IMT ca o platforma de integrare a TGE: micro-nanoelectronica, fotonica, materiale avansate, nanotehnologii

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www.imt.ro

IMT – Bucuresti

Principalele directii de cercetare:

- **Micro si nanotehnologii**
- **Micro si nanoelectronica**
- **Fotonica**
- **Materiale avansate**

TGE- Tehnologii Generice Esentiale (KETs)

- **Nanotechnologies**
- **Advanced Materials**
- **Micro- and nano-electronics**
- **Photonics**
- **Biotechnology**
- **Advanced Manufacturing**

TGE (KETs) - sunt tehnologii strategice, cu potential economic, care trebuie sa asigure leadershipul Europei si sa rezolve provocarile societale

IMT-Bucharest is a national institute spervised by **the Ministry of National Education**

Acting autonomously, like a scientific company; Having the status of a public institution.

Mission: **Integrating R&D with education and training and with support for industry (services, technology transfer); networking at national and international level innovation, in the field of micro-nanotechnologies and microsystems** (RF- MEMS, photonics devices and circuits, sensors, bio-nano-info technologies, CNT and graphene based sensors and nanodevices, (bio)sensors, integrated nano-bio systems, microfluidics, microactuators).

Main targeted applications: **communications, automotive, biomedical, health, environment, space, energy, robotics.**

Training activities: **master courses, internships, hands-on labs for students, PhD supervising and post-doc programs.**

Knowledge ⟶ TGE (KETs) ⟶ Market

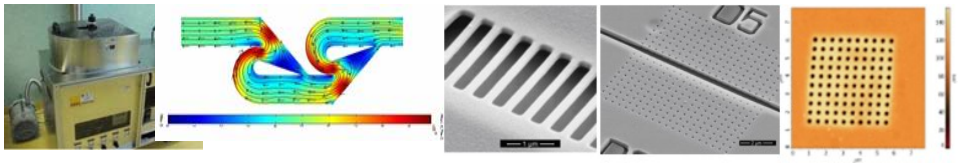
Implicarea IMT- Bucuresti in TGE (KETs)

- Proiecte de cercetare nationale si internationale in aceste domenii
- Proiecte finantate prin PPP (Public Private Partnership)
- Proiecte din Fonduri structurale

► Facilitati (infrastructuri) de micro-nanofabricatie; investitii in infrastructuri

►Sistem de servicii complexe cu acces pentru firme si universitati (investitii in educatie) prin acces direct sau proiecte comune de R&D&I

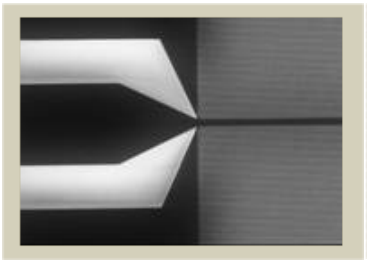
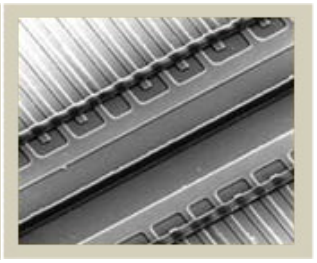
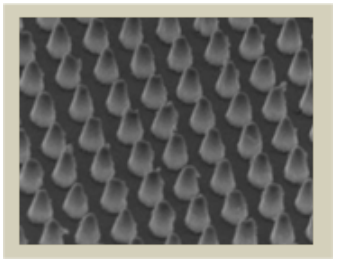
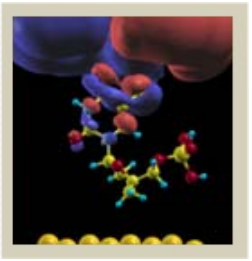
●Colaborare cu firme multinationale din Europa si Romania



National Reserch Projects related to KETs (TGE)

► PN II si STAR (ROSA)

1.Tehnologia Informatiei si Comunicatii
3. Mediu;
4. Sanatate;
7. Materiale, procese si produse inovative;
8. Spatiu si securitate;


National Reserch Projects related to KETs (TGE)

1.Tehnologia Informatiei si Comunicatii

1.7 Nanoelectronica, fotonica şi micronanosisteme integrate

Nanoelectronica

1.7.1 Experimentarea de noi materiale şi tehnologii pentru nanostructuri şi circuite integrate la scara nano

1.7.2 Experimentarea de noi arhitecturi de sisteme pentru nanoelectronică

1.7.3 Experimentarea de noi concepte (principii) de dispozitive nanoelectronice

1.7.4 Electronica transparentă

Micro - şi nanosisteme

1.7.5 Dezvoltarea componentelor şi microsistemelor pentru sisteme de comunicații; microsisteme inteligente reconfigurabile şi flexibile

1.7.6 Tehnologii microfluidice, micro/nano- biosenzori, laboratoare pe un cip, „microarrays", micro- şi nanostructuri şi micro- şi nanosisteme pentru diagnosticare şi tratament medical (inclusiv nanomedicină)

1.7.7 Microsenzori şi actuatori (inclusiv 3D)

1.7.8 Tehnologii de integrare eterogenă şi asamblare/încapsulare 3D pentru a permite realizarea de sisteme complexe pe un cip

1.7.9 Tehnologii convergente: micro-nano-bio-info

Fotonica

1.7.10 Noi materiale fotonice (materiale artificiale: cristale fotonice, materiale cu indice de refracție negativ etc.)

National Reserch Projects related to KETs (TGE)

► **IMT was involve in 15 FP6 European projects** (STREPs, IPs, NoE, CA, SSA, Marie Curie RTN, Leonardo da Vinci) **priorities IST (ICT) and NMP**

► **IMT was and is involved in 12 FP7 projects, priorities ICT, NMP, HEALTH, ENVIROMENT**

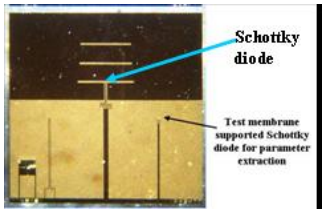
► **IMT is involved in 4 ENIAC (Nanoelectronics) projects**

► **IMT was and is involved in 6 MNT ERA-NET projects and 3 COST projects**

FP 7 projects (1)

REGPOT - FP7 project coordinated by IMT-BUCHAREST

• **MIMOMEMS- European Centre of Excellence in Microwave, Millimeter Wave and Optical Devices, based on Micro-Electro-Mechanical Systems for Advanced Communication Systems and Sensors**, REGPOT call 2007-1**, ICT**
Contract no. 202897, 2008-2011
Coordinator: IMT-Bucharest



IP projects

• **SMARTPOWER- Smart integration of GaN & SiC high power electronics for industrial and RF applications "**, IP FP7-**ICT**-2011.3.2, contract no. 288801, 2011 - 2014
Coordinator: **Thales SA - Thales Research & Technology, France**
IMT role: partner

• **NANOTEC- Nanostructured materials and RF-MEMS RFIC/MMIC technologies for highly adaptive and reliable RF systems ",** IP FP7-**ICT**-2011.3.2, contract no. 288531, 2011 - 2014
Coordinator: **Thales SA - Thales Research & Technology, France**
IMT role: partner

FP 7 projects (2)

IP projects

•**FlexPAET- Flexible Patterning of Complex Micro Structures using Adaptive Embossing Technology,** IP, **NMP**, 2008-2010
Coordinator: **Fraunhofer Gesellschaft zur Förderung der angewandten Forschung e.V. Fraunhofer Institut für Produktionstechnolgie (IPT),** Germany,
IMT role: partner

•**NanoValid- Development of reference methods for hazard identification, risk assessment and LCA of engineered nanomaterials,** FP7 Large-scale integrating Collaborative Project 2011-2015, IP, **NMP**.
Coordinator **NordMiljö AB (NOMI), Sweden**
IMT role: partner

STREP projects

FP 7 projects (3)

• **PARCIVAL- Partner Network for a Clinically Validated Multi-Analyte Lab-on-a-Chip Platform,**
FP7 **HEALTH**.2011.2.3.1-4, 2011 - 2014
Coordinator: Guus Simons, PathoFinder BV, Netherlands
IMT role: partner, Dr. Carmen Moldovan

• **NANOSUSTAIN- Development of sustainable solutions for nanotechnology-based products based on hazard characterization and LCA, FP7-NMP-ENV-2009, STREP**, 2010-2013.
Coordinator NordMiljö AB (NOMI), Sweden, Dr. Rudolf Reuther
IMT role: partner, Prof. Dan Dascalu,

• **MEMS-4-MMIC- Enabling MEMS-MMIC technology for cost-effective multifunctional RF-system integration,** STREP, FP7-**ICT**-2007-2, Contract no. 204101, 2008-2011
Coordinator: IMST GmbH
IMT role: partner, Dr. Dan Neculoiu

• **CATHERINE- Carbon nAnotube Technology for High-speed nExt-geneRation nano-InterconNEcts**, STREP, FP7-**ICT**-2007.8.1, Contract no. 216215, 2008-2011
Coordinator: Consorzio Sapienza Innovazione, Italy
IMT role: partner, Dr. Adrian Dinescu

The main characteristic of IMT is given by *its level of ambition, namely to be a visible actor at the European scale*.

Highlights

► **IMT- Bucharest was the first coordinator** from **Eastern Europe of an European Project in IST - FP4 - last call** (**1998-2001**), nominanated as finalist of the **Deschartes Price in 2002: "MEMSWAVE" project**

IMT- Bucharest- 2011: Innovation Union Competitiveness Report of EC

TABLE 5 — RO - Romania - Most active organisations in terms of EC contribution granted to the FP7 research projects

Legal Name	Number of Participations	% of all RO grant holders	EC contribution (M euro)	% of total EC contribution to RO grant holders
Universitatea Politehnica Din Bucuresti (UPB)	30	5.58%	6.93	9.58%
Institutul de Chimie Macromoleculara Petru Poni (ICMPP)	7	1.30%	3.54	4.89%
Universitatea Tehnica Cluj-Napoca (UTC)	16	2.97%	2.77	3.82%
Primaria Municipiului Iasi (IASI)	1	0.19%	2.38	3.29%
Institutul National de Cercetaredezvoltare Pentru Microtehnologie (IMT)	6	1.12%	1.98	2.73%

► **The first National Institute and the 5th of Romanian entities- regarding *the Most active organization in terms of EC contribution granted to the FP7 research projects***

Highlights

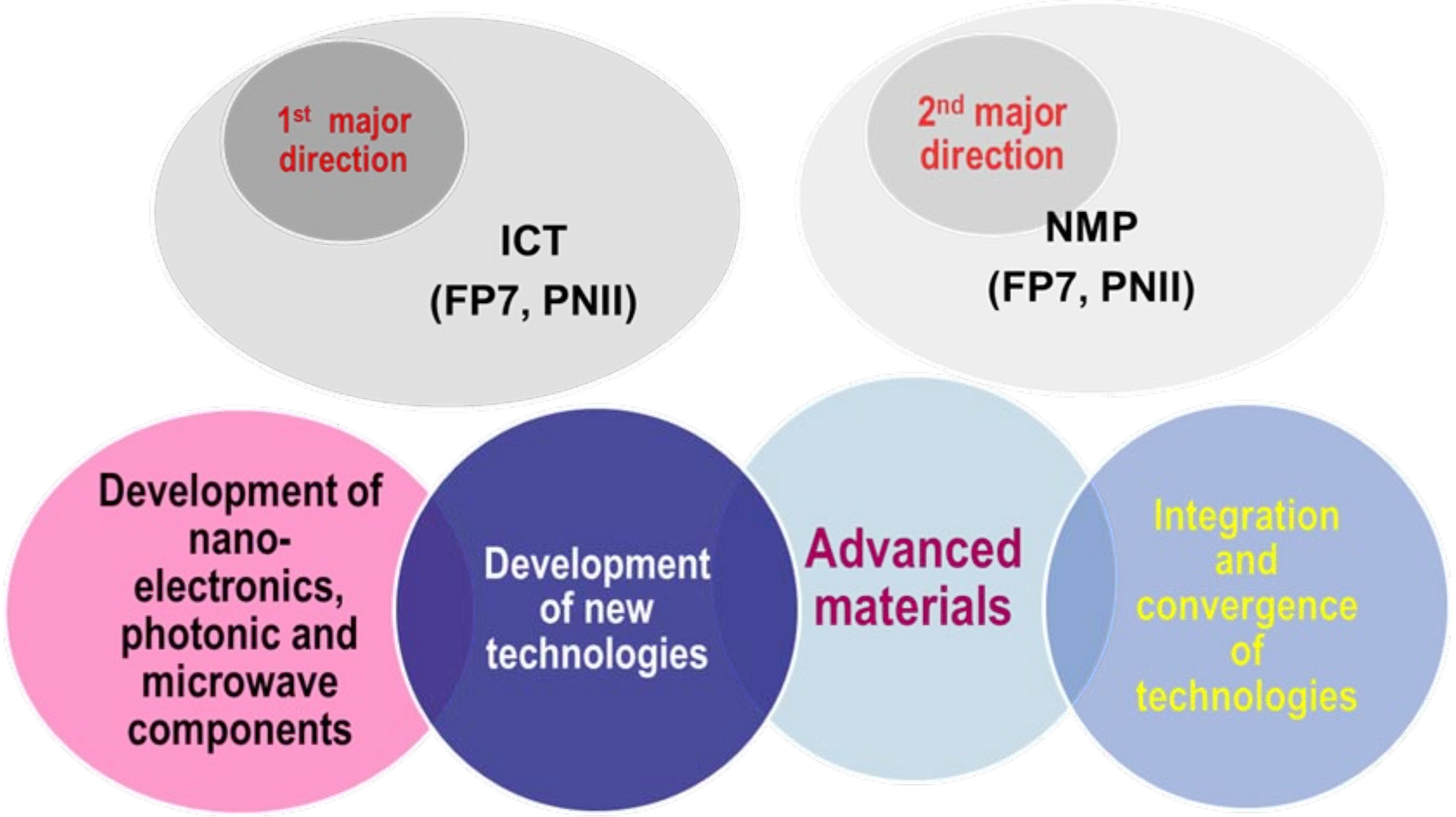
Top 50 RO organisations by funding, 2007 - 2012 (cumulated figures)

