GUVERNUL ROMÂNIEI

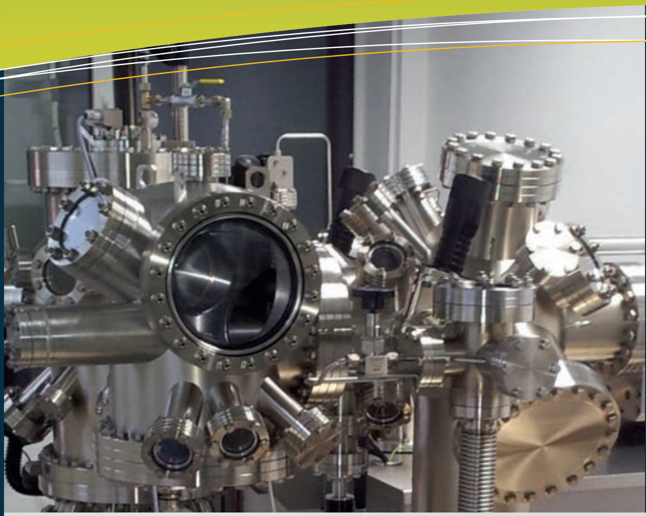
ANCS
AUTORITATEA NAȚIONALĂ PENTRU CERCETARE ȘTIINȚIFICĂ

INCDTIM

MOLECULAR AND BIOMOLECULAR PHYSICS DEPARTMENT UPGRADING

MDFMOLBIO

DECEMBER 2012



equipments

Molecular modeling

Processing and Fabrication

Characterization

State-of-the-art research infrastructure

As a result of the 2008 national competition for large research infrastructure projects, INCDTIM Cluj-Napoca has received funding for the project *Molecular and Biomolecular Department Upgrading - MDFMOLBIO*.

Project fully supported by the Romanian Government

The MDFMOLBIO project was carried out in the framework of the CAPACITIES programme, being centered on a major investment of about 6.5 million Euro in modern research infrastructure. Funding was provided by the National Authority for Scientific Research (ANCS) through the Executive Agency for Higher Education, Research, Development and Innovation Funding (UEFISCDI). The project was implemented during 2008-2012: its most important outcome is to provide a solid basis for aligning the Molecular and Biomolecular Physics Department of INCDTIM to the European Union's standards of excellence in research.

exploring the nanoworld

Its major aim is the upgrading of the Molecular and Biomolecular Physics Department through the acquisition of modern research infrastructure. Three new laboratories have been created at the end of the project implementation, whereas other seven existing laboratories were modernized.

It enables to extend and diversify the research activities carried out in the department, and eventually to transform the institute into a key regional player for knowledge base developement.

MDFMOLBIO project implemented at the National Institute for Research and Development of Isotopic and Molecular Technologies INCDTIM Cluj-Napoca

It is organically integrated within the 2007-2013 Strategy of INCDTIM for research, development, and innovation.

The modernized research facility is expected to attract highly qualified research personnel, especially graduate students of local / national universities, and also foreign students.

Technology Solutions

MBE NIL HPC VCD DPN NMR AFM STM Raman XRD

The MDFMOLBIO project has been implemented in the period 2008 - 2012 at INCDTIM Cluj-Napoca with the main purpose of modernizing the research infrastructure of the Molecular and Biomolecular Physics Department. The specific objectives of the project have been fully accomplished, giving rise in the end to a modern research facility that is expected to transform the department into a key R&D player in the field of molecular and biomolecular physics. A three-floor building was first rehabilitated by INCDTIM from its own funds and then equipped with state-of-the-art research infrastructure. The acquired equipment helped to consolidate existing laboratories, and also to create new laboratories for fabrication and characterization at nanoscale. The project was built on an integrated vision centered on the need to cover the full range of activities in molecular technology, from *in silico* molecular design and modelling, to (nano)fabrication, and finally to characterization by advanced analytical techniques. This vision offers the technological solutions for enhancing the research potential of INCDTIM.

