and Simulation Laboratory. Currently he is Head of Microphysical Characterisation Group.

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

He was the leader of some national research projects (Matnantech, Ceres, Orizont 2000) and partner in international projects (IMPACT, ASSEMIC- Marie Curie Training Network, PATENT-DfMM) and the author more than 15 scientific papers presented at conferences and published in journals (Sensor & Actuators, J. of Micromechanic and Microeng., Balkan Phys. Letters, Optical Materials, etc).

SERVICES:

High resolution surface morphology investigations by Atomic Force Microscopy (AFM): *• 3D surface topography recording and measurement (waviness, roughness, step heights, grains, particles etc); • x, y resolution: typical 20nm; z resolution: 2 nm; • compatible with nearly all solid samples, both conductive and non-conductive; • operates in ambient air, with no sample preparation needed; • maximum scan area: 20μm x 20 μm sample: area min. 2x3 mm, max. unlimited; thickness max: 2.5 mm, max roughness 5 μm.*

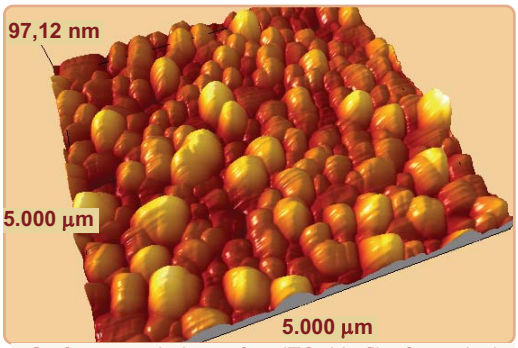
***Options:** 2D and 3D surface visualization, Inspection of image details by interactive rotation and scaling, Line-by line cross-section profile analysis, Roughnes statistical analysis, Histogram, Fourier analysis.*

AFM STUDIES OF NANOMETER-SCALE MECHANICAL PROPERTIES OF POLYMERIC MATERIALS

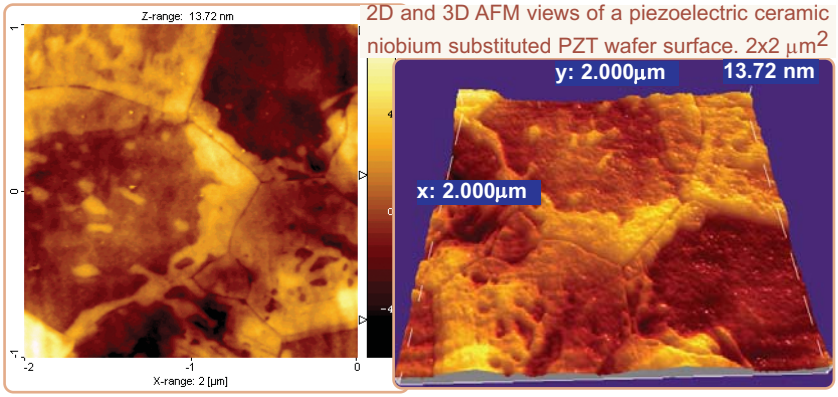
Achievements: Experimental conditions were determined for tracing force-distance curves by using a home-made AFM with various probe-samples sets. Required calibrations for the piezo driver and optical detection system were carried out using calibration gratings and stiff samples. Methods were established for appropriate displaying force-indentation curves and for deducing local mechanical properties based on contact mechanics models.

MINASIST Project: AFM applications to nanomechanical characterization of polymeric surfaces (2006-2008), Project manager: Raluca Gavrila (Ralucag@imt.ro)

SURFACE MORPHOLOGY STUDIES OF A LARGE VARIETY OF MATERIALS (SEMICONDUCTORS, DIELECTRIC COATINGS, THIN FILMS, POLYMERS, BIOCOMPATIBLE MATERIALS)



Surface morphology of an ITO thin film for optical applications – 5μm x 5μm AFM scan



2D and 3D AFM views of a piezoelectric ceramic niobium substituted PZT wafer surface. 2x2 μm^2

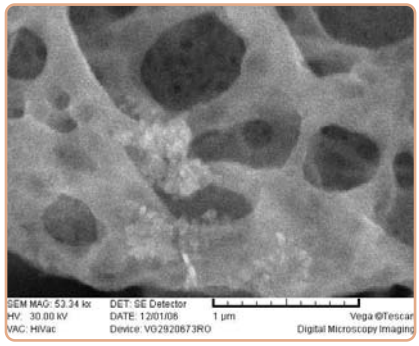
SERVICES:

Scanning Electron Microscopy *- characterization of various materials: • possibility of examination of non-conducting, water containing specimens in their natural state at low vacuum conditions in microscope chamber; • accurate and reliable automated analyses utilizing fast and precise computer controlled stage motorization, including motorised Z movement; • remote control of the microscope including stage movements control and possibility of remote diagnostics; • SE detector; • Retractable BSE detector*

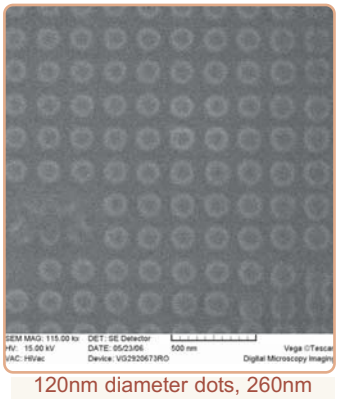
Electron Beam Lithography: *• Combining Electron Beam Lithography and Photolithography (Mix and Match); • EBL on Insulating Substrates; • Nanoelectrodes fabrication for bio nano-technologies applications; • EBL for Nanophotonics (photonic crystals, plasmon enhanced devices)*

SEM STUDIES OF SUBMICRON AND NANOMETRE SCALE STRUCTURES AND MATERIALS

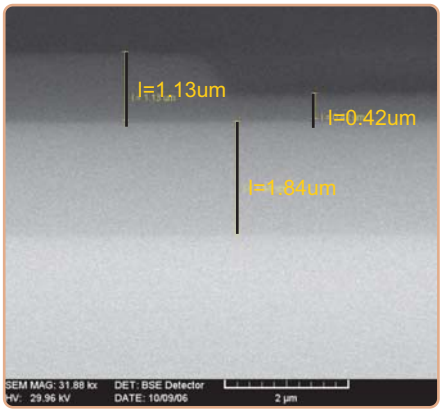
Achievements: High resolution SEM images (surface morphology and composition) for different structures and materials.



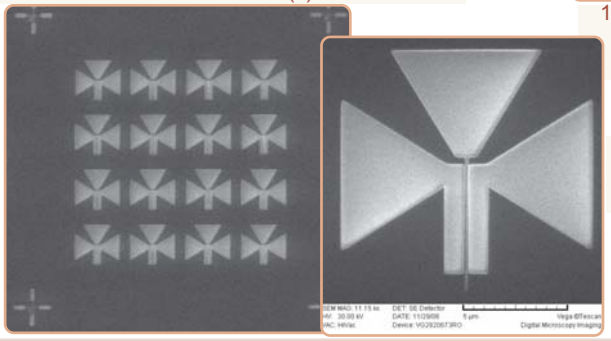
SEM image of a $La(1-x)A_xMn_{(x)}O_3$ nanopowder



120nm diameter dots, 260nm pitch, PMMA on silicon for photonic crystal applications



SEM measurement of the thickness of a photo-resist used in reactive ion etching application.



High Electron Mobility Transistor structure. Large electrodes with 200nm gap and 80nm gate line.
From left to right: the whole write field and a detailed structure

Contact person : Adrian Dinescu (adriand@imt.ro)

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 nano-structures, 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.

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

• ***Specific facilities:*** *Environmental testing:* Rapid change of temperature, Low air pressure, Damp heat, Temperature storage Mechanical acceleration, Vibrations, Salt mist, Sealing with bomb pressure test, Electrical endurance with thermal stress, etc.;

Accelerated testing: Bias & temp., Tilting & temp., Screening the reliable chips by laser acceleration of the recombination.

The Reliability Laboratory is co-operating with the Centre for Microscopy–Microanalysis and Information Processing of the University "Politehnica" Bucharest on: *Acordable Ti-Saphire Laser*


Acordable Ti-Saphire Laser

Atomic force microscopy (AFM), Confocal microscopy with laser scanning – analyses of stresses between various layer, Microscopy with laser scanning based on the analysis of the induced photocurrents, High resolution characterizations by laser beam and holographic interferometry.

