

MIMOMEMS - “European Centre of Excellence in Microwave, Millimetre Wave and Optical Devices, based on Micro-Electro-Mechanical Systems for Advanced Communication Systems and Sensors”, REGPOT call 2007-1, Grant Agreement 202897, Period: 2008-2011, Funding Scheme: Coordination and Support Actions

Coordinator: National Institute for R&D in Microtechnologies - IMT Bucharest (Dr. Alexandru Müller)

<http://www.imt.ro/mimomems>

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.

Two laboratories from IMT Bucharest, the RF MEMS Laboratory (<http://www.imt.ro/organisation/research%20labs/L4/index.htm>) and the Microphotonics Laboratory (<http://www.imt.ro/organisation/research%20labs/L3/index.htm>), have joint their efforts to create this European Center of Excellence in the frame of the FP7 REGPOT call.

This initiative came from previous successes of our teams: (i) the coordination of the FP4 EU project “Micromachined Circuits for Microwave and Millimetre Wave Applications “(**MEMSWAVE**, 1998-2001, FP4-INCO). This project was one of the first European projects in RF-MEMS and the first ICT project coordinated by an Eastern European Country team (IMT-Bucharest). For its state of the art results MEMSWAVE was nominated in 2002 among the top ten European projects for the Descartes Prize; (ii) successful participation in the FP6 NoE in RF-MEMS “AMICOM” (2004-2007) with many new and State of the Art results in the topics

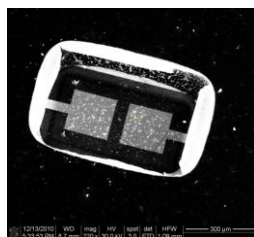
MIMOMES represented a support action for the developing of microwave, millimetre wave devices and circuits, optical devices and sensors based on MEMS technologies, with applications in modern communication systems.

The main objectives of the MIMOMEMS project were:

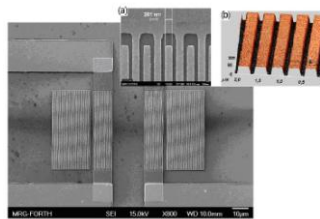
- (i) Exchange of know-how and experience with **twining partners, LAAS-CNRS Toulouse** (which has strong expertise in silicon based RF and millimetre wave microsystems, photonic devices, circuits manufacturing and characterization) **and FORTH Heraklion** (which has excellent knowledge of IIIVs (GaAs and related semiconductors) and wideband gap semiconductor processing (GaN, AlN),
- (ii) Recruitment of incoming experienced researchers,
- (iii) Acquisition, development/upgrading of research equipment,
- (iv) Organisation of workshops and conferences,
- (v) Dissemination and promotional activities.

Main results:

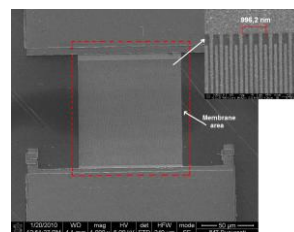
- **Highlights of the state of the art results obtained in cooperation with twining partners with the support of the project**



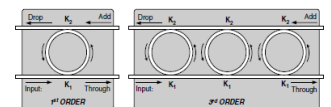
*FBAR structure on 0.5µm GaN membrane resonating at 6.3 GHz (A Muller, D. Neculoiu, G Konstantinidis et al., **IEEE Electron Devices Lett.**, vol 30, no 8, 2009, pp 799-801)*



*GaN based 5.3 GHz SAW structure (A Muller, D. Neculoiu G Konstantinidis G. Deligeorgis, A. Dinescu, A. Stavrinidis, A. Cismaru, M. Dragoman, A. Stefanescu, **IEEE Electron Devices Lett.**, vol 31, no. 12, 2010, pp 1398-1400)*



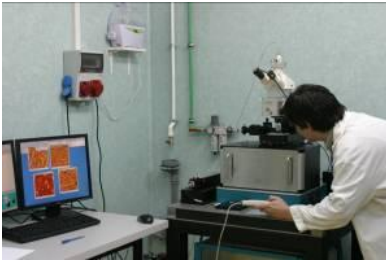
*GaN membrane supported UV photodetector (A Muller, G. Konstantinidis, A. Dinescu et al, **Thin Solid Films** in press doi:10.1016/j.tsf.2011.09.045)*