The main components of the infrastructure are:

1. Clean room – laboratory with high purity conditions, which hosts equipments for sample processing and analysis of supramolecular structures:
    - 1.1. Molecular Beam Epitaxy system (MBE)
    - 1.2. Molecular inkjet printing – integrated device for dip-pen nanolitography (DPN)
    - 1.3. Integrated device for nanoimprint lithography (NIL)
2. High-resolution (atomic-scale resolution) scanning probe microscopes:
    - 2.1. Scanning Tunneling Microscope (STM)
    - 2.2. Atomic Force Microscope (AFM)
3. Femtosecond laser system :
    - 3.1. Tunable femtosecond source from 200 nm to 2000 nm
    - 3.2. Transient absorption and fluorescence spectrometers
4. Cluster for high-performance computing (HPC) dedicated to numerical simulations and molecular modeling
5. Cutting-edge laboratory for chemical and biochemical syntheses and analyses.
6. High-resolution solid-state NMR spectrometer
7. X-ray single crystal diffractometer
8. Circular dichroism spectrometer and confocal Raman spectrometer for vibrational spectroscopy:
9. Equipment for photothermal spectroscopy and calorimetry: Professional thermographic NIR camera
10. Equipment for photothermal and microwave techniques: measurement of dielectric properties and microwave spectroscopy.

Newly created laboratories

L1. Processing and Analysis of Supramolecular Structures

L2. Scanning Probe Microscopy: Scanning Tunneling Microscopy and Atomic Force Microscopy

L3. Processing molecular systems with ultrashort (femtosecond) laser pulses

Upgraded laboratories

L4. Molecular modeling and numerical simulations

L5. Chemical and biochemical synthesis and analyses

- Synthesis of organic molecules
- Physico-chemical analysis
- Biochemistry

L6. NMR Spectroscopy

L7. X-Ray Diffractometry

L8. Vibrational spectroscopy: circular dichroism and Raman

L9. Photothermal spectroscopy and calorimetry

L10. Microwave techniques and applications

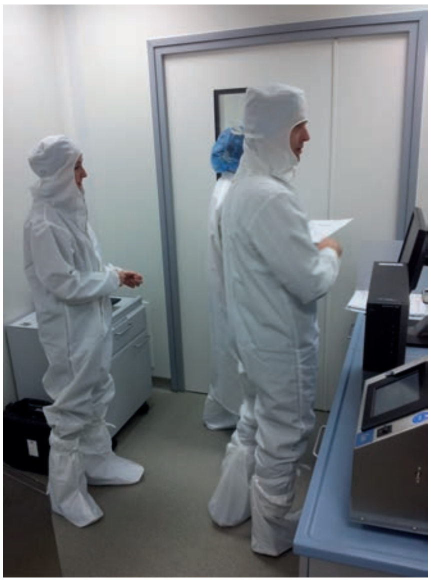
Special conditions for sample processing

through building of a clean room integrated system with different cleanliness levels for processing and analysis of supramolecular structures

Molecular Beam Epitaxy coupled with STM in Clean Room 2.

Through the MDFMOLBIO project the infrastructure of the Supramolecular Structures Processing and Analysis Laboratory was completed with an integrated system for air make up at different cleanliness levels required by specific experiments to be developed in controlled cleanliness conditions.

Clean room assembly has been done during 2011. It is modular in construction with two working areas with cleanliness levels according to ISO 14644-1:1999: ISO-5 CR1 and ISO-8 CR2. It has also an annex space for technological apparatus serving the equipment from CR1 and CR2, and a safety area access system unit (SAS) at the CR2 entry. Pass-through is allowed only between successive cleanliness units.



Dr. Nicoleta Toşa, Phys. Alia Ungurean and Dr. Peter Göransson during the training for Eitre®3 Nanoimprint System in CR1.

The units are separated by partition surfaces of specific materials according to ISO 14644-4:2001. All surfaces (walls, doors, windows, ceilings) are glare and certify the compulsory request of non-emission, non-retention.

Air-conditioning unit ensure the air pretreatment, which is then transported to the ceiling mounted fan filter units (FFU) and gratings. FFU are equipped with H13 HEPA filters having filtration levels. It supplies treated air according to the requested cleanliness levels.

Air flowing directly to the clean room is achieved through the ceiling mounted diffusers equipped with HEPA filters to establish the laminar flow. Then air returns from the rooms through air return grills located on the side walls, implying also fresh air input.

Nanoimprint equipment in CR1.

The areas of the clean room are dedicated to fabrication and characterization of supramolecular structures, thin films deposition and nanoimprinting under controlled cleanliness conditions.

The following equipment have been installed in the clean room: Molecular Beam Epitaxy coupled with Scanning Tunneling Microscope and Dip-pen Nanolithography in CR2, and Spin coater with backing treatment and a Nanoimprint in CR1.