• ***International Networks:*** Network of Excellence "Design for Micro and Manufacture PATENT-DfMM" - cluster "Reliability & Characterisation" (2004-2007), with 24 partners (universities, research centres, companies) from 18 European countries. The NoE contains four scientific clusters: "Testing", "Modelling & Simulation", "Reliability & Characterization" and "Packaging", all forming the workpackage WP9. Dr.M.Bazu is member of the Management Board and WP9 leader. The Reliability Laboratory is co-ordinator of four network projects: *"Reliability of MEMS basic moveable structures"* (10 partners), *„MEMS test structures for material, process and reliability characterization"* (10 partners), *„Methodology for accelerated testing and reliability analysis of MEMS"* (9 partners) and Inventory of standardization activities on MEMS.

• ***National networks:*** Contractor of the "*Development of a laboratory for assessing the quality of the product of microtechnologies 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 nano-structures 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).

Laboratory Head – Dr. Marius Bazu (mbazu@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. His recent research interests include methods for building, assessing & predicting reliability. He developed in Romania the accelerated reliability tests, building-in reliability and concurrent engineering approaches. Leader of a European project (Phare/TTQM) on a building-in reliability technology (1997-1999), Workpackage leader and Member of the Management Board of the NoE "Patent-DfMM", FP6/IST (2004-2007).

He is referent of the journals IEEE Transactions on Reliability, IEEE Transactions on Components and Packaging and IEEE Electron Device Letters. Recipient of the AGIR (General Association of Romanian Engineers) Award for the year 2000. Chairman/lecturer at international conferences: CIMCA'99 (Vienna, Austria), CAS 1991 (Sinaia, Romania), MIEL 2004 (Nis, Serbia & Montenegro). Author of more than 100 scientific papers (IEEE Trans. on Reliability, J. of Electrochem. Soc) 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.

MEMS ACCELERATED TESTING

A methodology for executing accelerated life testing of MEMS accelerometers was developed. Also, the state-of-the-art in accelerated testing was compared with current results obtained by the NoE Patent-DfMM, and a course on Accelerated Life Testing of MEMS was developed.

Equipment for testing at tilting & temperature of MEMS accelerometers

Achievements: An equipment for executing tilting & high temperature was manufactured by IMT, and MEMS accelerometers were tested at tilting&temperature. Another set of experiments containing testing at vibration & high temperature were executed at IMT and at the University of Liege (Belgium).

Project: Methodology for accelerated testing and reliability analysis of MEMS (RELMETH), grant of the NoE "PATENT-DfMM". Co-ordinator: IMT-Bucharest (Contact person: Marius Bazu, mbazu@imt.ro). Partners: 10 European research institutions.

RELIABILITY OF NANOSTRUCTURES

The time degradation phenomena arising in the three main areas of nanotechnologies (nanostructured materials, nanoelectronic structures and NEMS) are studied.

Achievements: Databases on methods for investigating degradation phenomena and on NEMS reliability were created and are accessible from the project webpage (www.imt.ro/nanofiabilitate). The annual project workshop, common with the CEEX project NANOCRYSTALNET (Nov.9, 2006), held in IMT, and gathered Romanian specialists in nanotechnologies.

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

BIOSENSOR FOR ENVIRONMENT MONITORING

The surface of working micro-electrode. Image at epifluorescence microscope (x10)

Biosensors detecting the environmental pollutant concentrations and offering the possibility to generate information continuously were developed. The design for manufacture approach was used, in order to develop a general methodology.

Achievements: An electrochemical micro-cell for building micro-biosensors based on detecting photosynthesis inhibition was executed. The biosensors contained polypirol, deposited on the working electrodes. As biologic material, the cynobacteria Synechocistis PCC 6803 stem MscL was used. The interfacing of the biologic material with the transducer was optimized by a covalent link of cyanobacteria on the surface of working microelectrodes and evidenced by using epifluorescence microscopy. The natural fluorescence emitted by the clorophila molecules in the visible area of spectrum was used. See Figure bellow, where the polypirol is non-fluorescent (black colour) and the cyanobacteria show a natural fluorescence (red colour).

A cluster formed by two projects was focused on designing and manufacturing the biosensors for environment protection:
"Biosensor for detecting and monitoring of xenobiotics in the effluents of the installations for biological purging of worn-out waters", MATNANTECH Project (2004-2006),
Co-ordinator: IMT-Bucharest. Partners: Institute of Biology Bucharest, "Petru Poni" Institute of Macromolecular Chemistry, Institute of Industrial Ecology Bucharest (ECOIND) and System of electrical characterisation for micro-biosensors, Core Financing Programme (2006-2008), Contact person Lucian Galateanu (luciang@imt.ro).

STANDARDIZATION

Two standards describing the procedures for Accelerated Life Testing of microelectronic devices (bipolar transistors and voltage regulators) have to be elaborated for Korean Electronics Technology Institute (KETI).

Project: Consulting Agreement between IMT and KETI (2006-2007), Contact person: Marius Bazu (mbazu@imt.ro).

A4: Prototype development laboratory

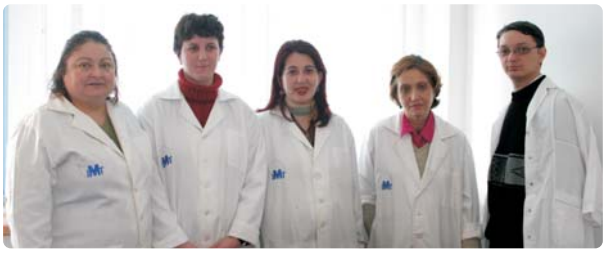
- Mission
- Main areas of expertise
- Research Team
- Services offer

• ***Mission:*** • Developing new technologies in the areas of Microsystems technologies: design, technological development up to the prototype level.

• New assembly techniques for Microsystems (based on MCM)

• Technological services: technological assistance in order to obtain prototypes starting from the experimental models (technological flows design, control gates, technological compatibilities) and defect analysis on technological flow.

• ***Main areas of expertise:*** Design and develop individual technological processes for Microsystems technology (as nuclear detectors technologies, piezoelectric integrated microsensors, high speed photodetectors and white LED micromatrix) and control technological compatibilities for M(O)EMS integrated using CMOS technology. MCM technologies and other nonstandard assembly technologies for Microsystems technological design.



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

• ***Research Team:*** The team is represented by a senior researcher (PhD), a senior technological development engineer, 2 PhD students (with background in chemistry) and a young engineer specialized in electronic applications field. The seniors of the team have industrial experience and company RD activity 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

• Defect analysis on technological flow

• Assembly techniques for MST

Example:

New MCM packaging technique for PIN microdetectors matrix with improved technological processes for optimized performances in transmission and direct coupling to the optical cable.

Characteristics:

• a silicon wafer used for PIN detectors assembly

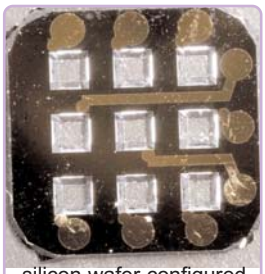
• optimized 2 masks technology

• two steps anisotropic silicon etching for lowering the roughtness

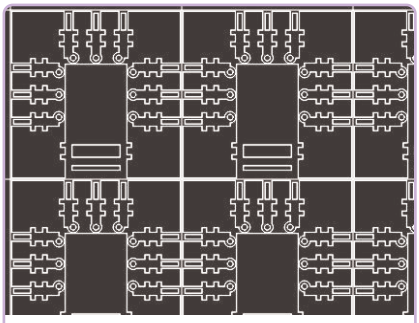
• AuCr interconnection thin film – where Cr is also used as etch mask

• a thin film of Au on the back side of the wafer both as mask for etching and ground plane for the individual PIN photodetector dices

• a 50 μm thick bronze-beryllium support used as ground palne for the micromatrix and also for configure the external pin connection of the micromatrix.



silicon wafer configured for 3x3 elements matrix before microdetectors assembly



Metallic ground plane mask (detail)

Contact person: **Ileana Cernica** (**ileanac@imt.ro**)

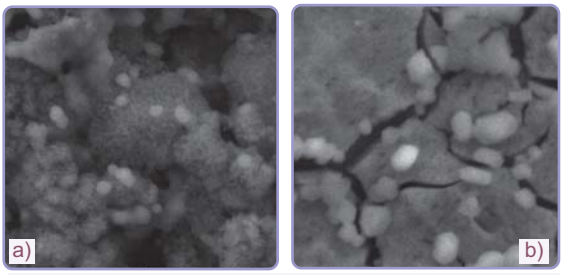
Laboratory Head – Dr. Ileana Cernica (ileanac@imt.ro)

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 ICs technologies, CMOS RD activities and as AQ responsible in the sole Romanian CMOS ICs industrial company for 10 years.