#	Organisation	Type	EU funding	%
1	UNIVERSITATEA POLITEHNICA DIN BUCURESTI	HES/REC	3,502,749	18.0%
2	UNIVERSITATEA TEHNICA CLUJ-NAPOCA	HES/REC	2,418,072	12.4%
3	INSTITUTUL E-AUSTRIA TIMISOARA	HES/REC	1,238,997	6.4%
4	INSTITUTUL NATIONAL DE CERCETAREDEZVOLTARE PENTRU MICROTEHNOLOGIE	HES/REC	1,149,126	5.9%
5	SIEMENS PROGRAM AND SYSTEM ENGINEERING SRL	LARGE	903,802	4.6%
6	INSTITUTUL NATIONAL DE CERCETARE-DEZVOLTARE IN INFORMATICA - ICI BUCURESTI	HES/REC	866,083	4.4%
7	INFO WORLD SRL	SME	603,431	3.1%
8	BLUE POINT IT SOLUTIONS SRL	SME	483,236	2.5%

► **Digital Agenda 2013 -results for ICT for period 2007-2012 IMT- Bucharest is ranked on the first place among the national institutes in ICT, on 4 th place in Romania**

► **Romania, through IMT** is the only country from Eastern Europe participating every year (since 2007), by invitation, to the ***World Micromachine Summit*** (devoted to **micro- and nanotechnologies and systems**), with the main actors in the field from all continents, providing a picture to worldwide industrial, academic and government initiatives

Research projects & main directions



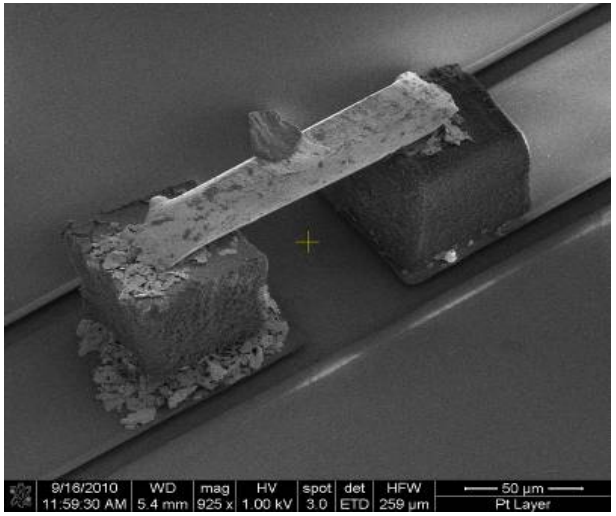
Results related to KETs (TGE)

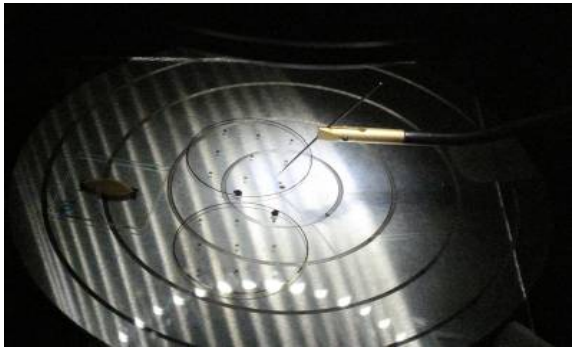
Results related to:
one KET or combine KETs

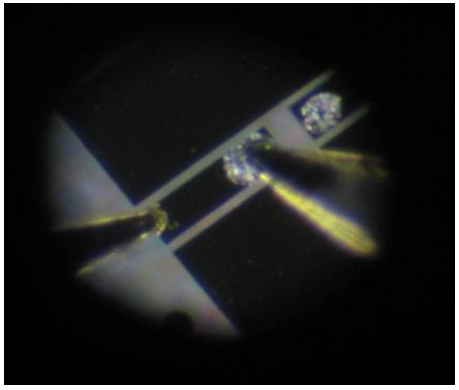
Results related to:
- **projects**
  - **new concepts,**
  - **new technologies,**
  - **demonstrators, proof of concepts**
- **ISI publications in important journals**
- **patents (national and 1 international)**

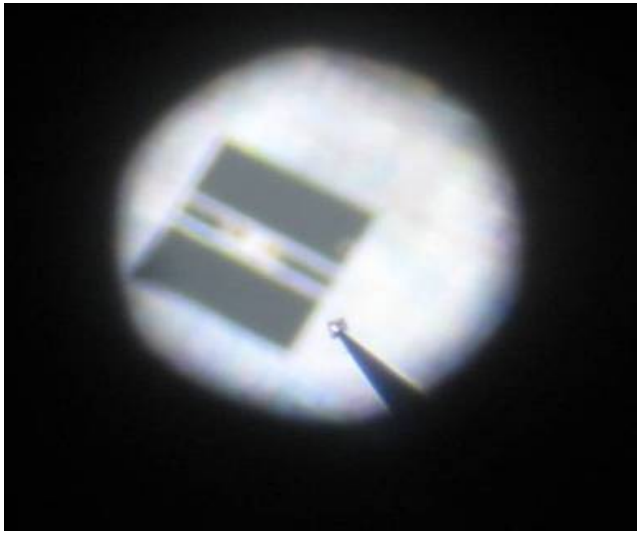
Carbon nAnotube Technology for High-speed nExt-geneRation nano-InterconNEcts – CATHERINE- FP7- ICT - STREP(2008-2010)
Vertical interconnects - proof of concept

Micro-Nanoelectronics



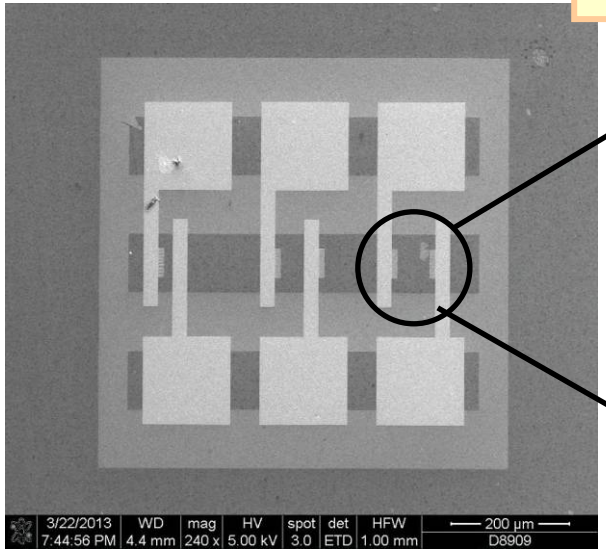


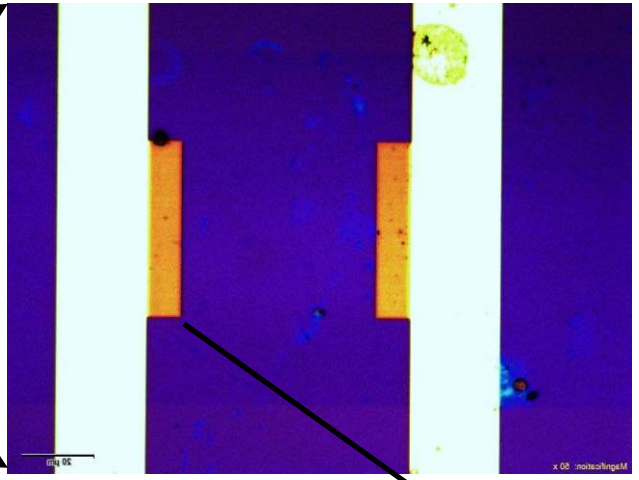


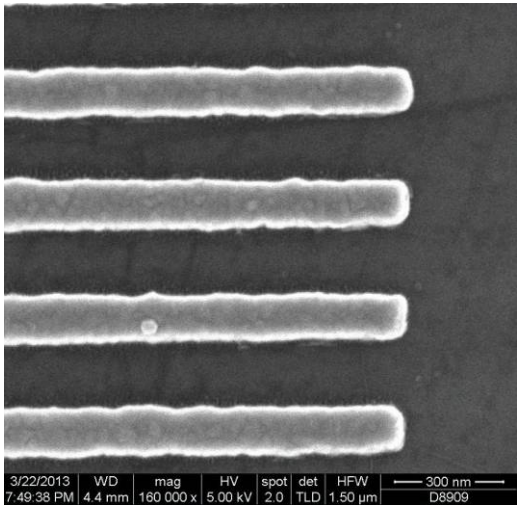


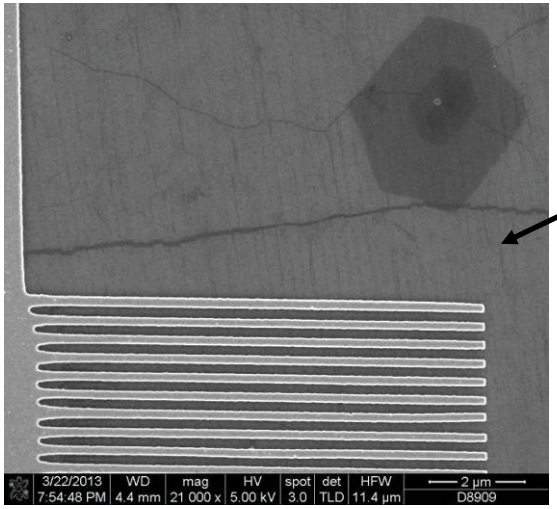
Graphene-based plasmonic photodetector

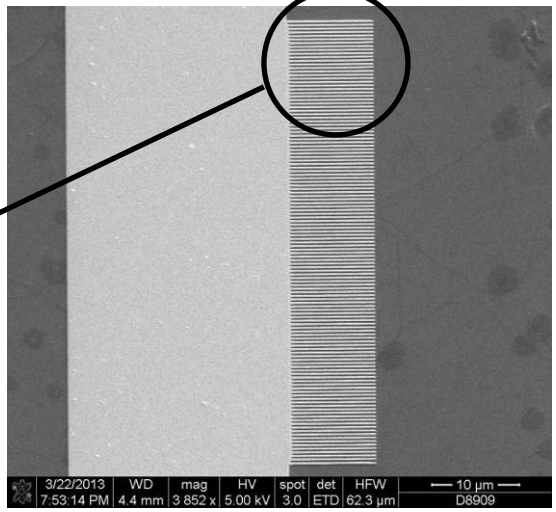
Nanoelectronics + Photonics



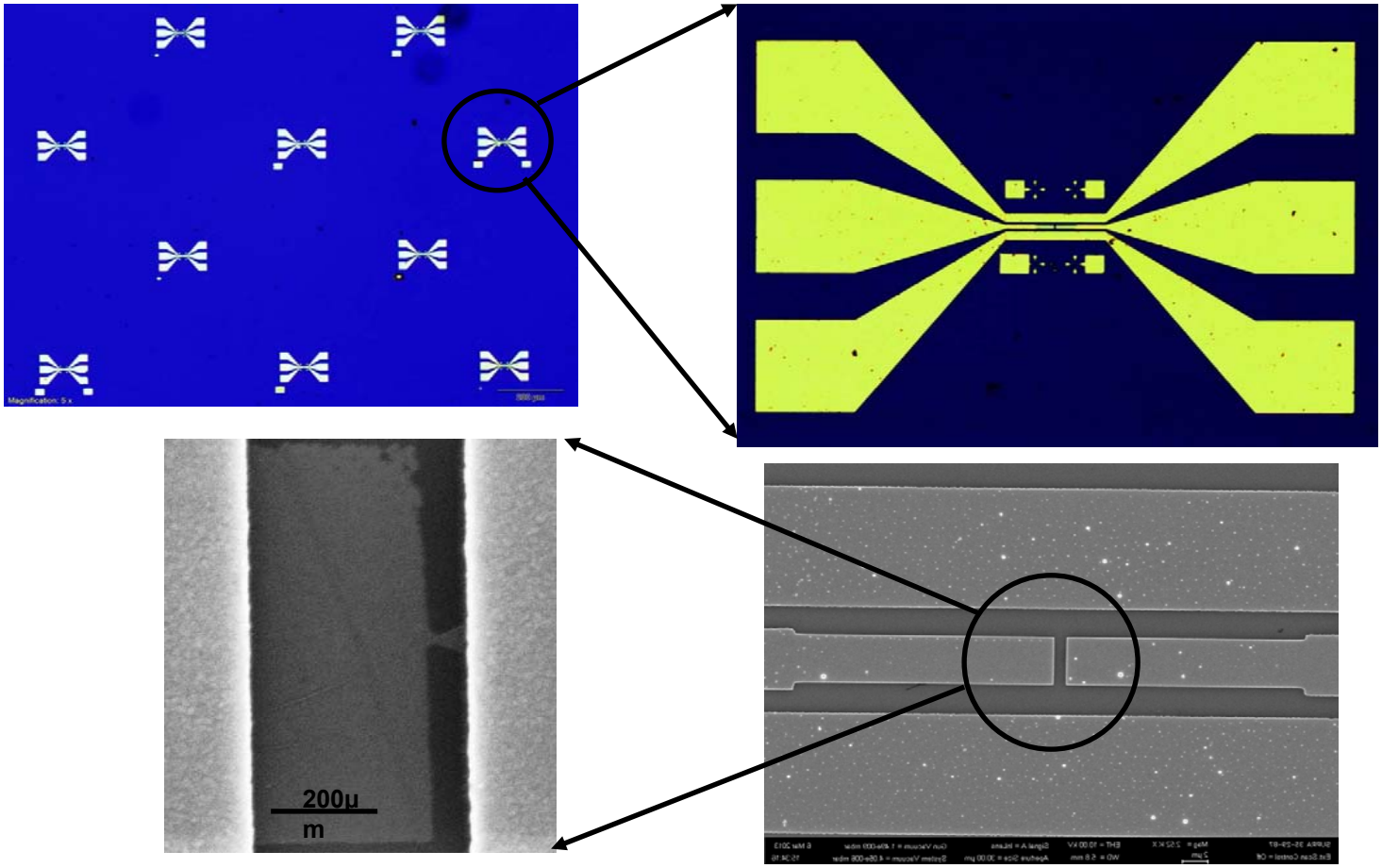








Nanoelectronics



JOURNAL OF APPLIED PHYSICS 115, 044307 (2014)

