The second module of the Eurotraining course

"Nanotechnology for electronics"

(Bucharest, 16-17 November 2009) is hosted by IMT-Bucharest
(National Institute for R&D in Microtechnologies), on 17th of November, 2009.

Welcome to IMT!

*This is a short guide to your visit, as well as a reminder of your presence in **IMT**. Further details about IMT can be found in two brochures: (a) **Scientific Report** 2008; (b) **Your reliable partner: IMT-Bucharest From technological services to scientific cooperation**. Both documents are available on the site: www.imt.ro. More details about the experimental facilities of IMT are available at: www.imt.ro/MINAFAB (IMT-MINAFAB is a Centre of Micro- and Nanofabrication, providing services for research, education and innovation). These brochures are also containing e-mail addresses for relevant contact persons. The printed versions are available, upon request.*

Prof. Dan Dascalu
General Director

Three different areas will be visited (45-50 minutes for each).

Area A (ground floor). Structuring and characterization at the nanoscale.

The visit in this area (class 100,000 - the so-called "gray zone") allows you to see part of the equipments installed here, namely: a couple of ***Raith e-beam tools for nanoengineering***, as well as the following characterization tools: **SEM, SPM** (scanning probe microscope), a **nanoindenter** (Agilent Technologies), **SNOM** (scanning near-field optical microscope), a **profilometer using white light interferometry** (Fogale nanotech), an **X- ray diffractometer** (Rigaku). Other equipments are placed in the clean room class 1,000 and cannot be seen during the visit.

- **Electron Beam Lithography and nanoengineering workstation- Raith e_Line from RAITH GmbH.** Ultra high resolution EBL (Electron Beam Lithography) and nano engineering workstation Raith e_Line is a versatile electron beam lithography system having complied with the specific requirements of interdisciplinary research, which allow nanoscale structuring. Selected options for nanomanipulation, EBID and EBIE expand this system to a nano-engineering workstation.
- **Field Emission Gun Scanning Electron Microscope (FEG-SEM) - Nova NanoSEM 630 (FEI Company, USA)**.
Applications: microphysical characterization of a variety of **challenging nanotechnology** materials such as metals, magnetic materials, nano-particles and powders, nano-tubes and wires, porous materials (e.g. Si), plastic Electronics, glass substrates, organic materials, diamond films, cross-sections, **microdevices** etc.
- **Scanning Electron Microscope - Vega II LMU @ Pattern Generator - PG Elphy Plus (TESCAN s.r.o, Czech Republic @ Raith, Germany). Applications:** • general purpose SEM imaging using secondary electrons (topography) and backscattered; • electrons (composition); • electron beam lithography with sub-50nm resolution;
- **Scanning Probe Microscope SPM NTEGRA Aura (NT-MDT Co., Russia).** The equipment enables several related techniques (AFM, STM, EFM, MFM, SKPM, Conductive AFM etc) for high resolution imaging and measuring of various surface properties. **Application:** • High-resolution surface profilometry; • Evaluation and optimization of thin film coatings for various applications (optical, packaging, paintings, wear-resistant etc); • Grain and particle size analysis; • Surface cleaning and polishing studies (characterization of optical surfaces roughness, electro-polished metal surface evaluation etc); • Determining process effects (e.g. plasma treatment) on surface properties; • Examining the impact of surface roughness on surface properties as adhesion or haze; • Microstructural studies (Pharmaceutical, Polymers); • Morphological studies of biological and biocompatible materials;
- **Nano Indenter G200 - Nanomechanical Characterization Equipment (Agilent Technologies). Applications:** High resolution mechanical characterization of a wide variety of materials (metals, semiconductors, ceramics, biocompatible materials), especially in the form of thin films, coatings etc. The characterized properties include hardness, Young's modulus, film adherence, wear behaviour, dynamic testing of polymers.
- **Scanning Near-field Optical Microscope - SNOM (Witec alpha 300S, Witec, Germany). Applications:** Imaging the optical properties of a sample with resolution below the diffraction limit with applications in nanotechnology, nanophotonics, nanooptics and plasmonics; Materials research and polymers; Single molecule detection; Life sciences;
- **Ultra High TrIple Axis Rotating Anode 9kW X-ray Thin Film Diffraction System, Rigaku SmartLab, (Rigaku Corporation, Japan). Applications:** • crystal structure (HR RSM, HR RC); • film thickness, density, roughness; • characterization of the ultra thin film (in plane XRD, grazing incidence); • particle/ pore size analysis (reflection SAXS, transmission SAXS); • phase identification, crystal structure (powder/thin film/poly/ mono/ crystal, trace, small area/quantity);
- **White Light Interferometer - Photomap 3D (Fogale Nanotech, France). Applications:** • surface topography of diverse materials (metals, plastics, semiconductors, biological materials etc); • residual stress measurement for different thin film deposition layers; • conceived not only for statistical surface roughness measurements but also for high precision measurement of mechanical or chemical micromachining; • transparent layers thickness measurements (plastics, glasses or varnish) with known refraction index; • MEMS dynamic measurements.

Area B (2nd floor). Simulation and design in micro- and nanosystems.