Now she is senior research scientist, currently coordinate 4 national R&D projects and is responsible person in EUREKA umbrella project MINATUSE and project manager of Romanian – German Centre for micro and nanotechnology Project. She is also involved in technology transfer activities being Project manager of Romanian- German Centre for Micro and Nanotechnologies Project and former executive director of Centre for Technological Transfer in Microengineering (CTT-Baneasa).

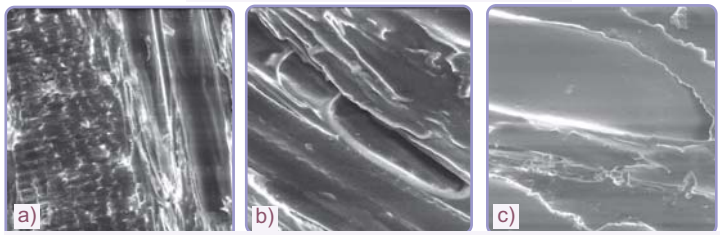
She is secretary of Scientific Committee of IMT. Other activities: is project evaluator in national RD programs (CEEX, CNCSIS) IEEE member and associate professor at University "Politehnica" of Bucharest (Faculty of Electronic, telecommunication and information technology and Faculty of Mechanics). Her Scientific activity was published in more than 50 papers in international journals/conferences, 98 technical reports and is author or co-author of 8 Romanian patents (2 of them won silver and 1 gold medals at International Inventions Exhibition in Bruxelles and Geneve) and 3 books.

Advanced manufacturing technologies for specific nanomaterials dedicated to ligno-cellulose composite used in furniture industruy finishing processes applications (FINAMAT)



SEM images: a) Alumina gel; b) Indium tin oxide gel

Beech tree substrate



SEM images of lignocellulosic composites substrates:

Optical images of lignocellulosic composites substrates: a) before coating; b) lacquer with alumina nanoparticles; c) lacquer with indium tin oxide nanoparticles

The main aim of the project is to develop new technologies for ligno-cellulose composites finishing, by totally replacing the organic solvents with nanomaterials with controlled properties.

Achievements:

• The technological experiments were focused to obtained sol-gel coating materials, easy to use for furniture technological applications, and by waterproofing properties turn into easy-to-clean, dirty repellent materials.

We obtained water based lacquers, who contain: • resins: APU 1062 Polymer Dispersion and APU 2005 Polymer Dispersion

• additives

• alumina nanoparticles, respectively indium tin oxide nanoparticles

Results: • We obtain alumina and indium tin oxide gel;

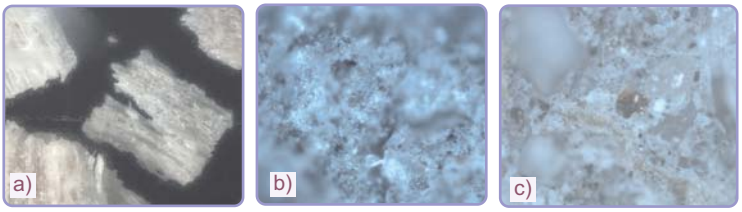
• The surface of the various coated substrates showed a fine-textured film, possibly due to the deposition of the lacquers with nanoparticles on the surface of the microfibres;

• The compatibility with the coating materials as well as the stabilization of the nanoparticles evaluated to play a key role in the improvement of scratch resistance were obtained.

MATNANTECH Project:2004-2006, Co-ordinator IMT-Bucharest,
Project manager: Ileana Cernica (ileanac@imt.ro)
Partners: National Institute Of Woods Bucharest, R&D Institute for Nonferrous and Rare Metals Bucharest, Valahia University of Targoviste

Advanced Nanocomposites materials used in civil constructions with antibacterial, selfcleaning properties and solar energy concentrators integrated structures for ambiental improvement NANOAMBIENT

The major aim of the project is to obtain „intelligent walls" i.e. new construction materials for walls structure (using cement and wood and composites bonding agent materials) and new materials (nanocomposites and integrated structures) for surface of the wall in order to obtain antibacterial and selfcleaning properties and to incorporate solar energy concentrators.



a) SEM image of wood dust; b) SEM image of cement samples; c) SEM image of cement-wood composite

Achievements:

• *Wood-cement composition results;*

• *Synthesis of Nanopowders*: Nanopowders obtained by chemical synthesis; Synthesis of zinc oxide; Synthesis of titanium oxide;

• Characterization of Oxide nanopowders: Characterisation of zinc oxide; Characterisation of titanium oxide;

CEEX Project, 2005-2008. Co-ordinator IMT-Bucharest, Project manager:Ileana Cernica (ileanac@imt.ro)
Partners: Large Consortium covering 7 from 8 Romanian Euroregion 6 R&D Institutes (3 national R&D institutes- Nonferrous and Rare Metals – Bucharest, Electrochemistry and Condensed Matter Timisoara, Analytical Instrumentation Cluj and 3 private R&D Institutes- National Institute of Wood – Bucharest,,CEPROCIM-Bucharest, Auxiliary Organics Products-Medias and 4 Universities (Politehnica - Bucharest, "Alexandru Ioan Cuza" - Iasi, "Ovidius" – Constanta, Valahia University –Targoviste)

On- line monitoring of drilling for sustainable management of oil resources using integrated Microsystems

The project intends to research and develop a micro-sensor system with applications in the oil extraction industry (drilling).

Achievements: • In the domain of the development of microsensors for pressure and temperature dedicated for oil drilling processes; • Preliminary technological steps; • Simulation of the working condition; • Simulation of the behaviour to the mechanical and thermic stress.

CEEX Project, 2005-2008. Co-ordinator IMT-Bucharest, Project manager: Ileana Cernica (ileanac@imt.ro)
Partners: Large Consortium oriented to industry: 3 SME (SITEX 45, ROMQUARTZ,ROMES) and one industrial partner (ROM-SYS), 2 national R&D institutes: Electrochemistry and Condensed Matter Timisoara, Laser, Plasma and Radiation Physics and 3 Universities (Politehnica - Bucharest, University Oil and Gas Ploiesti, Valahia University of Targoviste)

A2: Technology Laboratory for Microstructures

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

• ***Mission:*** The Technology Laboratory for Microstructures provides technical support for the research activity developed in institute. Our laboratory acts as a technological support for institute projects belonging to other laboratories. The spectrum of research activities was considerably expanded through recent investments in new equipments.

• ***Main areas of expertise:*** The Laboratory covers a broad range of technological process in order to fulfil the requirements for implementation of semiconductor devices, sensors, micromechanical and microoptical structure, 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 technologic processes offered by the Technology Laboratory for Microstructures. Besides silicon wafers, other materials as gallium arsenide 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 and biochemistry.

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 micro-fluidic devices by substrate microprocessing having applications in thermal transfer and biology.

• ***Research Team:*** The team is represented by four senior researchers, 1 chemist, 2 physicists and 1 electronist. The laboratory has also auxiliary personal specialised in technological processes.

• ***International Projects:***

The technology Laboratory for Microstructures, provides the 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.

Team from left to right:
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

• ***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;

• 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 electro-platting or chemical plattings, anodic oxidation, sol gel techniques.

Laboratory Head – Dr. Elena Manea (elenam@imt.ro)

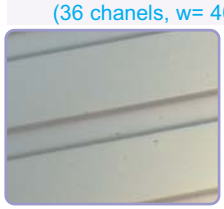
Present position: Dr. Elena Manea obtained the MSc degree in Physics (1978) and Ph.D. in Solid State Physics (1999) at University from Bucharest. 20 years experience in silicon planar technology. Research efforts aiming to develop the scientific knowledge concerning micro and nanaotechnologies and nanostructured materials for applications in the PV solar cells, technologies for microsystems and microsensors domains.

In this year the scientific activity is published in 5 scientific papers in journals (3 published in periodicals ISI ranked), 1 book, 13 communications in Proceedings, 4 communications in other publications and 2 patents.

Technology to obtain microfluidic devices by substrate microprocessing having applications in thermal transfer and biology.

Micro-heat sink based on silicon surface microprocessed Cu micro-channels (36 chanels, w= 40 μm, h =15 μm).

The project aimed to realize microfluidic devices based on microprocessed microchannels having applications in thermal transfer and biology. The method uses surface microfabrication techniques having the resist (thick, or thin) as a sacrificial layer. The resist structure build on silicon substrate is covered by electrochemical techniques with a metal (Ni, Cu, Au) film for applications in thermal transfer and by Ni, Au, or SiO, on silicon, quartz, ceramic, glass and plastic for biological applications.

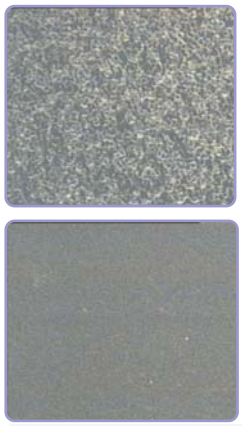


SiO semicircular microchannels on glass substrate (w ch= 15μm).