Towards a terahertz direct receiver based on graphene up to 10 THz

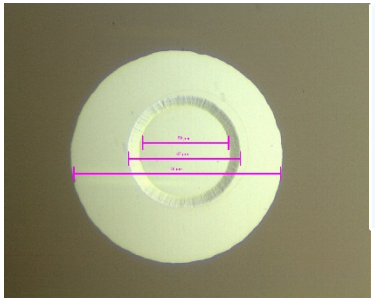
Mircea Dragoman,[1,a)] Martino Aldrigo,[2] Adrian Dinescu,[1] Daniela Dragoman,[3] and Alessandra Costanzo[2]

Micro-Nanoelectronics

NANOBIOTECHNOLOGY LABORATORY

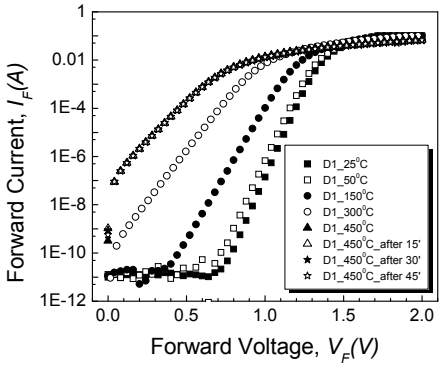
- **Devices based on silicon carbide (SiC) with applications in harsh environments**

1. High temperature sensors > Schottky diodes on SiC



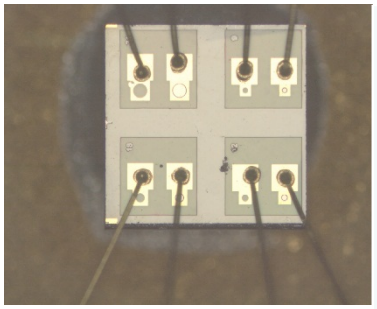
An oxide ramp termination has been designed in order to obtain an uniform distribution of the current density and a high breakdown voltage.

Schottky diodes based on SiC



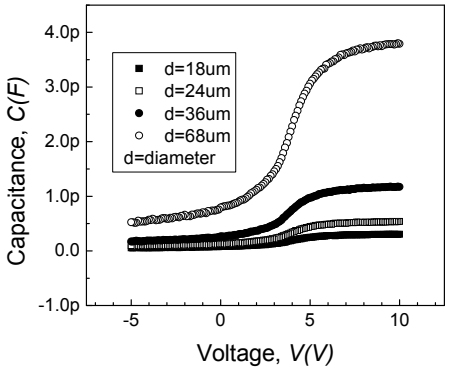
The I-V-T characteristics demonstrate that the Schottky diodes based on SiC successfully operate in the whole range of temperature 25 - 450°C. Moreover, a good stability at high temperature was shown.

2. Gas sensors for toxic environments and high temperature applications > MOS capacitors on SiC



MOS structures with different active areas

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



It can be noticed the 3 modes of operation for a MOS capacitor: accumulation, depletion, respectively inversion. Moreover, an increase of the capacitance with active area is observed.

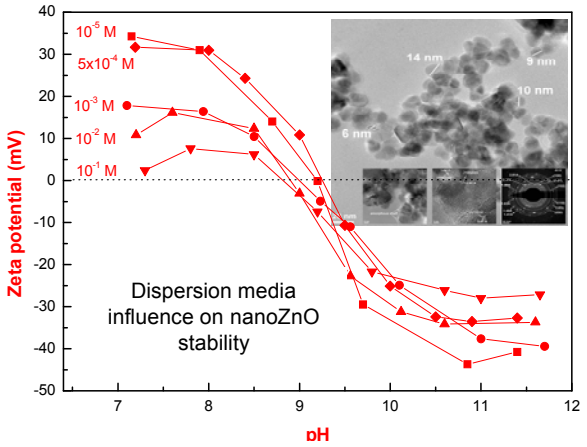
SiC-SET project (PNII- PCCA, 2012-2015)

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

Nanotechnologies

- **Nanomaterial / nanoproduct risk assesment**

FP7 (NMP) project NanoSustain (2010-2013) **- focused on developing innovative solutions for the sustainable design, use, recycling and final treatment of nanotechnology-based products**



Scientific data generated during the course of the project has provided new evidence and knowledge on how nanomaterials may interact and react with living systems and how strongly their behaviour depends on the particular physicochemical form and surface properties rather than on composition or concentration.

J Nanopart Res 15 (2013) 1352

FP7 (NMP) project NanoValid (2011-2015) **- launched as one of the "flagship" nanosafety projects.**

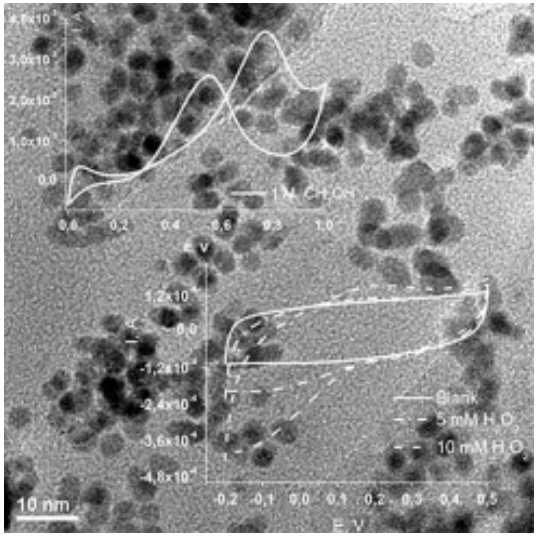
- is devoted to validation of the measurements and test methods for testing toxicity.
- in cooperation with international standardization bodies and the industry, advanced physical-chemical characterization methods for organic and inorganic nanomaterials are studied, aiming at developing a set of reliable reference methods and materials for the fabrication, hazard identification and exposure assessment of engineered nanomaterials.

LIFE+ (Environment Policy and Governance) project i-NanoTool (2013-2015)

- aims to support the European nanoparticles manufacturers with the implementation and enforcement of environmental laws, to facilitate these companies, the updated information regarding the environmental impact of its activities and legislation and also to give information about the existing methods for the assessment of the environmental impact of the nanoparticles.

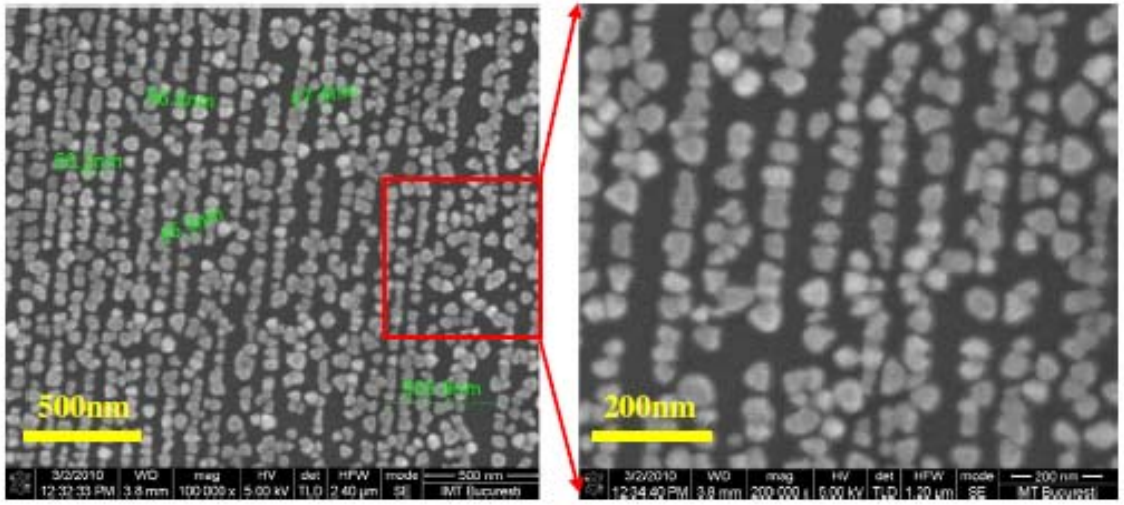
Advanced materials

- **Pt nanoparticles on graphene polyelectrolyte nanocomposite: investigation of H_2O_2 and methanol electrocatalysis**



A. Bragaru et al, ***Materials Chemistry and Physics***
146 (2014) 538–544

- **Gold nano-island arrays on silicon as SERS active substrate for organic molecule detection**

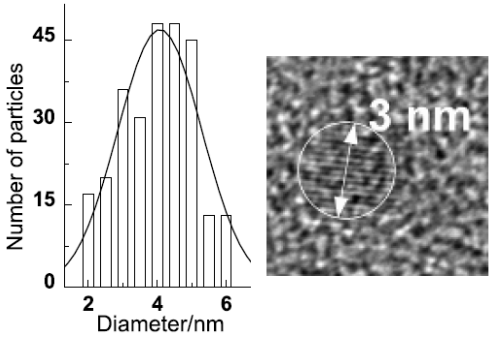


T. Ignat et al, ***Thin Solid Films***
550 (2014) 354–360

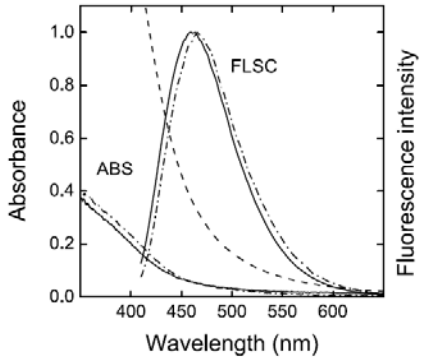
Advanced materials

- Complex Ideas national project (2012-2015): „Carbon quantum dots: exploring a new concept for next generation optoelectronic devices”
  - KETs involved: Advanced materials - under-5nm *carbon quantum dots*, chemically modified to acquire/optimize optical properties

    Photonics, Micro-nanoelectronics - OLED and PV devices integrating thin film layers of chemically modified CQDs

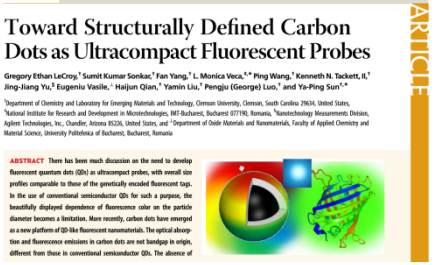


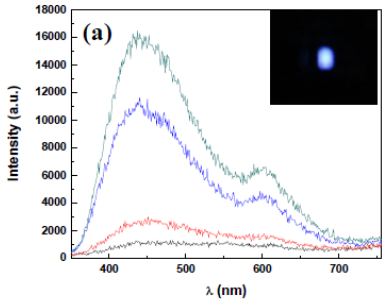
Size distribution and TEM of under-5nm carbon cores in CQDs

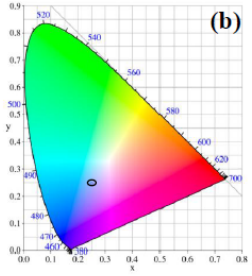


Absorption and fluorescence spectra of EDA-modified carbon dots

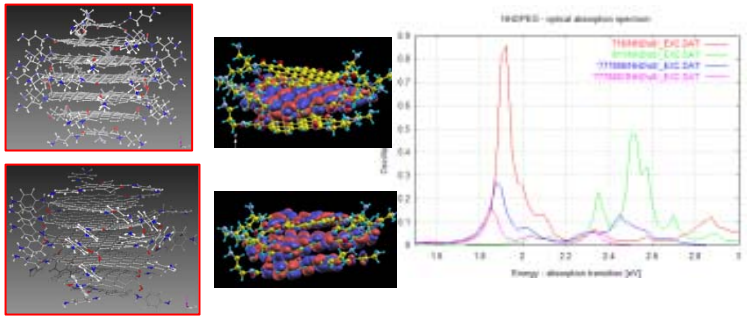
ACS Nano 2014
DOI 10.1021/nn406628s


Toward Structurally Defined Carbon Dots as Ultracompact Fluorescent Probes





Electroluminescence spectra of PEG-passivated CQDs; OLED device.