Laboratory for Computer-aided simulation and design: *microsensors and actuators, integrated microsystems, MEMS/NEMS, MOEMS, RF MEMS, microfluidics, lab-on-chip, micro and nano-systems for diagnosis and drug delivery.*

➢ **Computer Aided Design** using dedicated software tools: **COVENTOR 2008 and ANSYS**

• **Mask Design, Process Editor, 3D building and mesh**;

• **Modelling for technological processes/optimizations**;

• **Special features:** particularized use (macro or subroutine) creation; special geometrical modeling (AFM images reconstruction in CAD format, surfaces generated in accordance with mathematical expression, etc);

➢ **Computer Aided Engineering and Analysis** (using **FEM, FVM, BEM** tools);

• **Microfluidics analysis** (thermo)dynamics, electro-kinetics, diffusion, fluid mixing and separation in micro-components;

• **Electro-thermo-mechanical and piezoelectric analysis** (steady state and transient).

• **Coupled field simulations**: thermo-mechanical simulations; electro-mechanical simulations; multiphysics, fluid-solid interaction;

➢ **Software facilities in this lab:** COVENTORWARE 2008.010; ANSYS Multiphysics 11.0; COMSOL Multiphysics 3.4; MATLAB 7.8-7.9 and Simulink; Visual Studio 2008 Pro; Solidworks Office Premium 2008; Mathematica 7; Origin PRO 8;

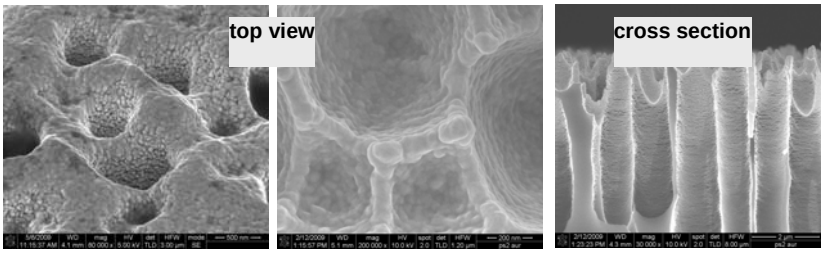
Area C (sixth floor, computer room for presentations). Research and development in the main laboratories of IMT, dealing with **Nanotechnologies, Photonics and RF components**, respectively.

Laboratory of Nanotechnology (4th floor)

The main areas of research activities are:

The **Functional nanomaterials** area is related to nanostructured silicon and to composite materials.

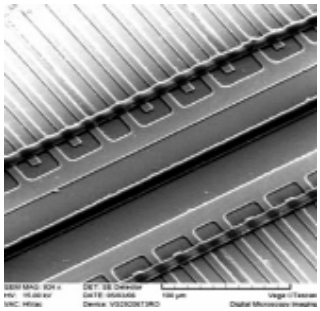
The **Nanobiosystems** area is illustrated by: biomolecular patterns in microarrays, integration of sensing elements onto biochips for study of bioreactions, and implantation of active device elements in cells to study cellular biochemistry.



SEM images of 100 nm Au covered macroPS substrate
PVD - Au on macroPS/p - Si (100) substrate electrochemical macroporous p-type silicon substrate covered with gold layer for **Protein Biosensor based on Electrochemical Impedance Spectroscopy as Detection Method**

The **Bio-Micro- Electromechanical Systems** (Bio-MEMS) area focuses on the design, modelling/simulation and fabrication of new complex devices on silicon for applications in many interdisciplinary areas such as biochips, or the the development of new fuel cell devices as clean energy sources.

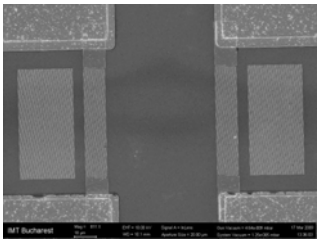
The **Energy Conversion Devices** a new direction regarding the development of the hybrid micro- and nanosystems with very promising results in the field of new fuel cell devices as clean energy sources.



Detail of the Metal-Semiconductor-Metal photodiode (inter-digitated structure integrated with the SU-8 optical guide)

Laboratory of micro/nano photonics (3rd floor):

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



Face to face SAW resonators for GHz applications structures with nanolithographic IDTs (150nm fingers)

Laboratory of micromachined structures, microwave circuits and devices (5th floor)

Main area of expertise:

• Development of circuits devoted to the millimeter wave communications based on semiconductor (Si, GaAs, GaN) micromachining and nanoprocessing;

• Design and manufacturing of micromachined, passive circuits elements, monolithically and hybrid integrated receiver front-ends based on silicon and GaAs micromachining;

• Acoustic devices (FBARs and SAWs) based on micromachining and nanoprocessing of wide band gap semiconductors (AlN , GaN);

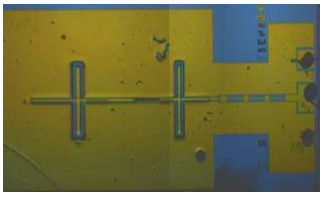
• Microwave devices based on carbon nanotubes;

• MEMS and NEMS technologies development;

• Microwave devices using CRLH materials (metamaterials);

• On wafer measurements up to 110 GHz;

"on wafer" characterization equipment up to 110 GHz.



Optical photo of GaAs membrane-supported 60 GHz monolithic receiver module with double folded slot antenna