Achievements: • Technological methods for microfluidic devices micro-processing using various substrates; • Non – standard photolithography; • Thermal and mass transfer modelling and simulation for microfluidic devices; • Measurement and characterization techniques of the microprocessed micro-heat sink (demonstrator device). Images are shown the results obtained in the last step of the research conducted within the frame of the project started in 2005 (see 2005 - IMT-Bucharest Scientific report, page 32).

MATNANTECH Project. Project Manager: Antonie Coraci; antoniec@imt.ro), IMT - Bucharest

New technology for capacitive enzymatic sensors based on enzyme immobilization in silicon macro porous matrix, for applications in the residual pesticide detection



a) Macro porous silicon matrix – Optical image
b) AChE enzyme immobilized on macro porous silicon matrix – Optical image
d) Final structure – SEM image

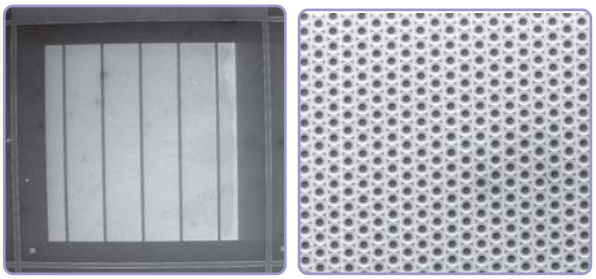
For this capacitive sensors, on the hand conventional techniques of silicon planar technology (thermal oxidation, physical depositing, photo-lithography, etching), the novel techniques of sensor preparation such as the anodic etching process to generate porous Si as carrier matrix for enzymes and specific immobilization strategies in order to stably biologically sensitive materials to microelectronic chips, have been used. AChE – based sensor for organophosphate pesticide are inherently inhibition mode.

Achievements: • 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; • Developed and optimized strategies in order to stably biologically sensitive materials to microelectronic chip; • Developed a new technology for a conductimetric enzyme biosensor for determination of organophosphate pesticide; • The experimental model testing and validation on specific applications

SECURITY Project. Project Manager: Chem Cecilia Podaru; (ceciliap@imt.ro), IMT - Bucharest

New technologies for photovoltaic devices with high conversion efficiency realization based on the monocrystalline silicon substrate surface nanostructuring through porosification techniques

Short description: 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 for to increase the PV solar cells light conversion efficiency.



SEM image of the solar cell structure texturised and porosified

The project approaches an important direction of the Romanian research – elaboration, fabrication and implementation of advanced new technologies leading to an increased competitive autochthonous production.

A low-cost electrochemical etching was used to form the PSL for applications in the PV field, in order to reduce the light power losses by surface reflection. For this purpose, PSL with pores dimensions in the range of an 8 nm to 2 μm depending on the conditions of formation and the characteristics of the silicon wafer have been obtained PS samples used in PV applications were prepared by electrochemical etching using as starting material crystalline p-Si wafers (100), 0.02 Ωcm resistivity, phosphorus doped and $HF:C_2H_5OH:H_2O$ as electrolyte. The current density range, 5 to 18 mA/cm^2 , anodisation time, 600 s, illumination, a 500 W halogen lamp, T=300K.

This method applied to the PV solar cells leads to an important growth of the incident light capture onto the structure surface, resulting the increment of the solar cells efficiency to over 20%.

Achievements: • Development of technologies for the realization of PV solar cells; • Design and fabrication of PV solar cells

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

NanoBioLab

financed by Scientific and technological network, RO-NANOMED, CEEX Programme

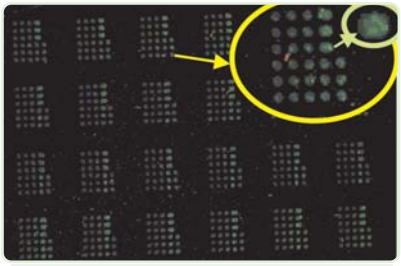
The **RO-NANOMED** network is targeting integration into the European Technology Platform (ETP) "NanoMedicine" (**http://cordis.europa.eu/nanotechnology/nanomedicine.htm**).

The scientific and technological networks coordinated by IMT-Bucharest at national level are used not only for promoting the cooperation with European technology platforms, but also for establishing laboratories to be used in common by research units and companies. These are playing an important role for multidisciplinary research and technology transfer.

Omni Grid Micro-Nano Plotter

RO-NANOMED contributed to the implementation of **NANOBIOLAB** laboratory, installed in the technological area of IMT-Bucharest, in the "Scientific and Technological Park for Micro and Nanotechnologies" MINATECH-RO.

NanoBioLab is devoted to technological research related to new materials, structures, particles, devices etc., involving biological materials. It represents a platform of interaction open to all RO-NANOMED participants, but also for cooperation with private companies, universities and other research institutes from Romania and abroad. This laboratory follows the model of Nano-Bio-Technological Centre (NBTC) from Cornell University, Ithaca, U.S. (direct contacts IMT-NBTC established since 2004).

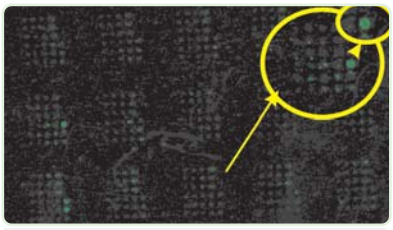


Si /Au After spoting

The 13 partners of the RO-NANOMED consortium cooperate in the realization of 14 research mini-projects, focused on the three domains defined by the European Technology Platform "Nanomedicine": regenerative medicine, targeted drug delivery and release and nano-diagnostics.

A close cooperation is developed with two Romanian companies DDS Diagnostic SRL and Dexter Com SRL and new activities are foreseen in partnership within the European project "INTEGRAMplus: Integrated MNT platforms and services – Service Action", IP coordinated by QinetiQ Ltd, UK.

The *activities developed in NanoBioLab* are mainly dedicated to microarrays, with applications in genomics and proteomics, using new specific equipments: Omni Grid Micro Plotter and GeneTAC UC4 Scanner.



After 60 min washing

The main advantages of using these equipments are related to the use of a small quantity of reagent (reduced from micro to nano-litres) and the high density of different samples on a surface assures an increased productivity of measurements.

The recent investigations developed by researchers from IMT-Bucharest and DDS Diagnostic (*see the pictures showing main results*) are related to surface modification for protein attachment to various substrates (glass slides coated with APS, NHS, ALD, poli-L-lysine, gold and silicon slides coated with gold). The substrates were printed with BSA of different concentrations, marked with CY3 and then washed with PBS (pH=7.4) after 20, 40 and 60 minutes. Before and after washing the intensity of the spots by scanning the slides and the UV – spectra of the washing residues were analyzed. The optimum time for washing tests is 40 minutes, after this time the surface has important modifications shown by the UV spectrum and low intensity of spots. A tail for high concentration was observed also after washing. This phenomenon was supposed to appear because the surface became saturate and it is an excess of substance on the surface. A next step will be to optimize the protein concentration for an optimum detection.

Dr. Patrick Boisseau, CEA-LETI, Grenoble, France presenting the Strategic Agenda of Research of the ETP Nanomedicine

One of the **RO-NANOMED network** *objectives* is to assure connexions at national level. IMT coordinates since 2006 the Romanian Collaboration Platform for NANOMEDicine (RCP-NANOMED), which includes 26 Romanian organizations, interested in the domain, from 9 National R&D Institutes, 1 R&D Institute, 4 Institutes of the Romanian Academy, 5 Universities, 2 research centers and 5 private companies.

The platform has the main goal to concentrate resources and correlate efforts at national level in order to develop the scientific and technological nanomedicine domain, in close collaboration with the ETP Nanomedicine. RCP-NANOMED was launched on 4th of July 2006 in Bucharest, with the participation of foreign specialists in the domain. During the event, the working group of the platform was established. The workshop "Cooperating in FP7; Biomedical applications of micro- and nano-technologies" was organized on 6th of December 2006, in Bucharest and several topics in the nanomedicine domain were presented with this occasion (7 presentations given by foreign participants). The German NanoBiotechnology Network "NanoBioNet" was represented in both events mentioned above.