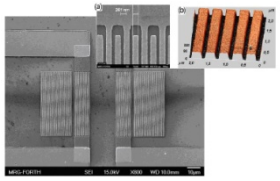
Theoretical atomistic modeling and analysis of structural, electronic and optical properties of modified CQDs.

European Centre of Excellence in Microwave, Millimetre Wave and Optical Devices, based on Micro-Electro-Mechanical Systems for Advanced Communication Systems and Sensors-"MIMOMEMS"- FP7 Project No 202897 (2008-2011), REGPOT call 2007-1 - Coordinator Dr. Alexandru Muller

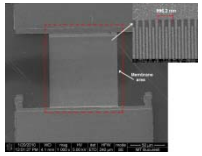
MIMOMEMS

SEVENTH FRAMEWORK PROGRAMME

► Collaborative scientific work and state-of-the-art devices and technologies have been developed in collaboration with the twining partners: FORTH Heraklion and LAAS Toulouse



GaN based 5.3 GHz SAW structure (A Muller, D.Neculoiu, G Konstantinidis, et al, IEEE Electron Devices Lett., vol 31, no. 12, 2010, pp 1398-1400)



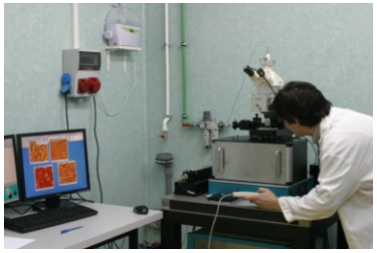
GaN membrane supported UV photodetector (A Muller, G. Konstantinidis, A. Dinescu et al, Thin Solid Films, 520 (2012) 2158–2161)

► Upgrade the research equipment (50% of founds)

Millimeter wave characterization equipment up to 110 GHz

Frequency syntesizer up to 110 GHz

Au plating facility for semiconductor wafers



Scanning Near Field Microscope SNOM Witec Alpha 300S

Micro-Nanoelectronics + Photonics + Advancesd materials

The overall aim of the MIMOMEMS project was to bring research activity in Radio Frequency (RF) and Optical Micro-Electro-Mechanical Systems (MEMS) at the National Institute for Research and Development in Microtechnologies (IMT-BUCHAREST), Romania, to the highest European level, and create a European Centre of Excellence in microwave, millimetre wave and optical devices, based on Micro-Electro-Mechanical Systems for Advanced Communication Systems and Sensors.

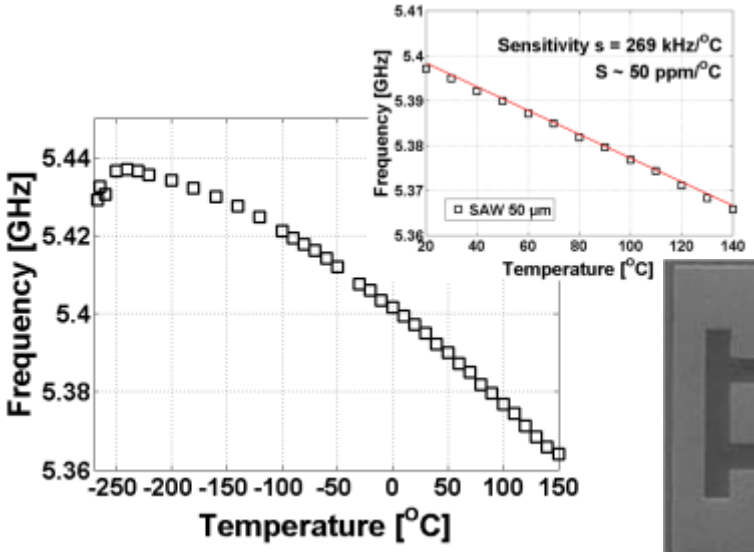
- 10 ISI ranked papers published in journals in cooperation with twining partners (IEEE Electron Device Lett., Electronic Letters, Appl. Optics, Microelectronics Journal, J. Opt. A: Pure Appl. Opt, Thin Solid Films, etc)
- Organizing of two Scientific Workshops and one Strategic Workshop devoted to the MIMOMEMS project at the IEEE International Semiconductor Conference, CAS 2008 - 2010 in Sinaia
- 20 projects proposals in FP7 and FP7 related calls have been submitted having the support of the MIMOMEMS project. Two IPs in the *FP7-ICT-2011-7* call (SMARTPOWER and NANOTEC) and 4 *projects in calls related to FP7 (ENIAC and MNT ERANET)* have been successful.

Nanoelectronics + Advanced materials

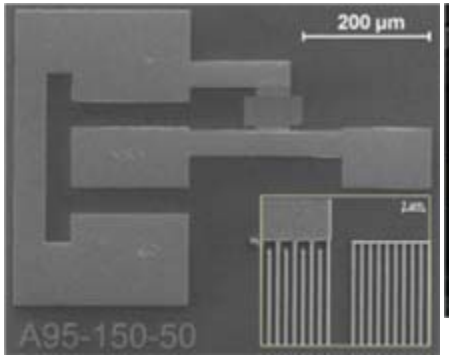
FP7 IP SMARTPOWER *«Smart integration of high power electronics for industrial and RF applications»*

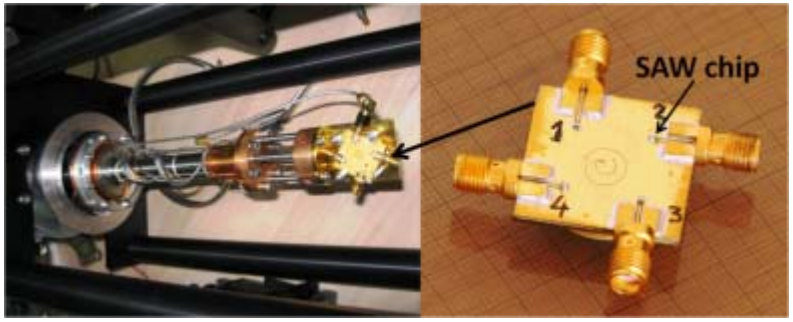
Coordinator Thales Research & Technology, France, 2011-2015

IMT team is involved in **the manufacturing of a GHz SAW based temperature sensor**. Work is performed in cooperation with FORTH Heraklion and Thales TRT, the coordinator of the IP. The sensing system will be placed close to the MMIC in a radar developed by Thales Systemes Aeroportes to measure the temperature which has to be read far from the radar.



- **Single port GaN based SAW structures** with IDTs having 100-200 nm wide finger/interdigit spacing.
- The structures have an interdigitated transducer with 150 fingers and 150 interdigits and 50 reflectors, placed on both sides of the IDT at different distances from IDT





(a) SEM photos of the single resonator SAW structure; (b) Cryostat set-up; (c) detailed photo of the ceramic carrier with the SAW temperature sensing devices.

Micro-Nanoelectronics

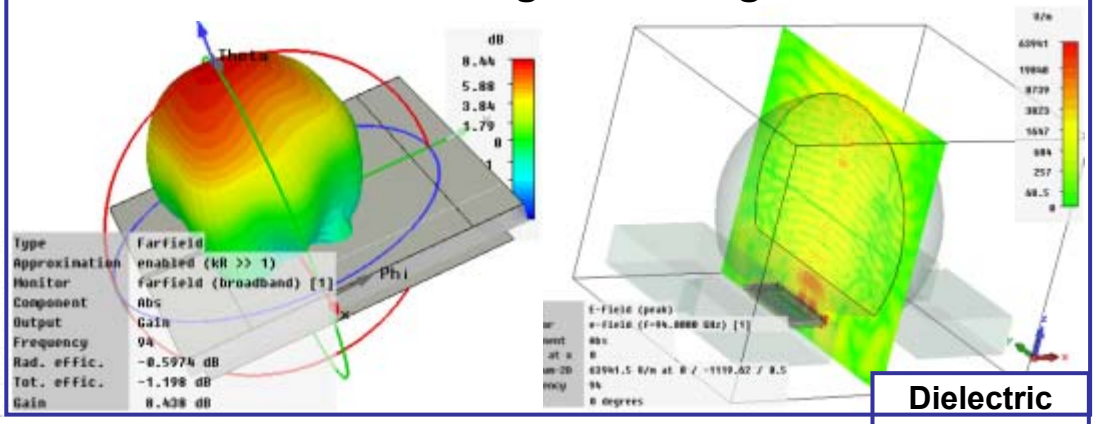
***FP7 IP NANOTEC** «Nanostructured materials and RF-MEMS RFIC/MMIC technologies for highly adaptive and reliable RF systems»*

Coordinator Thales Research & Technology, France, 2011-2015

The NANOTEC project aims to generate innovative approaches towards novel RF/mm-wave systems with increased functionality and potentially lower cost addressing future needs of European industry.

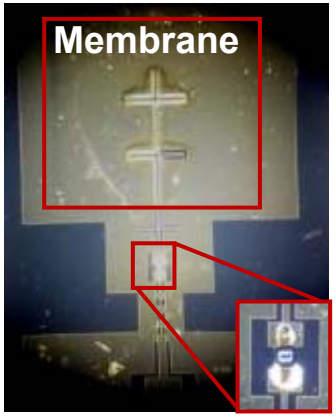
Major IMT contributions: design of the 94 GHz high-sensitivity antenna front-end for passive imaging & characterization of the RF-MEMS low-noise blocks for 94GHz.

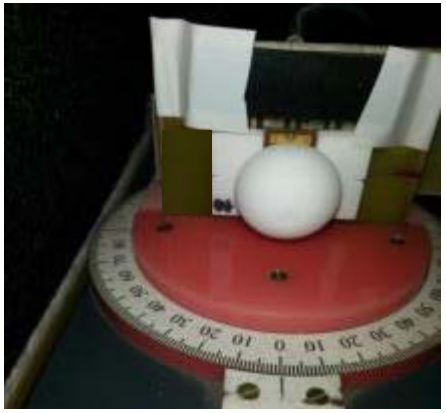
Electromagnetic design



Dielectric lens

Manufacturing & Measurements





Micro-Nanoelectronics

Participation in FP7 STREP MEMS-4-MMIC (2008-2012)

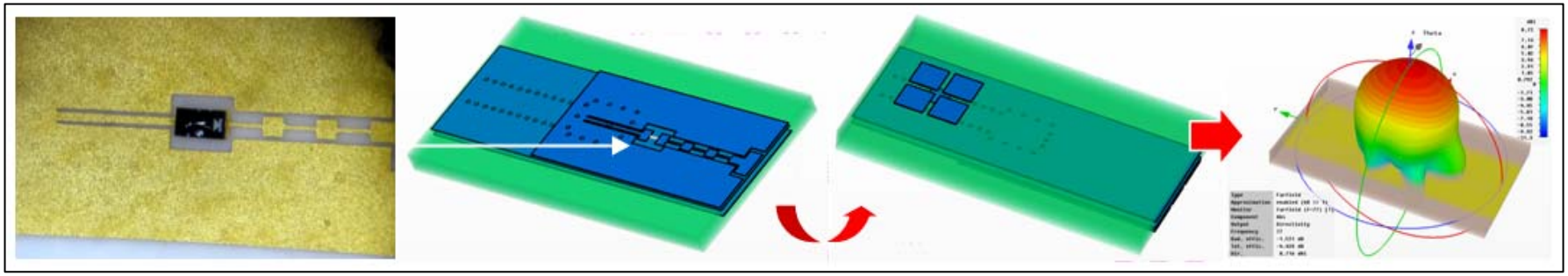
"Enabling MEMS-MMIC technology for cost-effective multifunctional RF-system integration" (http://www.mems4mmic.com***)***

- **Coordinator: IMST GmbH** (Germany)
- **Partners**:
  - Technical Research Centre of Finland (**VTT**)
  - **Ommic** – France
  - Swedish Defence Research Agency (**FOI**)
  - Institut d'Electronique, de Microélectronique et de Nanotechnologie (**CNRS-IEMN)** – France
  - **SAAB** Microwave Systems – Sweden
  - **IMT Bucharest** – Romania

Project meeting in Bucharest, March 2012

The **MEMS-4-MMIC** project was aimed at the integration of RF-MEMS switches onto MMIC creating highly integrated multifunctional building blocks for high-value applications. The project has been concluded successfully and a whole range of RF-MEMS MMIC components has been realized.