*Add-drop filters realized with a single microring resonator (left) and three parallel coupled microrings resonator (right) (D. Alexandropoulos, H. Simos, M. Kusko, D. Cristea, D. Syvridis, N. A Vainos “Microring resonators with enhanced tolerance to fabrication misalignments, **J. Opt. A: Pure Appl. Opt.** 11 (2009) 125401)*

- **Three Post Doc scientists** (two of them Romanian with a PhD in Germany and Singapore, one with a PhD at Politehnica Univ. Bucharest) have been hired using the project budget; now they have permanent positions at IMT-Bucharest

- **Up-grade of the research equipment: Upgrade to 110GHz** the 1-65 GHz set-up for on wafer characterization - **upgrade of the VNA up to 110 GHz**, and upgrade the on wafer measurements set-up up to 110 GHz, Frequency synthesiser up to 110 GHz; Near field scanning optical microscope (SNOM); Au plating facility for semiconductor wafers; Digital Serial Analyzer Sampling Oscilloscope with the Time Domain Reflectometry function, up to 50 GHz and the dedicated software and measuring accessories; Experimental set-up for UV photodetector responsivity characterization



The Scanning Near Field Optical Microscope



The millimetre wave characterization equipment up to 110 GHz



The Au plating facility for semiconductor wafers

- The MIMOMEMS project has funded the organization of **two scientific and one strategic workshop in RF and optical MEMS**. Reaching key players in the field, these took place alongside the IEEE organized International Semiconductor Conference (CAS) in Sinaia (2008 and 2010), Romania.
- **State of the art scientific results in cooperation with the twinning partners in the following topics: RF MEMS, millimetre wave components and circuits, photonics and GHz operating acoustic devices based on WBG semiconductors: 11 ISI ranked papers** published in cooperation with twinning partners in prestigious, high ranked journals like IEEE Electron Device Lett., Electronic Letters, Appl. Optics, Microelectronics Journal, J. Opt. A: Pure Appl. Opt, Thin Solid Films, etc. and **25 papers presented to prestigious conferences** (Asia Pacific Microwave Conference, EMRS, NATO Workshop, European Microwave Conference, MEMSWAVE,
- **Successful participation in European projects:** two winning IPs in the FP7-ICT-2011-7 call : "SMARTPOWER" and "NANOTEC" (2011-2014) both coordinated by Thales TRT France, and three related to FP7 projects (one ENIAC project-Nanocom and two ERA-NET- MEMIS and MULTINANOWIRES). The photonic team was involved in the FP7 IP Flexpaet.

Impact on Romanian Scientific Community

Collaborative scientific work and state-of-the-art devices and technologies have been developed in collaboration with the twinning partners, and co-authored papers in high-ranked journals have been published. The published results represent the state of the art in the scientific targets of the project. In addition, a **common European laboratory** including IMT-BUCHAREST, LAAS and FORTH has been created (**LEA SMART MEMS**). Strong cooperation has also been harnessed with other important European research centres in the field, including VTT Helsinki, Finland, as well as with a number of European industrial partners (Thales TRT-Fr, NXP-NI).

MIMOMEMS has contributed to increasing the competitiveness of IMT-BUCHAREST as a reliable European partner in the entire topics of micro and nanotechnologies:

- Development of new research sub-domains such as nanoplasmonics, grapheme-based nanocomposites and devices
- Increased visibility of the Romanian research teams
- New national projects – programmes **Ideas, Partnership and STAR**
- New scientific services for industry and research groups using the new acquired equipments

Integration of Romanian teams in EU research networks

Whilst in the past, the absence of industrial partners in Romania prohibited productive cooperation, European projects like MIMOMEMS have provided valuable opportunities for IMT-BUCHAREST to connect with European industrial partners. Today, IMT-BUCHAREST **is involved in four ENIAC projects, working together with industrial partners** (NXP, the Netherlands; Thales, France; and Volvo, Sweden) to research emerging solutions for true ground speed measurements at 77 GHz, and sensors for poisonous gases based on GHz GaN/Si acoustic devices. As well as with Infineon, IMT-BUCHAREST has established relations with companies like Renault TRT and Honeywell Romania.

The MIMOMEMS IMT team is one of the partners in the SMARTPOWER and NANOTEC winning Integrated Projects at the call FP7 ICT 2011-7 which are coordinated by Thales TRT France.

The teams have active participation in EU technology platforms Photonics 21, EPOSS and ENIAC.