Dr. Mathias Mallmann, Science Park, Sarbrucken, Germany presenting NanoBioNet, a competence network in nanobiotechnology

RONANOMED project coordinator: Prof. **Dan DASCALU** (***dascalu@imt.ro***), ***IMT-Bucharest***

NanoScaleLab

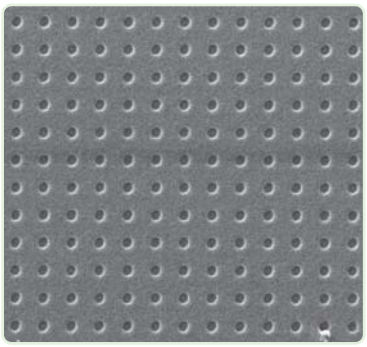
financed by Scientific and technological networks NANOSCALE-CONV and RTN-NANOEL, CEEX Programme

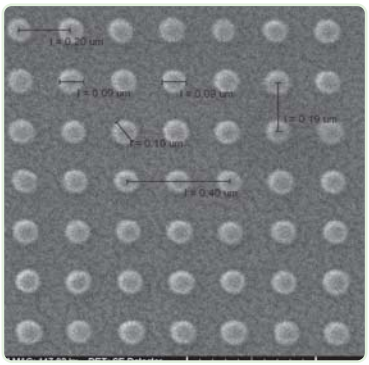
The mission of the ***NanoScale*Lab is characterization and fabrication at the "nano" scale,** more specifically**:** • Surface morphology imaging and characterization (AFM, STM, SEM); • Determination of the chemical composition of solid samples, thin layers or particles under investigation in electron microscopes; • Electron beam lithography for: quantum device studies, diffractive optical elements, MEMS and NOEMS, photonic crystal devices, GMR studies etc; • Scanning probe lithography;

PG Elphy Plus

***NanoScale*Lab** was initially financed by **NANOSCALE-CONV** (Network of scientific services for NANO-SCALE structuring and characterization, with applications in the development of CONVergent technologies). A new Nanolithography Equipment composed by a SEM and EBL was acquired by the Network and installed in the technological department of IMT-Bucharest.

The technical data are: **Scanning Electron Microscopy** TESCAN VEGA 5136 LM resolution: 3 nm @ 30 kV, accelerating voltage 200V-30 kV, electron gun source: tungsten filament, magnification : 13X – 1.000.000X, detectors: SE, BSE, LVSTD. **PG Elphy Plus** from RAITH 6 MHz high-speed pattern generation hardware.





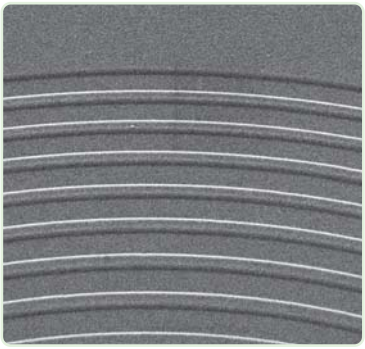
Test of nanolithography: Configurations in PMMA resist for manufacturing Fresnel lens, realized for the Laboratory Photonics, IMT-Bucharest

RTN-NANOEL NanoScaleLab is now also financed by RTN-NANOEL national network and other sources. The equipments which will be installed in 2007 are:

• General purpose Electron Beam Lithography System RAITH 50, with: Thermionic emitter; Laser interferometer stage with 100 mm by 100 mm travel range and 2 nm resolution achieved by closed-loop piezo-positionin; 10 MHz DSP -controlled digital pattern generator;

• SPM - Multifunctional Scanning Probe Microscope NTEGRA Aura (NT-MDT) - a system developed to perform measurements in vacuum, 10-2 Torr, and in controlled atmosphere environments;

• EDX- Energy dispersive X-ray microanalysis in SEM- system QUANTAX (Bruker AXS)- liquid nitrogen free XFlash® silicon drift detector, 135eV resolution, boron detection.



Test of nanolithography: Configurations in PMMA resist for manufacturing sub-wavelength photonic devices (sub-wavelength hole arrays for photonic crystals) realized for the Laboratory of Photonics, IMT-Bucharest

Supporting networks:

NANOSCALE-CONV (Network of scientific services for NANO-SCALE structuring and characterization, with applications in the development of CONVergent technologies) is coordinated by Dr. Raluca Müller (**ralucam@imt.ro**) in cooperation with Prof. Dan Dascalu (**dascalu@imt.ro**) from IMT-Bucharest.

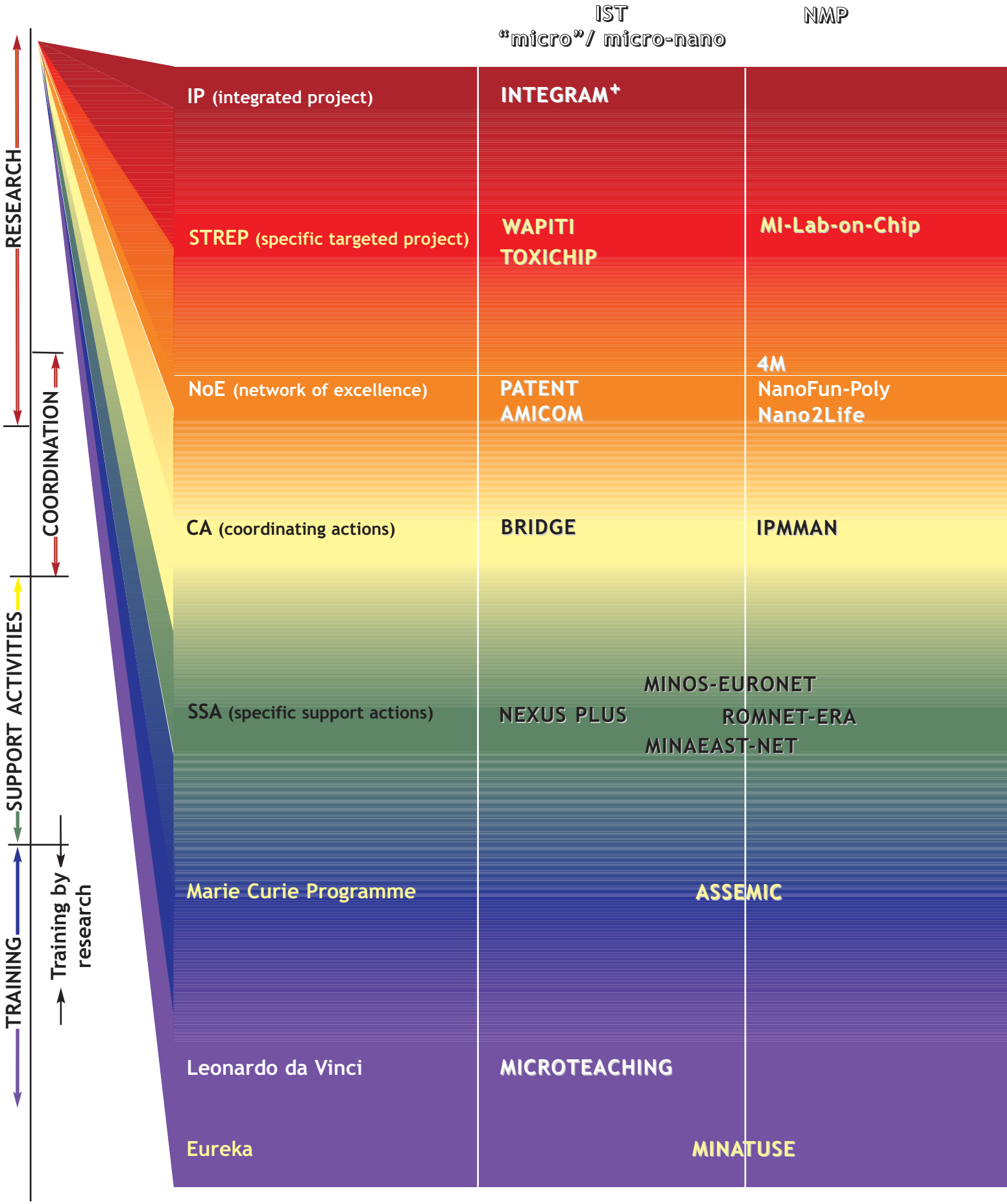
The scientific interest of the network is:

• Characterization of nanoparticles, micro- and nanodevices; • Characterization and modeling of 0D, 1D and 2D nanostructured materials and devices; • AFM investigation of surfaces; • Application of EBL in nanotechnology domain; • Application of EBL in nanostructuring hybrid inorganic/organic coatings for biosensors; • Thin films studies; • Biomaterials investigations; • Investigations of sol-gel materials; • Characterization of nanostructured materials for sensors.

RTN-NANOEL (Romanian Technological Network for integration in the European Platform for NANOELectronics, ENIAC) is a Romanian project devoted to a technological network with 10 partners (universities and research institutes - some of them being involved in PC6). The research activities are: research, technological and scientific services, training, dissemination and technological transfer in the field of nanoelectronics and main activities of the are focused on RF components (radio frequency) and micro-fluidics, mentioned in the "ENIAC agenda", domain where we already have experience in working with foreign companies (through European Projects) considering also the technological transfer. Research activities panned are in the following domains: new electronic nanodevices, new materials and technological processes, new architectures of the electronic systems. The RTN-NANOEL network provide also experimental technological services (nanostructuring and nano-lithography) as well as computer-aided design and simulation.