Processing and Analysis of Supramolecular Structures Laboratory

An air treatment and conditioning integrated system characteristic for clean rooms was built, having the following configuration:

Clean room (CR) with total surface of 58 m²:

- Clean room ISO-5, class 100 (CR1), effective surface of 10 m²
- Clean room ISO-8, class 100000 (CR2), effective surface of 28 m²
- Annex space S = 6 m²
- Safety area access system
- (SAS) effective surface of 7.5 m²

Clean room arrangement:

- Floor: carpet with sealed pores, glass fiber reinforced, antistatic, antiacid, cleansable
- Walls, doors, windows, ceilings of specific glare materials
- Filter fan units (H13 HEPA) with filtration levels: 5-10% (CR2) and 70-100% (CR1)
- Specific furniture of metal, ceramics and polypropylene

Air-conditioning unit

- Complete automatic system placed outside the building
- Water delivery: warm (70°C) and cold (7-12°C)
- Compact design with two built-in compressors, external chiller and 2 filtration levels
- Power of the fan engine: maximum 3.5 KW, three-phase 400 V, 50 Hz

Air general specifications:

- Circulating air flow: 4000 m³/h
- Humidity: 40 ± 10%
- Temperature: 22 ± 2°C
- Relative pressure 0+++ in CR1, 0+ in CR2, 0 in SAS
- Filtered particles size: 0.3 μm

Processing and Analysis of Supramolecular Structures Laboratory

Molecular Beam Epitaxy System

The equipment allows the deposition of different materials thin films, such as metals, semiconductors, oxides, organic molecules by molecular beam epitaxy technique under ultra high vacuum.

The main components and technical performances are:

- Cylindrical deposition chamber of 254 mm diameter fitted with seven ports for seven effusion cells
- Currently equipped with three effusion cells for Ga, Au and one for organic materials
- Fast Entry Chamber with a sample manipulator
- The RHEED (Refracted High Energy Electron Diffraction) system for monitoring the molecular epitaxy process. It consists of an electron source with "beam blanking", screen viewport, shutter, CCD camera and computer
- M-2000V spectroscopic elipsometer used for "in-situ" monitoring and control of thin films deposition process. It performs measurements of thickness, optical constants (n,k), depolarization, and “optical band gap” of deposited films. The spectral range is from 450 to 1000nm.
- The vacuum system is composed of an oil-free pump with a flow rate of 4m3/h, a turbo-molecular pump with a flow rate of 260 l/s, an ion pump with a flow rate of 230 l/s and a titanium sublimation pump with a flow rate of 1000 l/s. The ultimate pressure 1 x 10-10 mbar or better.

LAB-10 MBE System

ultra-performing equipment for epitaxial thin films deposition

Through the MDFMOLBIO project, the infrastructure of the Processing and Analysis of Supramolecular Structures Laboratory was completed with a Molecular Beam Epytaxy installation. The equipment is the *LAB-10 MBE Sytem* produced by *Omicron*, Germany, was installed at the beginning of year 2012 system and is operated by highly qualified research personnel.

The system is conceived to fulfill the highest and most stringent requirements of modern thin-film deposition. It is suitable for almost any application such as the deposition of metals, semiconductor growth, magnetic materials growth, oxide layer growth or organic molecules growth. Due to its modular and flexible design the *LAB-10 MBE System* can be upgraded at anytime with Omicron’s Multiprobe Analysis System range without any problems. As a matter of fact, our system is going to be coupled to a Scanning Microscope with AFM and STM capabilities, equipment which was also contracted within the MDFMOLBIO project. In this way the samples which are going to be fabricated in ultra high vacuum will be able to benefit, immediately after fabrication, from an AFM or STM analysis without leaving the ultra high vacuum environment.

By using this equipment we intend to develop applications of self-assembled molecular structures (SAMs) with custom-designed architectures and controlled functionality, fabricated by self assembling based on molecular recognition processes.

Custom designed nanoscale bilayers containing selected receptors, self-assembled on different micro/nano arrays surfaces (polymers, Au or Si) will be fabricated. Further engineering of such functionalized nanomaterials based on molecular recognition and host-guest methodologies, in conjunction with flexible and mechanically robust enough substrate platforms, have the great potential for applications such as separation of nanoparticles, sensors, drug delivery, etc.

Integrated Equipment Dedicated for Nanoimprint Technology

for high-performance molecular electronics

Dr. Bogdan Cozar in the experimental hutch of CR1.

