L6: Microphysical characterization laboratory

• **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.*

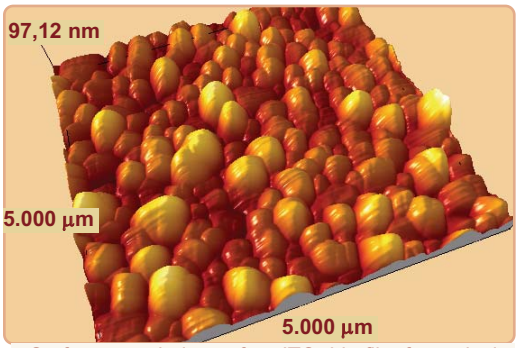
***Options:** 2D and 3D surface visualization, Inspection of image details by interactive rotation and scaling, Line-by line cross-section profile analysis, Roughnes statistical analysis, Histogram, Fourier analysis.*

AFM STUDIES OF NANOMETER-SCALE MECHANICAL PROPERTIES OF POLYMERIC MATERIALS

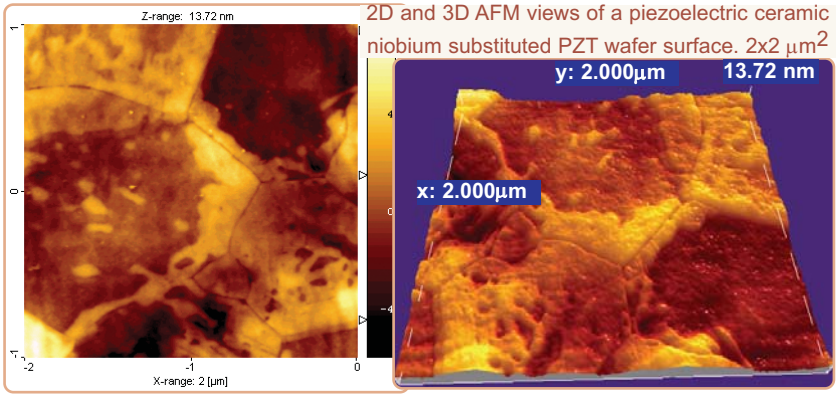
Achievements: Experimental conditions were determined for tracing force-distance curves by using a home-made AFM with various probe-samples sets. Required calibrations for the piezo driver and optical detection system were carried out using calibration gratings and stiff samples. Methods were established 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

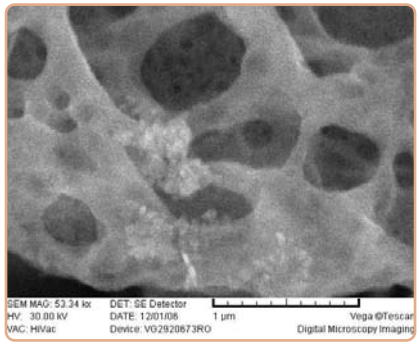
SERVICES:

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*

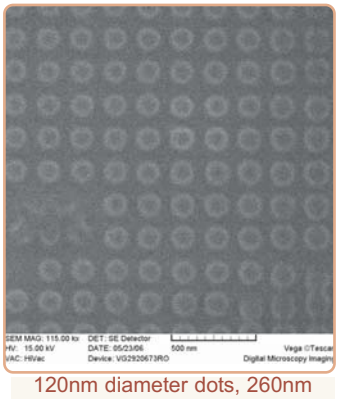
Electron Beam Lithography: *• Combining Electron Beam Lithography and Photolithography (Mix and Match); • EBL on Insulating Substrates; • Nanoelectrodes fabrication for bio nano-technologies applications; • EBL for Nanophotonics (photonic crystals, plasmon enhanced devices)*

SEM STUDIES OF SUBMICRON AND NANOMETRE SCALE STRUCTURES AND MATERIALS

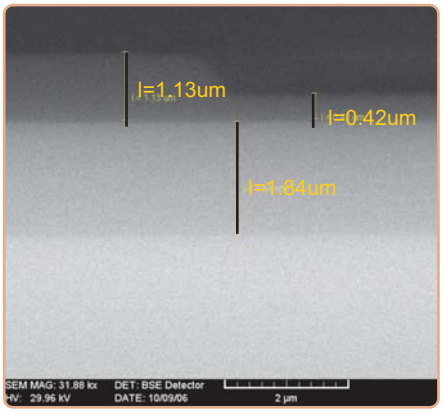
Achievements: High resolution SEM images (surface morphology and composition) for different structures and materials.



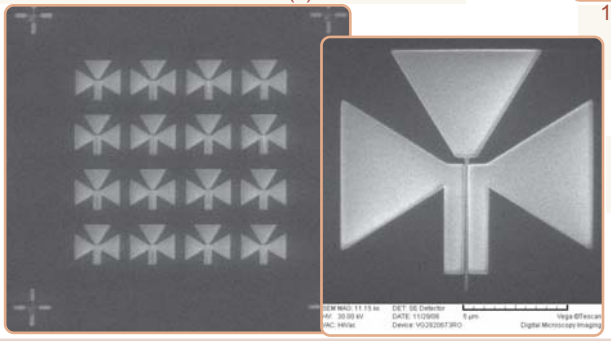
SEM image of a $La(1-x)A_xMn_{(x)}O_3$ nanopowder



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)