Prof. **Dan DASCALU** (***dascalu@imt.ro***) and Dr. Raluca Müller (**ralucam@imt.ro**) ***IMT-Bucharest***

IMT-Bucharest participation in EU Programmes



IMT-Bucharest participation in EU programmes spans a number of instruments on two FP6 priorities (2006-2007). In 2005 IMT also participated to **MST-Design** and **REASON** (IST in FP5)

• *Multi-domain platforms for integrated micro-nano technology systems – Service Action* (**INTERGRAMplus**), **IP**, Priority 2 -**IST**, Contract no.: 027540 (2005-2007), **Coordinator: QinetiQ Ltd**, UK. IMT position: partner; Contact person for IMT: **PhD. Carmen Moldovan** (**cmoldovan@imt.ro**)

• *Waferbonding and Active Passive Integration Technology and Implementation* (**WAPITI**), **STREP**, Priority 2 -**IST**, Contract no: 004073 507352 (2004-2007). **Coordinator: Prof. Helmut Heidrich**, Fraunhofer Institute for Telecommunications, Heinrich Hertz-Institut (FhG/HHI), Germany; IMT position: partner; Contact person for IMT: **PhD. Dana Cristea** (**danac@imt.ro**)

• *Development of a toxin screening multi-parameter on-line biochip system* (**ToxiChip**), **STREP**, Priority 2 -**IST**, Contract Number: 027900 (2006-2009), **Coordinator: PhD. Terri Wood, University College Cork - National University of Ireland**. IMT position: partner; Contact person for IMT: **PhD. Carmen Moldovan** (**cmoldovan@imt.ro**)

• Lab-On-A-Chip Implementation of Production Processes for New Molecular Imaging Agents (**MI-lab-on-chip**), **STREP**, Priority 3 -**NMP**, Contract no: 516984 (2005-2007). **Coordinator: PhD. Jean-Luc MorelleTRASIS SA, Liege, Belgium;** 5 partners involved. IMT position: partner; Contact person for IMT: **PhD. Student Oana Nedelcu** (**oanan@imt.ro**).

• *Design for Micro & Nano Manufacture* (**PATENT**), **NoE**, Priority 2 -**IST**, Contract no.: 507255 (2004-2007), **Coordinator: Andrew Richardson, University of Lancaster**, UK. IMT position in the project – Core Partner; Contact person for IMT: **Prof. Dan Dascalu** (**dascalu@imt.ro**).

• Advanced MEMS for RF and Millimeter Wave Communications (**AMICOM**), **NoE**, Priority 2 -**IST**, Contract no: 507352 (2004-2006), **Coordinator: Prof. R. Plana, LAAS_CNRS Toulouse,** France; 22 partners. IMT position: partner; Contact person for IMT: **PhD. A. Muller** (**alexm@imt.ro**)

• *Multi-Material Micro Manufacture: Technologies and Applications* (**4M**), **NoE**, Priority 3 -**NMP**; Contract number: NMP2-CT-2004-500274 (01.10.2004 – 30.09.2008). **Coordinator: PhD. Stefan Dimov,** Cardiff University, UK, IMT position: Partner; Contact person for IMT: **PhD. Carmen Moldovan** (**cmoldovan@imt.ro**)

• *Nanostructured and Functional Polymer-Based Materials and Nanocomposites* (**NANOFUN-POLY**), **NoE**, (2003-2007), Priority 3 -**NMP**, **Coordinator: Prof. José M. Kenny**, **Italian Consortium for Science and Technology of Materials (INSTM),** Italy; Contact person: **PhD. Irina Kleps** (**irinak@imt.ro**).

• *A network for bringing NANOtechnologies TO LIFE* (**Nano2Life**), **NoE**, (2003-2007), Priority 3 -**NMP**, **Coordinator: PhD. Patrick Boisseau, CEA** France. IMT position: Associated Partner; Contact person for IMT: **Prof. Dan Dascalu** (**dascalu@imt.ro**).

• *EUROPRACTICE - coordination of proactive NAS interaction and an awareness dissemination and exploitation bridge* (**BRIDGE**), **CA**, Priority 2 -**IST**, Contract number: 507307, (2004-2005), **Coordinator: Rutherford Appleton Laboratory, Oxfordshire,** UK, IMT position: subcontractor; Contact person in Romania for IMT: **PhD. Carmen Moldovan** (**cmoldovan@imt.ro**)

• *Improvement of industrial Production Integrating Macro, Micro And Nanotechnologies for more flexible and efficient manufacturing* (**IPMMAN**), **CA,** Priority 3 - **NMP**. **Coordinator PhD. Ana Almansa, A.R.C. Seibersdorf Research GmbH**, Austria. Contact person for IMT: **PhD. Raluca Muller** (**ralucam@imt.ro**).

• *MIcro-NanOSystems EUROpean NETwork pursuing the integration of NMS and ACC in ERA* (**MINOS-EURONET**), **SSA**, Priority 2 -**IST**, Contract no: 015704 (2005-2007), **Coordinator: National Institute for R&D in Microtechnologies (IMT-Bucharest)**; 17 partners. Coordonator: **Prof. Dan Dascalu** (**dascalu@imt.ro**).

• *Micro and Nanotechnologies going to EAESTern Europe through NETworking* (**MINAEAST-NET**), **SSA-General**, Contract no: 510470 (2004-2006), **Coordinator: National Institute for R&D in Microtechnologies (IMT-Bucharest)**; 12 partners. Coordonator: **Prof. Dan Dascalu** (**dascalu@imt.ro**).

• *NEXUS - Supporting IP's and NOE's ensuring SME representation and introducing NAS partners* (**NEXUSPLUS**), **SSA**, Priority 2 -**IST**, Contract number: 507293 (2004-2007), IMT position: subcontractor; Contact person for IMT: **PhD. Carmen Moldovan** (**cmoldovan@imt.ro**)

• *ROManian Inventory and NETworking for Integration in ERA* (**ROMNET-ERA**), **SSA-General**, Contract no: 510475 (2004-2006), **Coordinator: National Institute for R&D in Microtechnologies (IMT-Bucharest)**; 5 partners. Coordonator: **Prof. Dan Dascalu** (**dascalu@imt.ro**).

• *Advanced Handling and Assembly in Microtechnology* (**ASSEMIC**), **Marie Curie Research Training Network**, Contract: 504826 (2004-2007), **Coordinator: Prof. Dr. Werner Brenner from Institute of Sensors and Actuators Systems, Vienna Univesity of Technology-ISAS**; IMT position: partner; Contact person for IMT: **PhD. Raluca Muller** (**ralucam@imt.ro**)

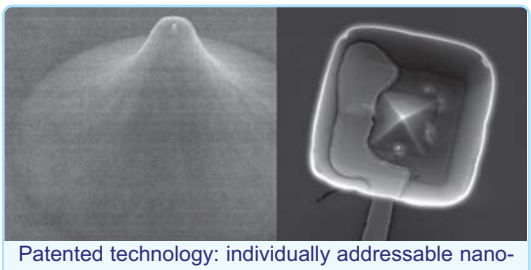
• *New teaching and learning methods and basic qualifications in job education* (***Microteaching***), **LEONARDO DA VINCI** Project, Priority 2 - **IST**, Contract number: 146157 (2004-2007), **Coordinator: Zentrum für Lern- und Wissensmanagement und Lehrstuhl Informatik im Maschinenbau (ZLW/IMA) der RWTH Aachen,** Germany. Contact person for IMT: **PhD. Raluca Muller** (**ralucam@imt.ro**).

• *Micro-Nano Technology Use by SMEs*, (**MiNATUSE)**, **EUREKA** Project, (2005-2011), **Coordinator: CEA / LETI Grenoble**, Contact person for IMT: **PhD. Ileana Cernica** (**ileanac@imt.ro**)

• *Research and Training Action for System on Chip Design* (**REASON**), **FP5 – IST,** Contract no. IST-2000-30193, (2002-2005), 22 partners, **Coordinated by Prof. Wieslaw Kuzmicz, Warsaw University of Technology**, Poland. IMT position: subcontractor. Contact person for IMT: **PhD. Carmen Moldovan**.

• **MST-Design**, **FP5 – IST**, Contract no. IST-2001-33393, 2003-2005, 6 partners, **Coordinator: European Technology for Business Ltd.**, UK. IMT position: participant. Contact person for IMT: **Prof. Dan Dascalu**.