IMT involvement: design and characterization of millimeter wave circuits in the K and W band



77 GHz receiver designed by IMT Bucharest and processed at VTT Finland

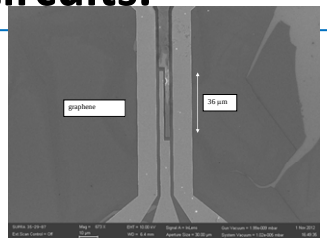
Nanoelectronics + Advanced materials

FP7 STREP NANO RF «Carbon Based Smart System for Wireless Application»

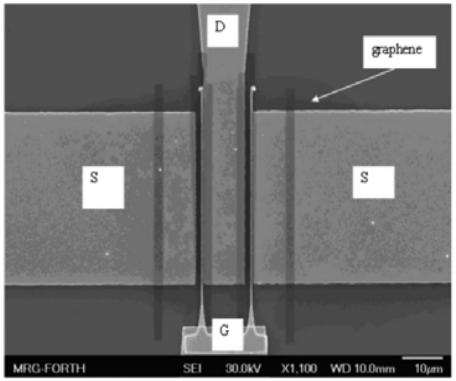
Coordinator Thales Research & Technology, France, 2011-2015

The concept of NANO-RF is to develop a new approach for future generation of T/R modules by using CNT and graphene technologies leading to a revolutionary new "nano T/R module" working at very high frequencies (up to 80 GHz).

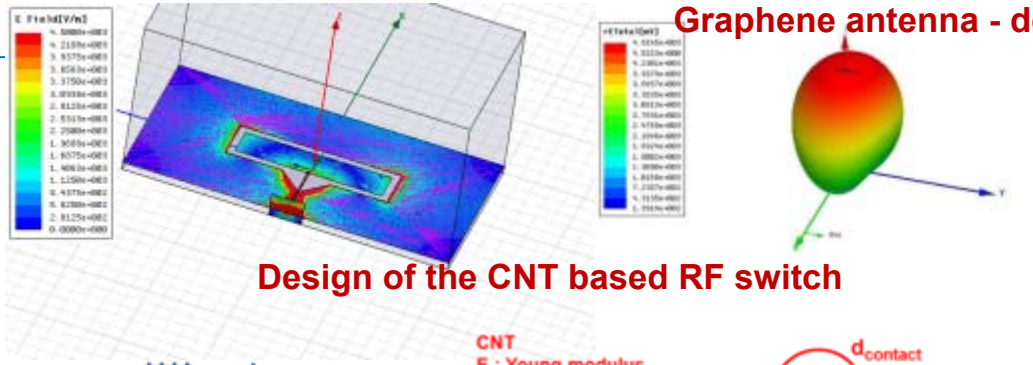
Major IMT contributions: The IMT role is the design of CNT and graphene devices and circuits.



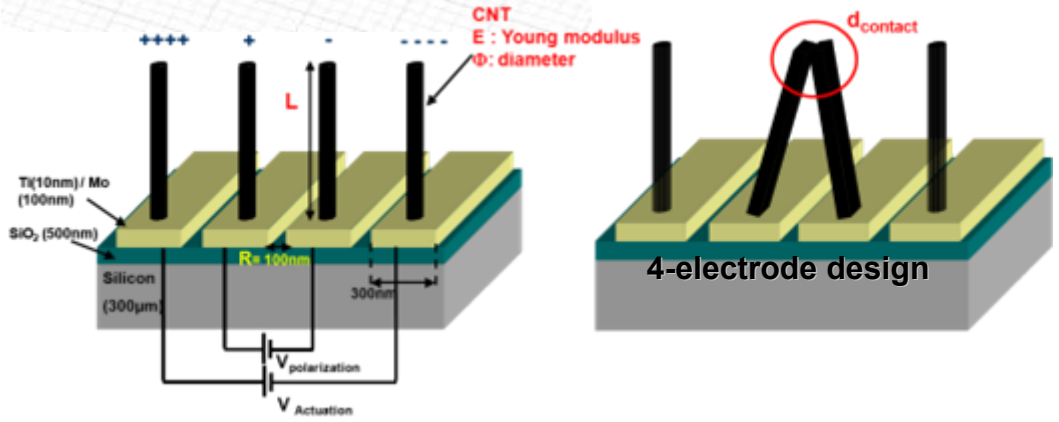
SEM image of the CPW line over graphene



Graphene antenna - design



Design of the CNT based RF switch



PARCIVAL - Partner Network for a Clinically Validated Multi-Analyte Lab-on-a-Chip Platform *FP7 HEALTH Project, 2011 - 2014*

PARCIVAL will develop a **multi-analyte lab-on-a-chip platform** for simultaneous detection of resistance patterns, biomarkers for severity of infection, and infectious pathogens from patients and air samples. It will enable point-of-care testing for immediate evidence-based therapy thereby reducing unspecific use of antibiotics.

Potential applications:
Flexible multi-analyte Point of Care testing platforms, including multiplex DNA , RNA and biomarker testing will definitely find their way in doctors's offices, small clinical institutes, hospitals as well as in large central laboratories.

PARCIVAL consortium:
- PathoFinder B.V. (the Netherlands);
- HSG-IMIT (Germany);
- IMT Bucharest (Romania);
- Labor Stein (Germany);
- Erasmus MC (the Netherlands);
- Rohrer AG (Switzerland);
- ASKION GmbH (Germany);
- Agrobiogen GmbH (Germany);
- EADS (Germany).

Key Enabling Technologies in PARCIVAL:

Biotechnology: *Pathofinder, Labor Stein, Agrobiogen, Erasmus MC*

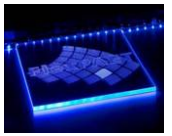
Micro- and Nanoelectronics *Rohrer AG, HSG-IMIT*

Advanced manufacturing systems: *IMT Bucharest, ASKION*

patient sample → multi-analyte test carrier → flexible panel detection → fully integrated diagnosis

Photonics EU project

Flexible Patterning of Complex Micro Structures using Adaptive Embossing Technology FLEXPAET– FP7 project (IP)



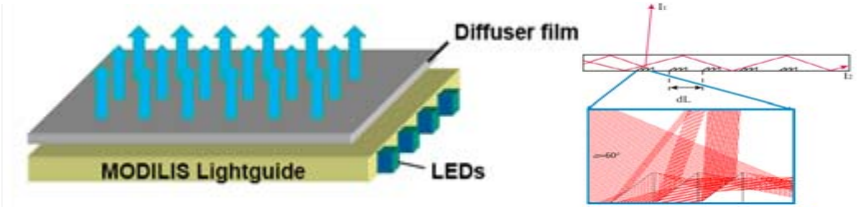
Aim: development of an innovative ***process chain and of a machine for high volume production of large-area masters micro structured surfaces for diffractive optial elements***

Coordinated by ***Fraunhofer IPT***, with important ***industrial participation***:

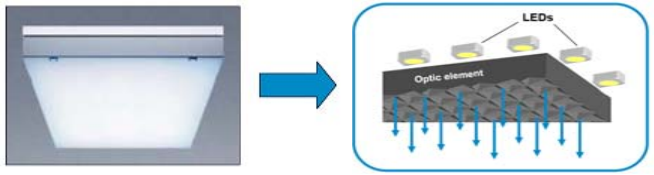
- ❑ **1 large company-** Zumtobel- Austria,
- ❑ **7 SMEs** :
  - INNOVALIA and DataPixel - Spain,
  - Eitzenberger Luftlagertechnik and JFA Präzisionswerk - Germany,
  - IPU –Denmark
  - Gaggione SAS - France
  - Oy Modines - Finland,

Applications

- **backlight technology**



- **light ceiling**



IMT Role: 1. Development of an algorithm for embossing optimization of large areas DOEs for obtaining the required optical properties

Embossed test slide 90mm x 250mm backlight

M.Kusko, C. Kusko, and D. Cristea, **J. of Optical Soc. of America 27, 2010,**

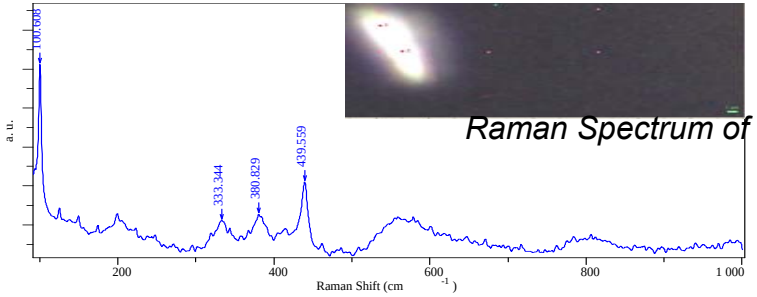
Photonics + Advanced materials EU project

MNT ERA NET Project *"Multifunctional Zinc-Oxide based nanostructures: from materials to a new generation of devices (MULTINANOWIRES)*

Cooperation with Univ "Dunarea de Jos" Galati and UNINOVA-Portugal

- **ZnO interconnected nanowire networks grown from solution on patterned substrate**

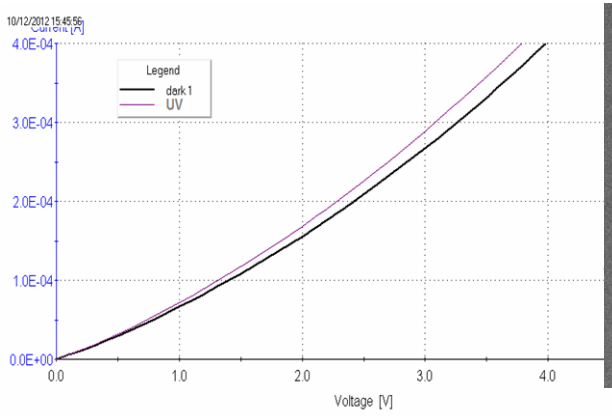
SEM images of ZnO interconnected nanowire networks grown on quartz

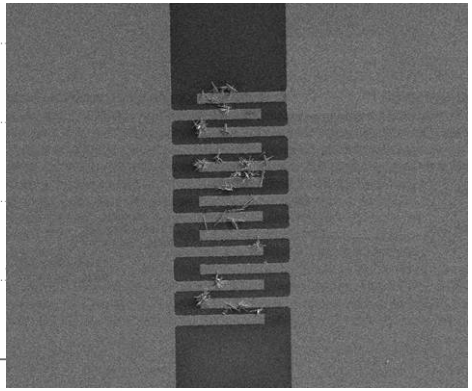


Raman Spectrum of a ZnO nanorod

- **UV detector**

I-V characteristics in dark and under UV illumination

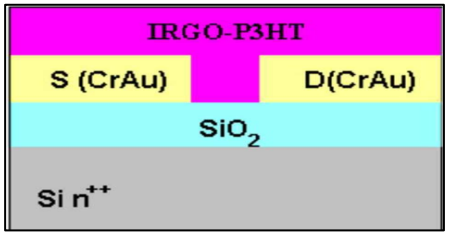


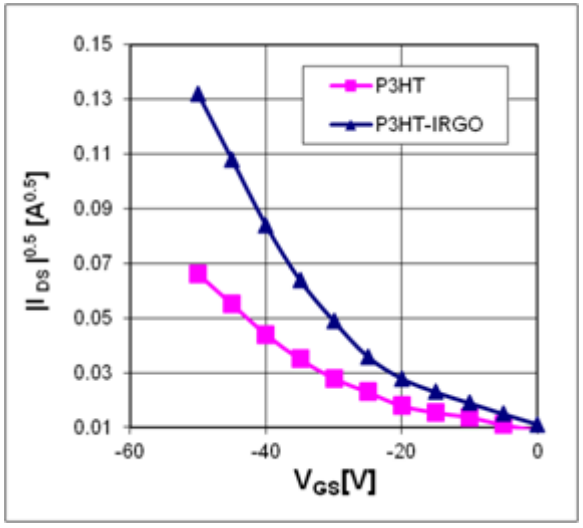


ZnO NWs connect two adjacent gold electrodes

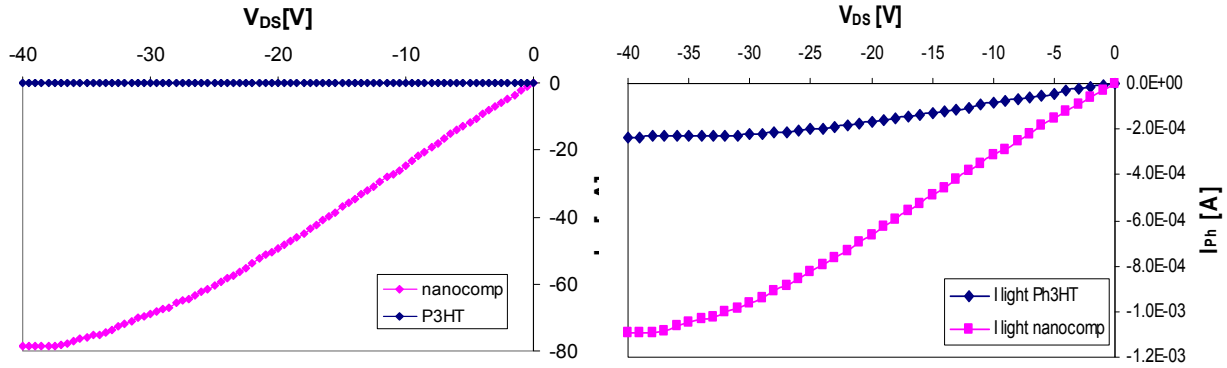
Graphene/P3HT based devices (Project "Ideas")

Substrate (gate): high coductivity Si
Gate dielectric: SiO_2 300nm-thick
Interdigitated gold electrodes for drain and source (bottom contact configuration).
Active layer: spin-coating IRGO-P3HT solution in chloroform DCB in glove box under N2 athmosphere + annealing (160°C for 15 minutes in the oven under nitrogen).





