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

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

National projects:
- IMUNOSENSE ("Miniaturized immunosensor arrays technology, for herbicide detection");
- BIOMICROTECH ("Miniaturized biosensor micro-technology for fast detection of contaminations from food")

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

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

Dr. Carmen MOLDOVAN is the head of the laboratory. She graduated on Electronics and Telecommunications and she owns a PhD in Microsensors. She was responsible from IMT side in the TOXICHIP project, FP6 STREP (IST), for the development of temperature, pH sensors and O2 sensor integrated into a microfluidic platform for toxicity detection.

She was involved in the 4M NoE (NMP), working on demonstrators, in Ceramic cluster, having the goal to integrate a non-standard micromachining process into a ceramic substrate and in the Sensors and Actuators cluster and IMT in INTEGRAMplus FP6 IP (IST), dealing with technology convergence and integration and virtual design and manufacturing. She’s currently coordinator of the PESTIPLAT MNT-ERANET project and BIOMICROTECH, a National Project The scientific activity is published in more than 70 papers in journals, books and communications in Proceedings.

MAIN ACTIVITIES AND RESULTS IN PROJECTS:

Miniaturized biosensor microtechnology for fast detection of contaminations from food

The goal of BIOMICROTECH (PN II contract no. 52-173/2008) project was the development of miniaturized biosensors technology integrated in microfluidic chips, for the detection in the ng/L domain of organophosphorus insecticides from food (milk, juices from fruits and vegetables) and water by involving the microtechnology techniques on silicon and microbiology techniques, accessible to project consortium. A sensitive acetylcholinesterase (AChE) amperometric biosensor proposed in the project is single use, reproducible, mass production, low cost and has commercial value. For obtaining the microelectrodes used like transducers for depositing biological material the optimization of MEMS (Micro Electro Mechanical Systems) technologies is required, such as: realization of 2D configuration and respective masks for microelectrodes structures, depositing dielectric on silicon substrate, metal (Ti/Au) deposition and patterning, PSG or Si3N4 deposition as passivation layers for protection of the metal. There are two techniques studied, for surface functionalisation: the organofunctionalisation method (organic compounds with: thiol (-SH) group, amino (-NH2) group, medium modifier is organic group) and inorganofunctionalisation method (a metal (gold), Au<111>, for the adherence of the bovine serum albumin (BSA) to the substrate.

Fig.1. Agilent LCR Meter measurement system
Miniaturized biosensor microtechnology for fast detection of contaminations from food

The substrate’s hydrolysis produces measurable changes in the PEG polymer layer impedance, seen as a capacitance variance as shown in figure 3, or as a conductivity variance as shown in figure 4.

Miniaturized immunosensor arrays technology, for herbicide detection - IMUNOSENSE

The objective of project IMUNOSENSE is to develop the technology to produce an array of integrated immunosensors with optical and electrical detection in the ng/l domain of herbicides in food and water, involving microtechnology techniques on silicon and piezoelectric substrates, and molecular biology techniques available at the consortium level.

The project has led to the development of production techniques for integrated immunosensors on a semiconductor (silicon) substrate and on a piezoelectric (langasite) substrate for ultrafast analysis, with high accuracy, with increased sensibility compared to the ELISA technique (the immunochemical technique currently in use) and with increased specificity towards the detection of: atrazine, hydroxiatrazine, 2,6-dichlor-benzamide (BAM), 2,6-dichlor-benzenitril (Diclobenil). Testing of SAW devices on a langasite substrate SAW structures were developed on the new langasite substrate, resulting in the 4 microns width interdigitated electrodes from figure 5. For surface functionalisation and sensor preparation, a microfluidic channel and pumping system have been used. The sensor’s transfer function is presented in figure 6.

INKJET PRINT: Inkjet printing technology for microsensor manufacturing, using Dimatix DMP 2800 equipment. The InkJet printing technology has been developed because it is offering an easy to use technology compared to the conventional processes which implied lithography, CVD, PVD processing, and high substrate processing costs; it has the capability to deposit droplets of fluid, of the picolitter magnitude, such as liquid silver or organic inks, on all types of surfaces, including flexible ones, the possibility of using cheap flexible substrates like PET (Poly-Ethylene-Terephthalate) sheets, paper sheets, etc; the possibility of using metallic inks and polymer inks like: Poly-Ethylene-Di-Oxy-Thiophene doped with Poly-Styrene-Sulphonate (PEDOT:SS) and Poly-ANIline (PANI). The printing of metallic electrodes made on Silver Ink (Figure 7) offered the needed interdigitated electrodes for different sensors development.