CENTRE FOR TECHNOLOGICAL TRANSFER IN MICROENGINEERING (CTT-Baneasa)



Patented technology: individually addressable nano-electrodes exposed via a special silicon micro-fabrication procedure. Applications: electrochemical cells with integrated electrodes for: electrochemical (bio)sensors; bioelectrochemistry (cell chemical studies); medicine (cell or tissue electrical activity studies); scanning electrochemical microscopy.

CTT-Baneasa *was established by IMT-Bucharest in 2003* and was accredited as an autonomous entity in March 2006. The major mission of the Center is to become an active professional link between research and industry, within the field of micro- and nanotechnology. We have a twofold objective: • Establishing networks of industrial experts, well informed and directly interested in leveraging on the R&D outcome and on state of the art knowledge, equipment and services; • Inspiring the focus of the innovation efforts toward economic effects such as licensing and transfer of technology;

Throughout 2006, the center carried out or participated to more than 30 specific activities and events. Here is a selection: • participation to the International Exhibition of Inventions, Scientific Research and New Technologies - INVENTIKA 2006 - under the patronage of the Romanian Ministry of Education and Research and the International Exhibition of Inventions of Geneva - organized within the Bucharest International Technical Fair–TIB; • two research products of IMT were presented and received a gold medal and a WIPO medal for the best Woman Inventor; • the IMT-Bucharest's booth included poster presentations with formerly awarded inventions (Brussels and Geneva, 2004-2005); • participation to the Romanian seminar: "Support strategies for innovation and technology transfer. Opportunities and challenges", Bucharest; • the presentation highlighted the particularities of technology transfer in micro/nanotechnology industry, reviewed two models of recently established innovation support structures (NetPark/UK and CeNTech/Germany) which served as initial model for the establishing of CTT-Baneasa, and presented the activity and opportunities related to CTT-Baneasa and the technopark MINATECH-RO; • realization of 26 new product datasheets for the IMT offer portfolio; • the technologies presented belong to the following areas: RF-MEMS, (bio)sensors, biochips and drug delivery, microelectronics, microfabrication and technological procedures, photodetection and MOEMS, reliability testing systems, microstructuring, nanomaterials and coatings.; • editing of presentation posters of CTT, and of the present offers of IMT-Bucharest (products and technology services); • realization of technology transfer files for two products: volume silicon microstructuring for MEMS fabrication, and packaging technology for pressure micro-sensors; beneficiaries are two Romanian companies from the MINATECH-RO technopark; • due diligence survey of the intellectual property status in IMT-Bucharest, regarding: patents and trademarks already issued (13 authorizations), patents currently applied for (19 submissions), patent ideas declared as "near-future applications" (about 7 expected in the next 4-8 weeks); • the patent portfolio (all are registered at the Romanian Patent Office-OSIM) covers the following areas: nanostructures, micro/nano photonics, micro-fabrication, surface structures, microelectronics, microsensors, microfluidic devices, MEMS, optical devices; • the survey detected 7 patents and at least 3 patent ideas with commercial potential, that are now being promoted through event and contact channels; • update of the online downloadable general presentation of IMT-Bucharest, CTT-Baneasa and Minatech-RO: material collection and editing of the present issue of the Scientific Report IMT-Bucharest/2006; • publication on the CTT site of the products/ technologies/services offered by IMT.

Distinctions received at
INVENTIKA 2006 Bucharest-Geneva

In terms of national and international networking, CTT-Baneasa maintains the institute's interface with the following programs:

• **INTEGRAMplus** – a FP6 IST-IP project implementing a customer-responsive design and prototyping service in **EUROPRACTICE** system, with special focus on MEMS. Our centre assists the access of network members to the institute's microsystem technologies. In this framework, we provide complete assistance for companies: from the one-stop shop approach *(idea → project → design → prototype → batch)*, to technological assistance, to consultancy, education and training; • Romanian-German Centre for Technological Assistance and Training in Micro and Nanoengineering – a project started in October, 2005, designed to consolidate and develop a Romanian-German partnership in micro/nano-technology, in order to leverage on the R&D results in both countries. • A center's national initiative of assembling a network of providers and users of knowledge and technologies in micro/nano-engineering. There are now 63 partners in the network, mainly research groups from institutes and universities, companies and non-governmental organizations. We tested their R&D interests via a dedicated inquiry form and deduced the following distribution: sensors (48%), electronic industry (44%), materials such as powders, carbon nanotubes, polymers, composites (36%), life sciences (31%), metrology/instrumentation (27%), as well as other technologies such as thin layers, solar cells, communications etc.

CTT-Baneasa assists the services provided by IMT-Bucharest for the **scientific park MINATECH-RO**. The Centre collaborates with the Chamber of Commerce and Industry of Romania, University "Politehnica" of Bucharest, S.C. ROMES S.A. (the collaboration will be extended also to other partners which will provide services for the Center). Since 2006, CTT-Baneasa is a member of the Romanian Association of Technology Transfer (AROTT).

The Science and Technology Park for Micro and Nanotechnologies MINATECH-RO was established by a consortium coordinated by IMT-Bucharest and including the "Politehnica" University of Bucharest (PUB) and the private company S.C. ROMES S.A.

MINATECH-RO was created and received institutional funding in 2004-2005 through the national INFRATECH Programme, administered by the Ministry of Education and Research. The financing from INFRATECH and IMT-Bucharest served for new clean room facilities, state-of-the-art equipment acquisitions and fitting out spaces for companies active in the micro- and nanotechnologies field. In June 2006, the park was officially launched, with the first companies already in.

Some of the activities of the science park are performed by using CTT-Baneasa (see the previous page). The direct contact of companies with research groups, as well as the access to technological facilities are essential. Indeed, the science park provides not only standard conditions (room for offices, telephones, internet, secretary services), but also the possibility to use equipments requiring special working conditions, characteristic for chemistry laboratories or laboratories in the semiconductor industry: cleanliness, air conditioning, stove aspiration (for chemical substances), neutralization of waste products (for environment protection), deionised water, nitrogen, protection from explosion, etc. These equipments will be installed in spaces rented to companies or in common spaces. Technical assistance will be provided for all these equipments, together with consultancy for the R&D activities of the companies and the rental of certain equipments. The incubation area of the park is situated in IMT, on the industrial platform Baneasa.

Official inauguration of the MINATECH-RO technopark, with Prof. Anton Anton, president of the National Authority for Scientific Research and Prof. Dan Dascalu, CEO of IMT-Bucharest.

A technological pole located in the MINATECH-RO Park

As a result of numerous significant acquisitions, the presently available R&D equipment infrastructure covers the entire route for micro- and nano-device technology, from computer simulation and design, to clean room microfabrication, to materials and devices characterization. A few relevant highlights: professional level CAD/CAE applications (CoventorWare, ANSYS Multiphysics, CADENCE, Mentor Graphics), 1000/100 clean room, electron beam evaporation and sputtering box chamber system, professional lithography system - ultra high resolution electron beam lithography and metrology tool, including cross-over free column with highest beam current density at 2nm spot and laser interferometer stage, high accuracy maskless lithography system - direct write pattern generator, biomolecule array printer and surface analyzer, microarray scanner and workstation, LPCVD furnace for LPCVD and annealing processes, RIE System, SEM/FIB nanolithography (EBL) system + compact laser interferometer stage, analytical probing system, spectroscopic ellipsometer, SEM, AFM, Raman and system microscopes.

Strengthening the links with industrial and other research entities: meeting organized in IMT to discuss opportunities of collaboration and of working toward common funding goals.

National networks and common laboratories

The Romanian R&D programme CEEX, or "Research for Excellence" (2005-2008) is financing "science and/or technological networks", facilitating European cooperation and especially participation to European Technological Platforms (ETP). IMT is coordinating three such networks. The first one, called RONANOMED (Integrated Research Network Devoted to Nanobiotechnology for Health: Romanian Nanomedicine Network) is targeting the ETP of Nanomedicine. The partners in this network are carrying on exploratory research in 14 small projects grouped in three clusters, focusing on the thematic areas of the above mentioned European platform. This network also supports the set-up of the NanoBioLab common laboratory, equipped with a nanoplotter and a nanoscanner for testing microarrays and located in the "clean-room" area inside IMT. IMT has the capability to design and fabricate microarrays and biochips (as shown by its participation to FP6), a specific target of convergent technologies. The other partners are also providing access to some of their equipments. Another network is NANOSCALE-CONV (Network for scientific Services for Structuring and Characterization at the Nanoscale, with Applications in the Development of Convergent Technologies), again with a common laboratory installed in IMT, providing the electron-beam lithography at the nanoscale. The third network coordinated by IMT, called RTN-NANOEL (Romanian Technological Network for Integration in the European Platform for Nanoelectronics) will consolidate the above laboratory. Again, in these two networks the partners are sharing access to their equipment and they are performing common exploratory research.