Net photocurrent ($I_{ph} = I_{DS(light)} - I_{DS(dark)}$) ***under illumination*** (V_{GS}=-20V)

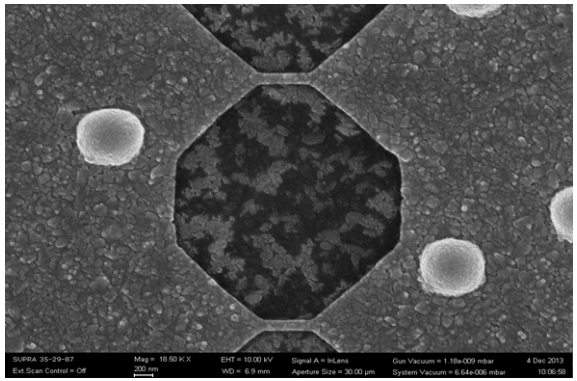


DUV- UV light

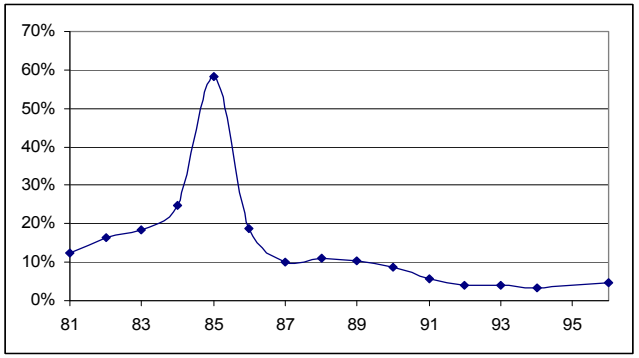
Broadband light source (UV-Vis-NIR)

C.Obreja et. al, , **Applied Surface Science 276** (2013) 458– 467

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

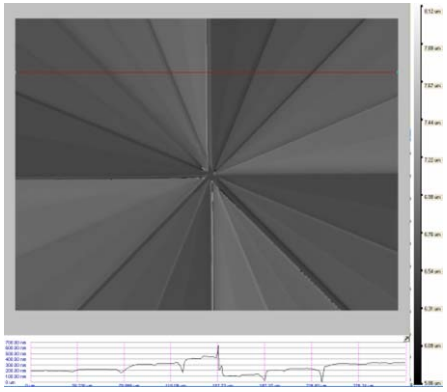


Metallic mask for realization of an YBCO based SQUID

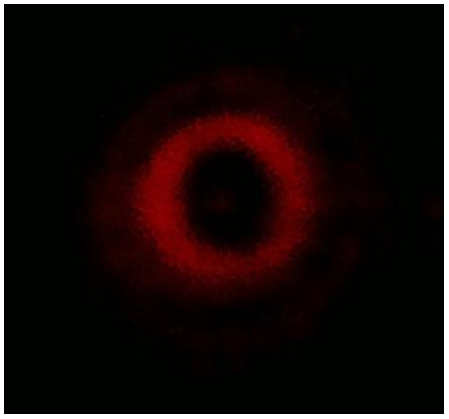


Relative variation with temperature for an YBCO based bolometric structure illuminated with IR.

Secured high volume free space optical communications based on computer generated holograms (Project “Partnership”)



White light interferometry of a diffractive optic element which generates an optical vortex with the topological charge 4.



Optic vortex with the topological charge m=4.

Interference of two optical vortices with m = 4 and m = -4.

Related FP 7 projects

Participation in JTU ENIAC (Nanoelectronics)

- **SE2A- Nanoelectronics for Safe, Fuel Efficient and Environment Friendly Automotive Solution**

ENIAC2008-1, Coordinator: NXP Semiconductor Netherlands BV, The Netherlands.
IMT role: partner, Dr. Alexandru Muller

- **MERCURE- Micro and Nano Technologies based on wide band gap materials for future transmitting receiving and sensing systems**

ENIAC2009-1, Coord: Thales Research and Technology, France.
IMT role: partner, Dr. Alexandru Muller

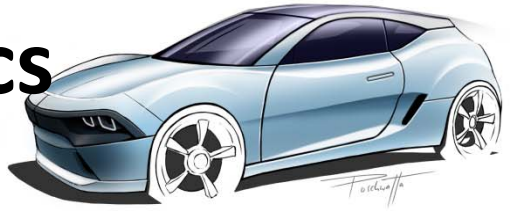
- **NANOCOM- Reconfigurable Microsystem Based on Wide Band Gap Materials, Miniaturized and Nanostructured RF-MEMS**

Coordinator Thales Research and Technology, France
•IMT role: partner, Dr. Mircea Dragoman

- **MotorBrain- Nanoelectronics for Electric Vehicle Intelligent Failsafe Drive Train***;*

ENIAC-2010-1, Coordinator: Infineon AG, Germany
IMT role: partner, Dr. Gabriel Moagar-Poladian

KET Nanoelectronics



Nanoelectronics for Electric Vehicle Intelligent Failsafe Drive Train - ENIAC

Nanoelectronics as key enabler for Efficient & Safe FEV

Project Coordinator: Dr. Reiner John, Infineon Technologies AG, Germany

Germany Austria Italy Spain Czech Sweden Nederland Romania United Kingdom

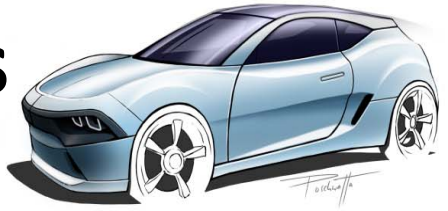
IMT Project Responsible: Dr. Gabriel Moagar-Poladian

Romanian participants: ***Infineon Technologies Romania & IMT-Bucharest***

Role of the Romanian team : design & realization of a torque sensor

KET- Nanoelectronics

MOTOR BRAIN



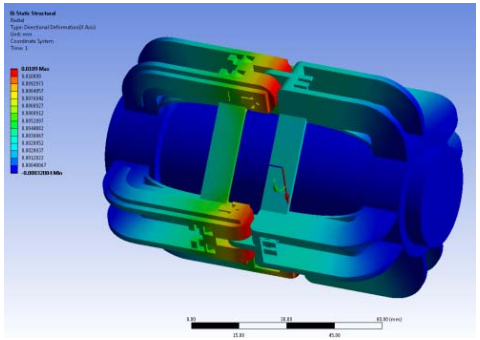
Results

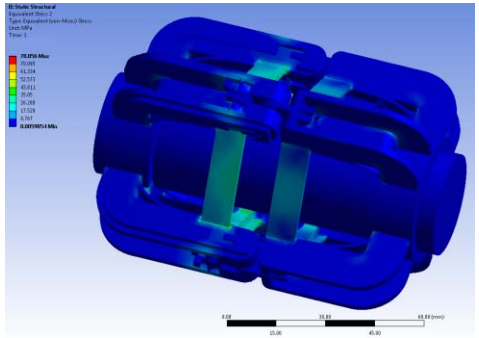
- *magnetic* → conceived, simulated and realized in beta version (polymer)
- *optical* → conceived and simulated, it can "amplify" the torque angle
- *nanostructures* → conceived

redundant: 4 sensors are considered
discriminates between torque and other solicitations
compensates for:

- angular acceleration (may be confused with torque)
- magnetization variation (temperature, mechanical stress)
- the effect of external magnetic fields

resistant to centrifugal forces.





1 % accuracy achievable !

ANSYS simulation of the torque sensor behaviour under the action of centrifugal force at 10.000 rpm. Left: radial displacement; Right: von Mises stress.

Beta version of the torque sensor (sensing part) made by Rapid Prototyping

infineon

eniac JOINT UNDERTAKING

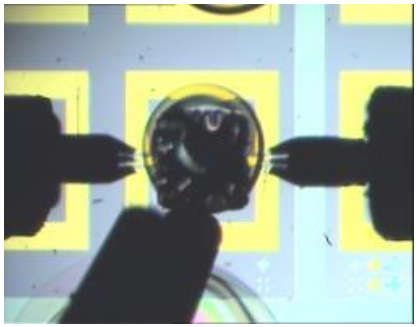
Nanoelectronics + Advanced materials - ENIAC

ENIAC–MERCURE «Micro and Nano Technologies Based on WBG Materials for Future Transmitting Receiving and Sensing Systems»

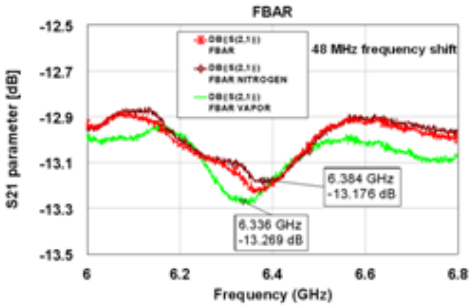
Coordinator Thales Research & Technology, France, (2011-2014)

Coordinator of the IMT team: Dr. Alexandru Muller

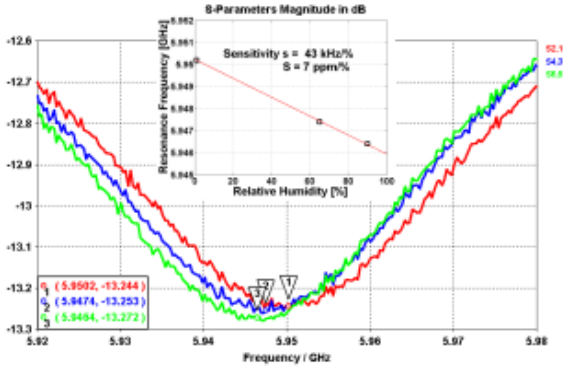
- Fabrication and characterization of a **humidity sensors, based on film bulk acoustic resonator (FBAR) structures and surface acoustic resonator (SAW)** structures **working in the GHz frequency range**.
- The work is done in cooperation with FORTH Heraklion Greece, University of Science and Technology Krakow Poland and Via Electronics Jena Germany.



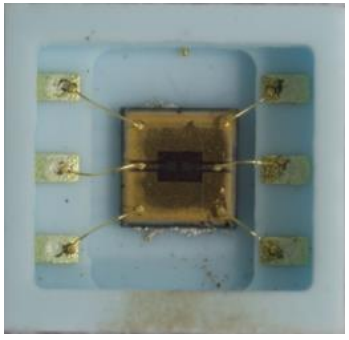
A coated FBAR structure under test as humidity sensor (on wafer)



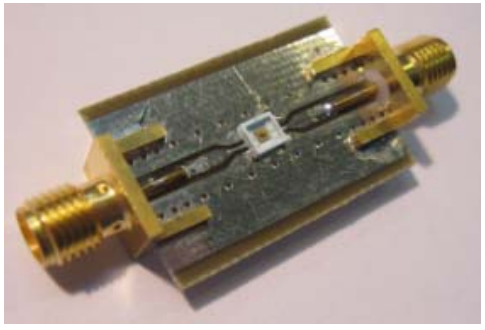
Resonance frequency for FBAR structure coated with polymer measured on wafer (red in surrounding humidity, brown dry nitrogen flow, green after water spray)



Resonance frequency vs the relative humidity for the FBAR packaged sensor



The devices packaged in a special LTCC package designed by IMT; manufactured by Via Electronics Jena

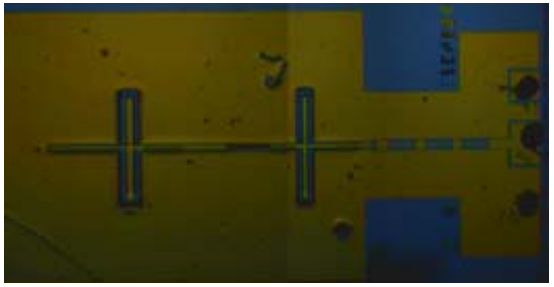


PCB holder FBAR humidity sensor and resonance frequency shift measurement

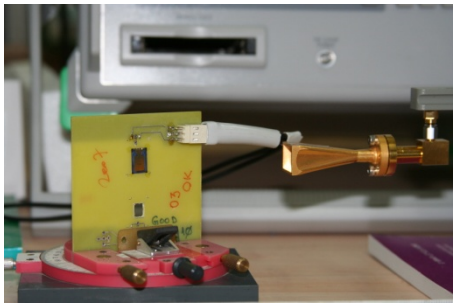
ENIAC 2008-1: „Nanoelectronics for Safe, Fuel Efficient and Environment Friendly Automotive Solution - SE2A”

Coordinator: **NXP Semiconductor Netherlands BV**, The Netherlands.
Contract No: 12009, 21 European partners

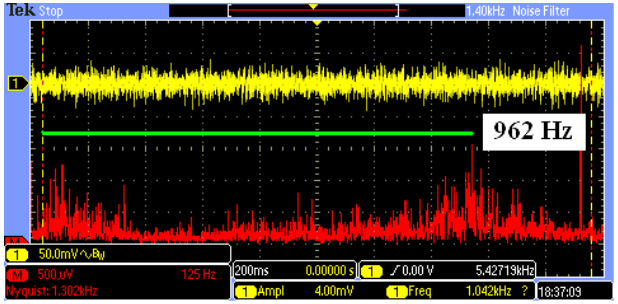
IMT team has developed a **Monolithic millimeter wave (77 GHz) Doppler Radar** for real ground speed measurements for SUV cars. The proof of concept was performed with a membrane supported monolithic integrated direct (video-type) receiver module for 77 GHz based on GaAs micromachining