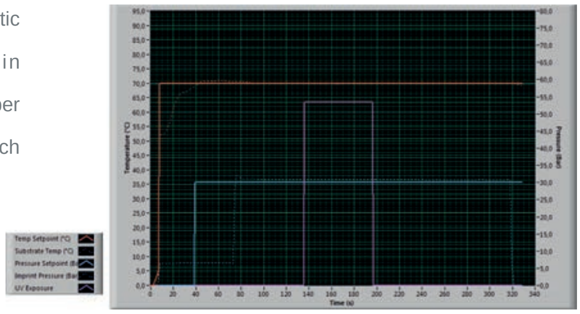
Through the MDFMOLBIO project, the Clean Room Class 100 was equipped with an integrated tool for nanoimprint lithography (NIL). At the moment, this is the only one in the country. Due to the patented Soft Press® technology, to the minimum Feature Size of < 20 nm, and <15 nm minimum Residual Layer, this system has a wide range of applications: from integrated circuits, opto electronic and photovoltaic devices, magnetic storage media, to nanobiosensors used in nanomedicine. The NIL system was installed in October 2012, being operated by highly qualified research personnel.

NIL is a high-resolution, high-throughput and cost-effective nanopatterning technology. It consists in the replication of a mold with nanopatterns into a thermoplastic / UV cured resist.

The fabrication of nano- and microdevices is a hot topic in the entire scientific community. Not only the future of semiconductor integrated circuits will be affected, but also the commercialization of many innovative devices which are far superior to current devices.

A domain of interest for us is the development of biosensors and microelectromechanical systems (MEMS). NIL is a very appropriate technique due to the ability to precisely immobilize biomolecules in well-defined patterns while retaining their native functionality. Patterned surfaces and their chemical landscape provide cues for cells to attach, migrate and assemble into functional systems. Imprint methods are useful because they permit direct construction of a variety of shapes with varying physical-chemical properties being, in the same time, accessible methods for academic research.

The imprint lithography techniques permit the fabrication of structures with a resolution of 20 nm or better, imprinting of 2D and 3D structures, patterning and modification of functional materials, with operational ease for academic and industrial research in developing devices.



Evolution of parameters during an UV-NIL imprint process.

Dr. Alia Ungurean using Eitre® 3.

Processing and Analyzing Supramolecular Structures Laboratory

The integrated Nanoimprint Equipment dedicated for nano-imprint technology is composed of two independent units:

- The nanoimprinting system *Eitre® 3* Nanoimprint Lithography System (Obducat).
- The plasma treatment system *FEMTO* plasma cleaner (Diener electronic GmbH + Co. KG.)

Eitre® 3 Nanoimprinting System which is able of thermal, UV and simultaneous thermal and UV cure imprinting.
The equipment is compatible with a clean-room Class 100.

- Maximum size of imprinted sample/ mould: 77 mm in diameter
- Imprinting pressure range 1-70 bar, by applying an uniform field of compressed air
- Imprinting temperature: up to 200ºC
- UV Module: the Mercury Lamp emits standard wavelengths (250-400 nm)

FEMTO Plasma System is connected to the *Eitre® 3* Nanoimprint System. Using reactive ions etching, the residual resist resulted from the nanoimprinting process is removed.

- Spinning around of small parts in the chamber will be prevented by using a slow ventilation of the vacuum chamber.
- Control of plasma processes by optical end point detector: detection of photoresist will turn the plasma into light blue, after the detection plasma will burn purple and dark.

Processing and Analysis of Supramolecular Structures Laboratory

NanoInk has developed the *DPN 5000 NanoFabrication System* to have the standard controls and tools for all tip-based nanofabrication applications, while maintaining compatibility with a wide range of applications.

Standard features include:

Custom DPN® Scanner
InkCAD™ Version 4.0 Software
Ultra-Low Noise LFM & AFM Imaging
New DPN Stage & Optics
Linux® DPN Controller
E-Chamber Controller

DPN 5000 System supports all of the following options:

Customized Ink Library Option
2D nano PrintArray™ Kit
Active Pen™ Array Kit
AFM Imaging Modes
Applications Support Package
Extended Service Package

NanoInk designed a custom scanner for DPN which allows for compatibility with a wide range of cantilever geometries, reflectivities, and ink coatings.
Relevant features include:

Compatible with NanoInk 1D & 2D pen arrays and ink protocols

Sum signal switch for photo-detector adjustment, allowing maximum ink versatility and patterning control

Extended laser and photo-detector working range to accommodate multiple cantilever array geometries