The top-class cleanroom facility is used by the companies located in the technopark, as well as by interested partners.

2006 International Semiconductor Conference
CAS 2006 - IEEE event organized by IMT-Bucharest

The **2006 International Semiconductor Conference (CAS 2006 www.imt.ro)** was organized at the end of September and was the 29th of an annual sequence and the 16th edition with international participation. The conference is **an IEEE event, being sponsored by the IEEE Electron Devices Society**. The conference is also sponsored by ***Ministry for Education and Research***, the IEEE - Romania Section and the Electron Devices Chapter and also held under the aegis of the **Romanian Academy** as well as under aegis of the Electrochemical Society, Inc., including the European Local Section of the Electrochemical Society, Inc. All the contributed and invited papers presented at the conference were published in the CAS Proceedings, an ISI proceedings, delivered to the participants at the beginning of the conference. The quality of papers accepted for publication in the Proceedings is guaranteed by the evaluation made by referees (including members of the International Advisory Committee and of the Technical Program Committee).

Images from the poster sessions

The Conference profile has been gradually extended from semiconductor device physics and technology **to micro- and nano-technologies.**

The main topics from 2006 were: Nanoscience and Nanoengineering; Microphotonics; Advanced Microwave Devices and Circuits; Microstructures for bio & medical applications; RF MEMS & NEMS; Microsensors; Physics of Materials; Advanced Device Structures; New Materials for Semiconductor Devices.

In 2006 **7 invited speakers** from Denmark, France, Italy, Ireland, Germany, Singapore, and South Africa were presented at the conference.

CAS 2006 displayed **a total number of 103 papers** (96 regular and 7 invited) structured in oral sessions with 51 presentations, and poster sessions with 25 presentations. The authors were from 17 countries on 3 continents: Europe, Africa and Asia.

Images from the oral sessions

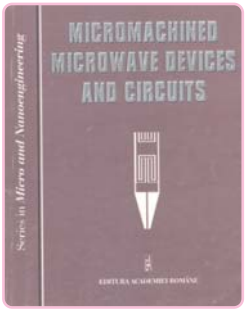
130 scientists from prestigious research centers (LAAS Toulouse, EPFL Lausanne, FORTH Heraklion, Tyndall Cork, IMT Bucharest), universities (Cambridge, Darmstadt, "Politehnica" Bucharest, Imperial College, Delft, Athens, Syddansk Universitet, Denmark, Napoli), from industry (GME mbH Munchen, Germany, EV Group, St. Florian, Austria) and also from European Patent Office, Berlin, Germany were present.

Loukas Michalas Univ of Athens, Greece receiving award for the best student paper.

A special session was dedicated to the student papers and the best papers presented were awarded by IEEE Romania section.

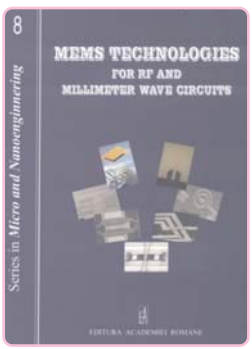
In 2007 the 30th edition of the conference will be held between 15th October and 17th October. June 10th is the deadline for submission of contributed and invited papers. Invited speakers from Univ. of California, Univ. of Liverpool, IMEP Grenoble, Univ of Bremen had already confirmed there participation.

The MEMSWAVE workshop



The Inco-Copernicus Project 977131 *"Micromachined Circuits for Microwave and Millimeter Wave Application"* -MEMSWAVE- was coordinated by IMT Bucharest and has connected nine different Western and Central Eastern European groups.

The workshops organized as dissemination activity of the project in 1999 and 2001 were open events, with participation of scientists from outside the MEMSWAVE consortium, as well. *Both workshops were organized in connection with the CAS conferences.* A special volume in the series Micro and Nanoengineering of the Romanian Academy Printing House "Micromachined Microwave Devices and Circuits" was dedicated to the second edition of the workshop and was published in 2002.



The high interest generated by the first workshops, has determined for them a future independent and itinerant existence. Being now an itinerant European event, the next editions of this workshop were organized at FORTH Heraklion (2002), LAAS Toulouse (2003), Uppsala University (2004), EPFL Lausanne(2005) and the 7th edition took place in 2006 at Orvieto, Italy . Continuing the tradition, the extended version of most interesting papers which have been presented at the MEMSWAVE workshops were published in the series Micro and Nanoengineering of the Romanian Academy Printing House in 2003, 2004, 2005 and 2006. The volumes were launched at the beginning of the next edition of the workshop.

In 2007, the MEMSWAVE workshop will be held at Barcelona, Spain in June and will be organized by Universitat Politècnica de Catalunya, (**http://congress.cimne.upc.es/memswave07**).

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Other

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3. ***"Realization Technology for a Microsensor Hall Integrated on Silicon"***, Marioara Avram, Cecilia Codreanu, No. 120515/29.09.2006.

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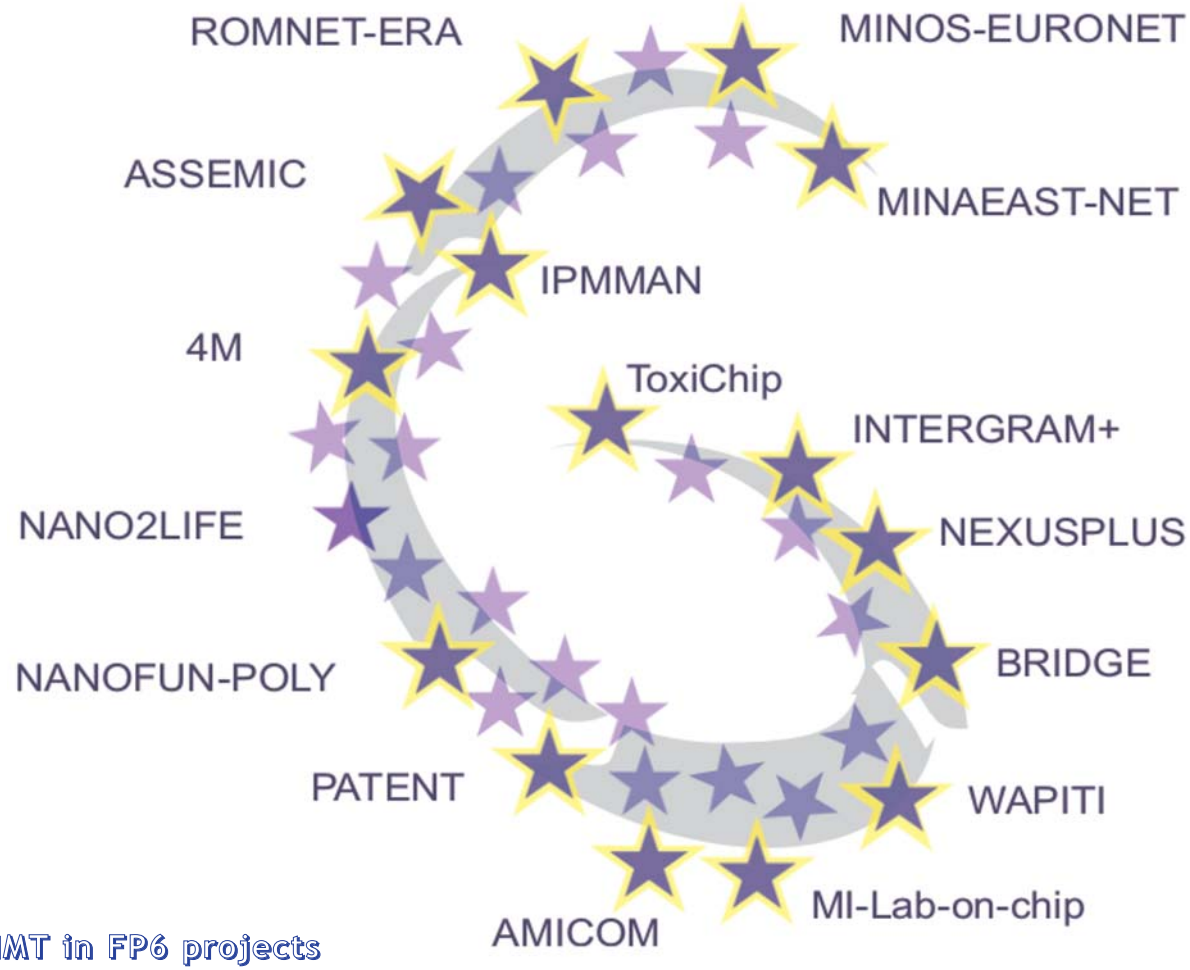

IMT in FP6 projects

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