Membrane supported structure fabricated using GaAs micromachining): monolithical integration of a Schottky diode with a double folded slot antenna



Detail of the experimental setup: membrane supported Doppler sensor



Proof of concept for the true speed sensor:
Tape speed: 2.7 m/s;
Doppler frequency: 962 Hz;
Measured speed: 2.65 m/s

New ESA Projects related to KETs (TGE)

ESA (European Space Agency)

Project: 0-level encapsulation of reliable MEMS switch structures for RF applications (2014-2016) – **started end of April**

ESA (European Space Agency)

Project: *Proba 3 Coronograph System A proposal for ESA, submitted by CSL & the Coronograph System Consortium in response to RFQ/3-13899/13/NL/GLC*

IMT-Bucharest responsible partner for "Occulter Position Sensor Emitters Heads"

Project phase: negotiation with ESA

IMT is/was involved in Structural Funds Projects

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

► **POSDRU-** Human resources development through postdoctoral research in **micro and nanotechnologies domain**

► **CENASIC-Research center for integrated systems nano-technologies and carbon based nanomaterials**

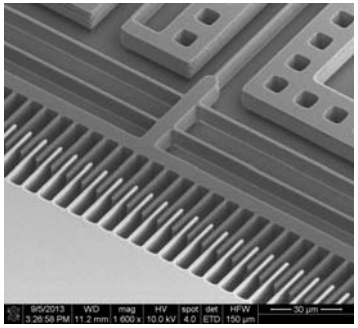
► **RO-BG MicroNanotech - Romanian-Bulgarian Services Centre for Microsystems and Nanotechnology**

MICRO - NANOFLUIDICS LABORATORY

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

The main equipment

Plasmalab System 100
ICP Deep Reactive Ion Etching System
Manufacturer: Oxford Instruments



SB6L - Wafer/Substrate Bonder System
Manufacturer: Suss MicroTech
Acquisition date: 2011
Bonding processes: Si to Si; Si to Glass; Polymer and adhesive

PIV for Microfluidics (Particle Image Velocimetry)
Acquisition date: 2012
Microfluidics PIV is a new and innovative technique for quantifying flows in: Microstructures, MEMS, Biomedical flows, Lab-on-a-chip. Measurements in microfluidic systems in chemistry, bio-chemistry, medical devices, DNA analysis

Microfluidic Pumping System
Manufacturer: Dolomite
Acquisition date: 2012

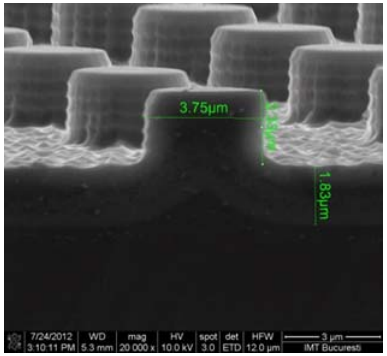
MICRO - NANOFLUIDICS LABORATORY

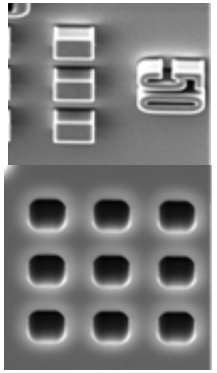
MICRONANOFAB- Microfluidic Factory for "Assisted Self-Assembly" of Nanosystems

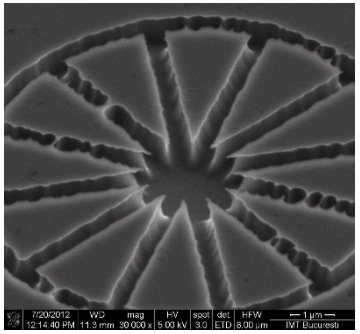
Advanced Manufacturing

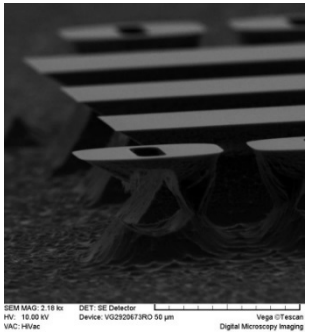
Implementation of microfluidics technology

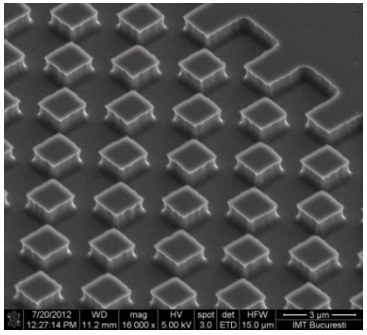
Experimental research concerns anisotropic deep silicon etching and polymer microfabrication for microfluidic applications

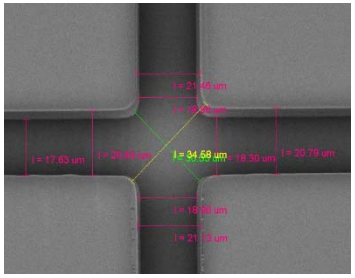


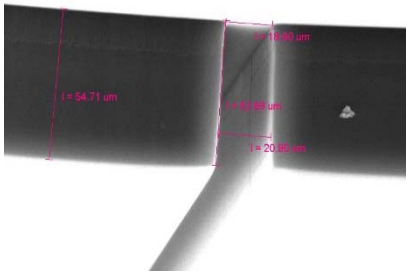


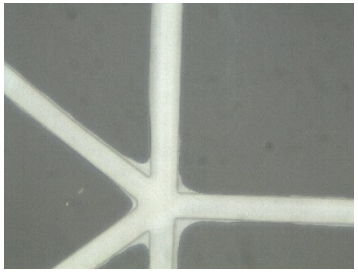


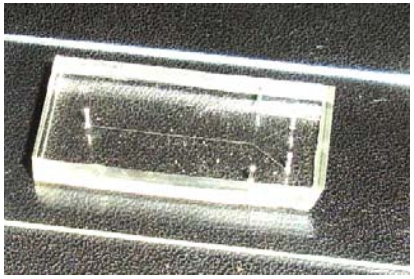








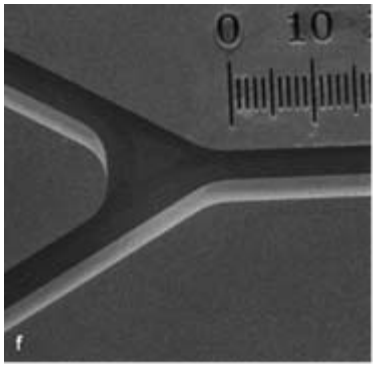




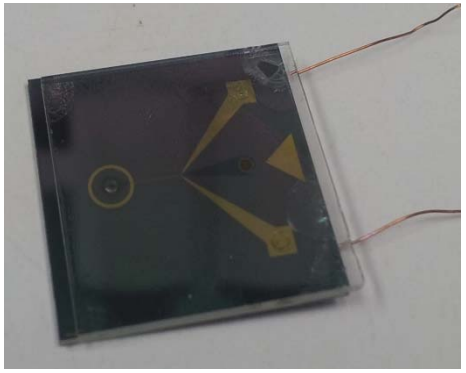
MICRO - NANOFLUIDICS LABORATORY

Advanced Manufacturing

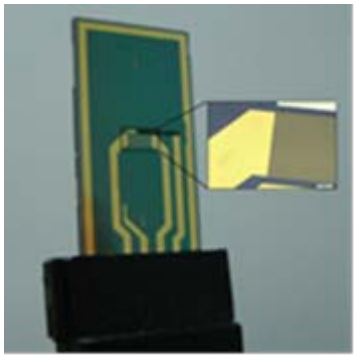
Applications of microfluidics technology



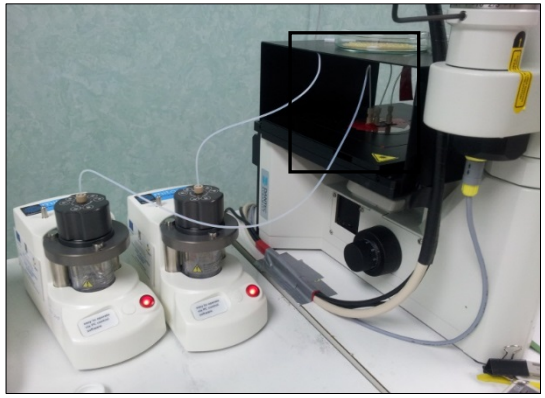
Microfluidic system for liposomes synthesis by hydrodynamic focusing

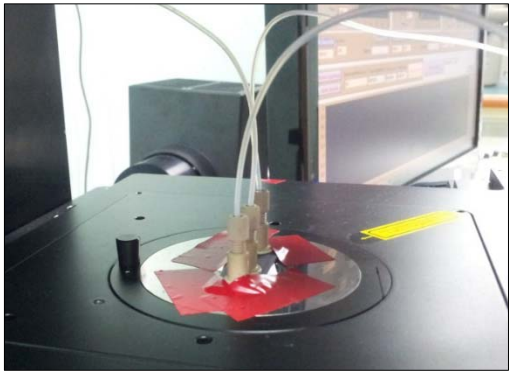


Magnetophoretic microfluidic system



Dielectrophoretic microfluidic system





(a) The experimental setup - hydrodynamic focusing system with two lateral flow, it involves the use of two microfluidic pumps. (b) details of the microfluidic device used and microconnectors.

CENASIC

Research Centre for Integrated Systems Nanotechnologies and Carbon Based Nanomaterials POS-CCE

www.imt.ro/CENASIC

A new infrastructure within IMT Bucharest dedicated to technologies based on Carbon nanomaterials: SiC, graphene nanocrystalline diamond

Under construction!

Totally in use from April 2015

MAIN OBJECTIVES

► New building - 1000 sqm

- 4 levels: clean room, technical level, 2 levels for labs and offices
- New spaces for: R&D/education/collaborations

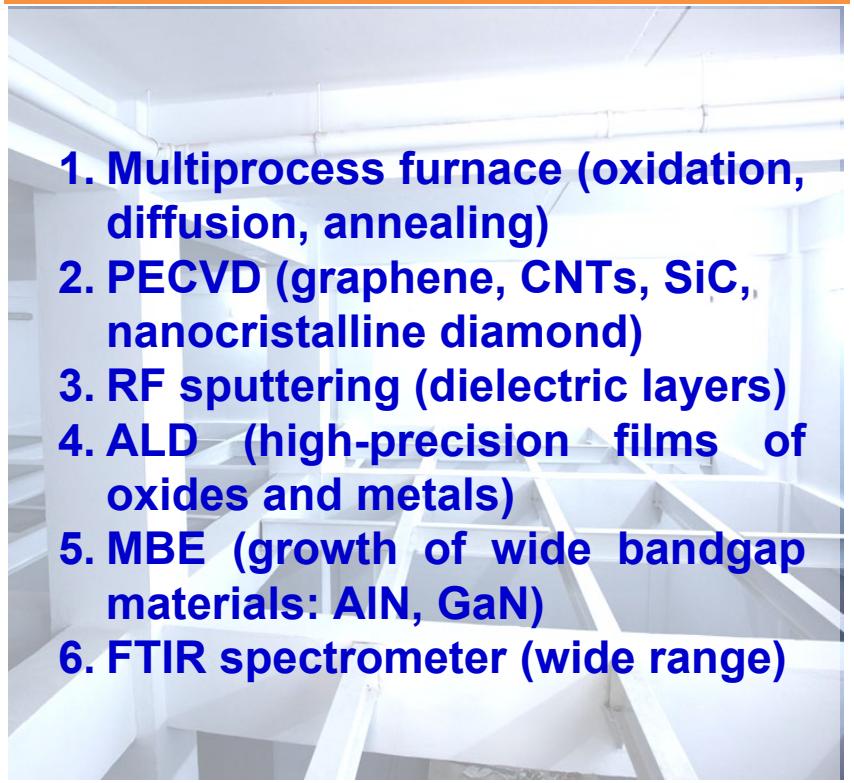
► Dedicated technological facilities:

- Clean room – 200 sqm, class 1000/100 (adjacent and complementary to the CVD and Dry-etching clean room)
- Advanced equipment for synthesis, processing, characterization, simulation
- New 10 positions for researchers

RESEARCH DIRECTIONS

- **SiC technologies and functional micro-nanostructures; Processes for SiC-based micro- and nanostructures**
- **Technologies for graphene and hybrid MEMS/NEMS**
- **Technologies for nanocrystalline diamond and applications in MEMS/NEMS and precision mechanics**