Adjustable laser focus up to 2 mm for precise focal placement

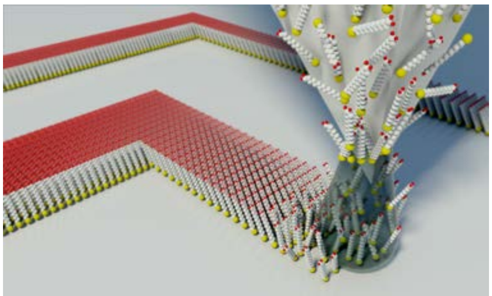
NanoInk has integrated an environmental chamber as part of the *DPN 5000* System, which controls the environmental conditions during DPN experiments.

Temperature and humidity sensors monitor the enclosed environment in real time, both parameters are controlled by PID feedback loops.

Bottom-up Nanofabrication based on Atomic Force Microscopy

DPN 500 NanoFabrication system for molecular technologies

Nanotechnology involves actively building nanoscale components, preferably from the bottom-up. The Dip Pen Nanolithography method is a true bottom-up nanofabrication process. It combines versatile nanopatterning capabilities with high-performance AFM imaging. Together with a complete suite of micro-electro-mechanical systems (MEMs) based ink delivery devices, users may begin creating their own nanostructures hours after installation.



An illustration of the DPN process [http://www.nanoink.net]

The DPN process has the unique advantage of offering a direct method for delivering various molecular species onto a single surface in one experiment. Moreover, it can selectively place these molecules at specific sites within a particular nano-structure or larger device. Such a technique, offers many new and uncharted possibilites.

The primary strengths of this technology are:

1. Directed placement of materials at defined locations with nanoscale precision.
2. Flexible "on-the-fly" pattern generation.
3. Multi-component patterning at micron and sub-micron scales.

Selected DPN applications would imply:

NanoAffinity Templates

Use DPN to pattern nanoscale features that direct the binding and orientation of other nanoscale objects developing new molecular technologies.

Solid-State NanoPatterning

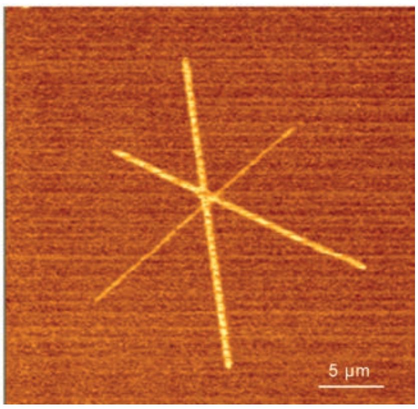
Directly deposit etch resists to create nanoscale patterns of any material on any substrate.

BioNano

Use DPN to create custom arrays of biomolecules.

Directed Placement

Decorate existing micro/nano structures using DPN for molecular electronics applications.



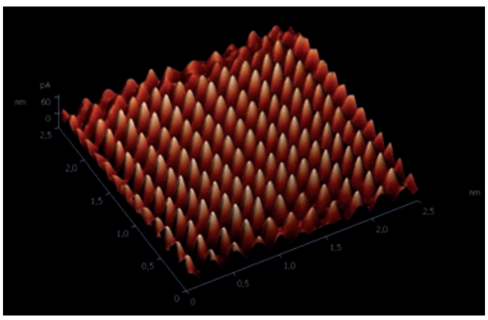
16-Mercaptohexadecanoic acid (MHA) on Gold Substrate.

Interdisciplinary research at the nanometer scale: AFM+Confocal Raman+TERS

integration of SPM with confocal microscopy/ Raman scattering spectroscopy

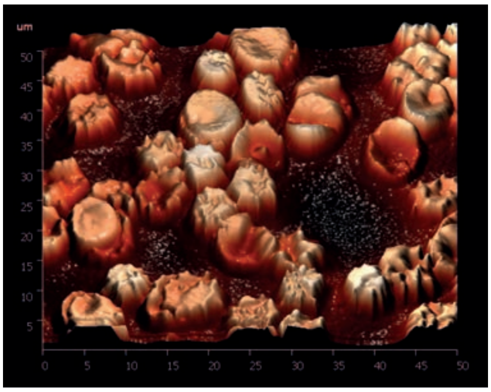
The newly created laboratory includes also an *NTEGRA Spectra* platform (NT-MDT), installed by the end of 2011. The equipment integrates the Atomic Force Microscope (AFM) and Raman Confocal Spectrometer *SOLAR TII*; it supports most of the existing AFM modes, providing comprehensive information about physical properties of the sample with nanometer scale resolution, whereas chemical composition can be simultaneously retrieved via confocal Raman spectroscopy. Measurements can be performed either through upright or inverted light excitation geometries. Complete Raman spectrum is recorded in each point of 2D / 3D scan with further powerful software analysis. The equipment is optimized for Tip Enhanced Raman Spectroscopy (TERS).