NEW EQUIPMENT

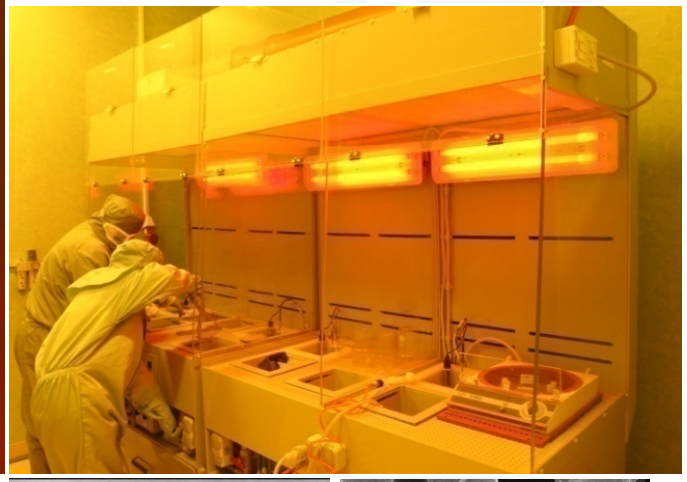


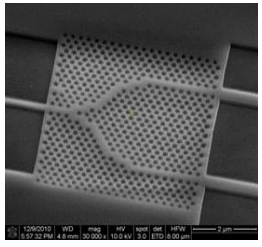
1. **Multiprocess furnace (oxidation, diffusion, annealing)**
2. **PECVD (graphene, CNTs, SiC, nanocristalline diamond)**
3. **RF sputtering (dielectric layers)**
4. **ALD (high-precision films of oxides and metals)**
5. **MBE (growth of wide bandgap materials: AlN, GaN)**
6. **FTIR spectrometer (wide range)**

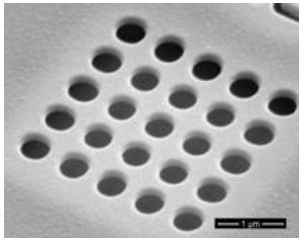
NEW LABORATORIES

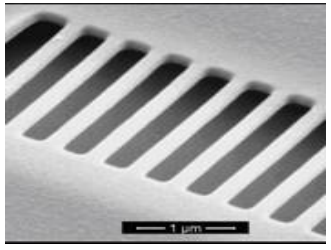
1. Laboratory for Thermal processes
2. Laboratory for Processing of carbon based nanomaterials and nanostructures
3. Laboratory for Thin layer spectrometry
4. Laboratory for Graphene technologies
5. Laboratory for Chemistry of hybrid interfaces
6. Electro-mechanical and sample preparation room
7. Laboratory for Electromechanical testing and reliability
8. Laboratory for Simulation and design for carbon-based MEMS/NEMS

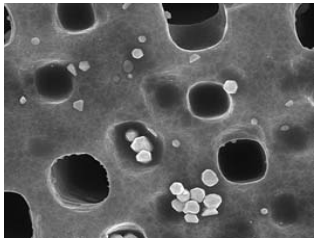
Facilities for Micro-nanofabrication: IMT-MINAFAB











Facilities for Micro-nanofabrication: IMT MINAFAB



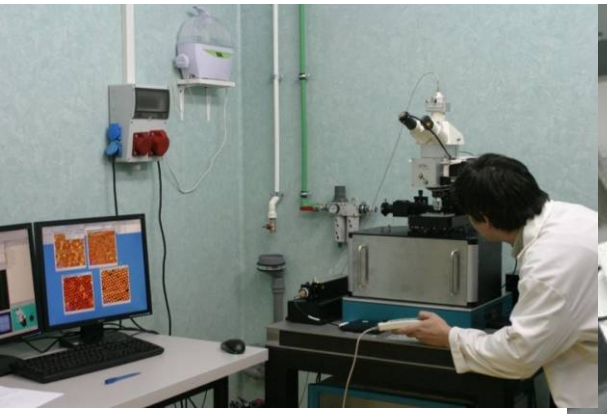

- **Main facilities:**
  - A **class 1000 clean room** (220 sqm) for the **mask shop** and the most demanding technological processes (in use since September 2008);
  - A class 100,000 clean room, the so called "**Grey Area**" (200 sqm), mostly for the **characterization equipments** (in use since September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

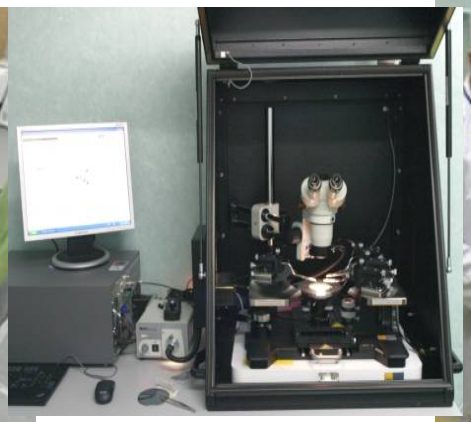


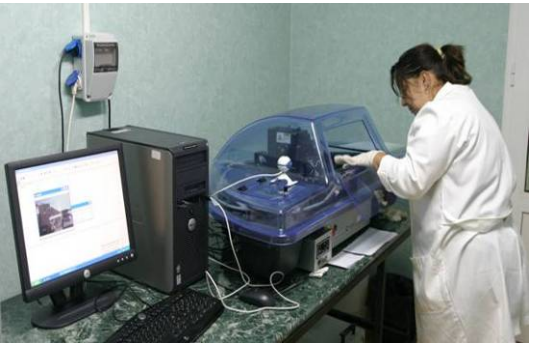
Clean room, class 1,000

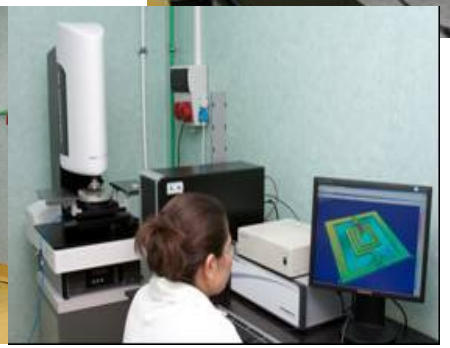
Services at IMT related to KETs (TGE)



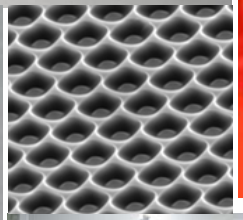







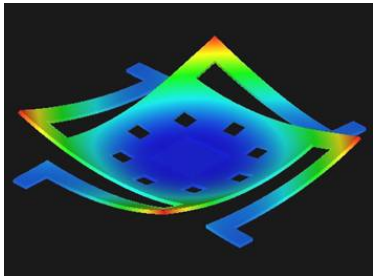
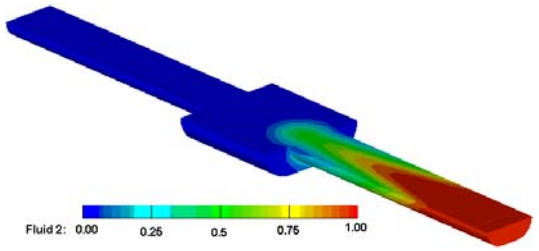
Services at IMT related to KETs (TGE)

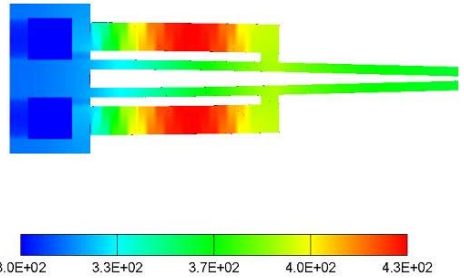


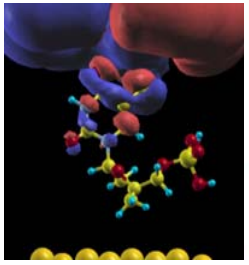
Services at IMT related to KETs (TGE)

Computation, Simulation and Design

- High performance computing server - IBM x3850 HPC server - 32 cores XEON X7350 @ 2.93 GHz, RAM 200 GB, HDD 1.5 TB
- Coupled analysis for MEMS - CoventorWare 2013 (COVENTOR, USA) - ARCHITECT, DESIGNER, ANALYZER, MemElectro, MemMech, CoSolveEM, MemETherm, MemPZR, MemPZE, Damping MM, InertiaMM, MemHenry, MemCFD, Netflow, SwitchSim, ReactSim, MemFSI, BubbleSim, DropSim, SEMulator3D, EM3D ; Ansys Multiphysics 12.1 (ANSYS, USA) - structural, thermal, acoustic, electro magnetic and coupled field analyses; COMSOL Multiphysics
- Photonic components - simulation, modeling and design - Opti FDTD 8.1, Opti-HS, OptiBPM 9.0, OptiGrating (Optiwave, Canada)
- Microwave and millimeter wave circuits and microsystems: design and modeling - IE3D, CST, FIDELITY (Zeland, USA)
- Atomistic DFT calculations: electronic structure calculations and ab initio molecular dynamics simulations of molecules and solids - SIESTA (ICMAB-SIESTA), Inelastica






The experience of IMT in cooperation with industry in European Projects

► **Thales Research and Technology (TRT), Paris** in

- **FP7:** SMARTPOWER, NANOTEC, NANO-RF
- **ENIAC**: MERCURE, NANOCOM

► **NXP Semiconductor Netherlands BV (Philips)** in: **ENIAC**:SE2A

► **IMST GmbH, Germany in: FP7 MEMS4MMIC**

MOTORBRAIN; Infineon Technologies AG Germany, Siemens Germany; ZF Friedrichshafen AG Germany, AVL List GMBH Austria, NXP Semiconductors BV Netherlands, Volkswagen AG, Germany- ENIAC

Cooperations with multinational companies, from Romania

► **Honeywell Romania**

- **Agreement of cooperation, IMT offering scientific service**
- **Access to technology and host of equipments**

► **INFINEON Technologies Romania**

- **Partners in ENIAC project : MOTORBRAIN: Nanoelectronics for Electric Vehicle Intelligent Failsafe Drive Train;**

Coordinator: Infineon AG, Germany - IMT role: partner

IMT Implication in FP7 Projects – partner with airspace companies

- **Thales Systèmes Aéroportés (TSA), France:**

-**Smart Power** *Smart integration of GaN & SiC high power electronics for industrial and RF applications.*
- **Nano-RF** *Carbon Based Smart Systems For wireless applications*.

- Thales Systèmes Aéroportés (TSA), France
- **EADS Deutschland GmbH , Germany**

-NANOTEC- *Nanostructured materials and RF-MEMS RFIC/MMIC technologies for highly adaptive and reliable RF systems*
-NANOCOM- *Reconfigurable Microsystem Based on Wide Band Gap Materials, Miniaturized and Nanostructured RF-MEMS* - ENIAC

Educational activities at IMT

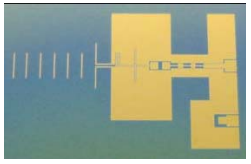
KETs

➢**New Master (M.Sc. Courses) at the Faculty for Electronics, Communications and Information Technology**, **"Politehnica" University of Bucharest** starting October 2009 and held in IMT (with **access to experimental facilities**).

- **Microsystems**:
  - **Intelligent sensors and microsystems;**
  - **Microphysical characterization of micro and nanostructures**;
- **Micro- and Nanoelectronics**:
  - Advanced Technological Processes
- **Electronic Technology for Medical Applications**:
  - **Micro- and Nanotechnologies for Medical Applications**

►**Hands-on courses**

• "**Microsensors**", for students of year IV, Faculty of Electronics, Tele-communications and Information Technology, "Politehnica" University of Bucharest: **Applications lab at IMT using MINAFAB Facility**



• **Applications lab for RF-MEMS master course**

In loc de Concluzii

In acest moment in **Strategia Industriala Europeana referitoare la micro si nanoelectronica** considera ca **semiconductorii si lantul lor valoric** sunt motorul inovarii si competitivitatii in sectoarele economice importante

Pana in 2020-2025 este necesar ca **productia de componente semiconductoare in Europa sa se dubleze,** pentru a asigura inovarea tehnologiilor si a produselor, pentru cresterea si recastigarea competitivitatii pe piata mondiala, in vederea asigurarii leadershipului european

Conceptul "**Smart Eveything Everywhere**" necesita integrarea componentelor electronice si a sistemelor in orice produs in viitorul apropiat

Este important pentru dezvoltarea economica si specializarea inteligenta ca aceste **Tehnologii Generice Esentiale** sa fie considerate si in Romania

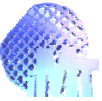
Pentru o dezvoltare economica sustenabila si o specializare inteligenta, Romania trebuie sa promoveze TEG

►Pe langa materiale avansate si nanotehnologii exista potential pentru micro-nanoelectronica-fotonica, tehnolohii high-tech prezente in domenii cum ar fi ICT, Spatiu, Securitate, dar si in toate celelalte domenii economice prioritare: sanatate, mediu, energie, agricultura

►Fara promovarea acestor TEG (micro-nanoelectronica-fotonica) nu pot fi realizate generatiile viitoare de sisteme inteligente miniaturizate (smart systems) sisteme integrate, autonome energetic, predictive, cognitive si reactive

►In prioritatile Horizont 2020, in ICT alaturi de software, apar si componente si sisteme micro-nanoelectronice (ex. Call-ul ICT 25 - 2015: se refera la "*Generic micro- and nano-electronic technologies*")

ECSEL- Intiativa PPP la care Romania a aderat, se refera la "*a new generation of components and systems* "promoveaza leadershipul european in dezvoltarea tehnologica, proiectare si productie, pentru aplicatii in automotive, spatiu, securitate, santate, energie. Fara aceste tehnologii, materiale si produse micro-nanoelectronice nu poate exista o dezvoltare a domeniilor economice care sa raspunda provocarilor societale.



Va multumesc pentru atentie