Owing to its multifunctionality, availability and simplicity, AFM has become one of the most prevailing tools for nanotechnology nowadays. It has a great advantage in that almost any sample can be imaged, be it very hard, such as the surface of a ceramic material, or a dispersion of metallic nanoparticles, or very soft, such as highly flexible polymers, human cells, or individual DNA molecules. An atomic force microscope allows us, for example, to get images showing the arrangement of individual atoms in a sample, or to see the structure of individual molecules.



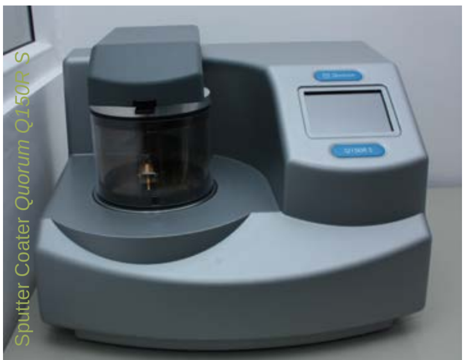
STM image of HOPG sample. Constant current mode. Scan size: 2.5 x 2.5 nm². Bias 0.1 V, FB 0.01. 80:20 Pt/Ir tip.

Besides its imaging capabilities, AFM has various spectroscopic modes by which other properties can be determined at nanometer scale. The strong enhancement of the electromagnetic field near nanometer scale metal asperities (nano-antennas) is at the origin of the TER spectra.



Tapping mode AFM height image of RBC measured with NSG03-A probe in air. Scan size 50 x 50 µm².

By using a specially modified AFM tip, Au/Ag coated (*Quorum 150R S*), the Raman signal strength is multiplied by a few orders of magnitude from a precisely scanned, localized spot on the surface several nanometers in diameter. To keep an optimal balance between maximum signal strength and the shortest penetration depth into the sample, the platform installed at INCDTIM was configured with three lasers, software selectable.



Sputter Coater Quorum Q150R S

Scanning Probe Microscopy Laboratory

NTEGRA Spectra platform combines a laser scanning confocal microscope and an AFM capable of both tip and sample scan modes

Configurations:

- Upright for simultaneous AFM - Raman TERS imaging of opaque samples; objective 100x (NA0.7)
- Inverted optimized for simultaneous AFM - Raman - TERS imaging of samples on transparent substrates; *Olympus IX71* microscope, high NA immersion objective (NA1.3)
- Measurements in air, liquids, gaseous environments and vacuum up to 0.5 x 10^{-2} Torr
- Quartz Crystal Microbalance, closed liquid and gas cell
- Exchangeable scanners: 100x100x10 µm; 1x1x1 µm
- Stand alone operation
- Most of the existing AFM modes are available
- Air and vacuum: contact; semi-contact; non-contact, Lateral Force Microscopy (LFM), Spreading Resistance Imaging (SRI), Force Modulation Microscopy (FMM), Piezoresponse Force Microscopy (PFM), Phase Imaging, Magnetic Force Microscopy (MFM), Electrostatic Force Microscopy (EFM), Scanning Capacitance Microscopy (SCM), Kelvin Probe Microscopy (SKM), AFM Spectroscopy, Adhesion Force Imaging, AFM Lithography (force and current); STM/STS
- Liquids: contact, semi-contact, LFM, FMM, Phase Imaging, AFM Spectroscopy
- Data acquisition and image processing: NOVA software

Raman spectrometer *SOLAR TII*

- Lasers: 532 nm, 632.8 nm, 785 nm; 90 cm^{-1} Rayleigh filter
- Spectral resolution: < 0.22 cm^{-1} (532 nm); < 0.1 cm^{-1} (785 nm);
- Spatial resolution: < 200 nm (XY), 500 nm (Z)
- 4 gratings: 150, 600, 1800 ls/mm and Echelle (spectral resolution < 0.1 cm^{-1})
- Detection: CCD camera

Vibration isolation: optical table *NEWPORT RS4000*

Sputter Coater *Quorum Q150R S*

- Au/Ag targets

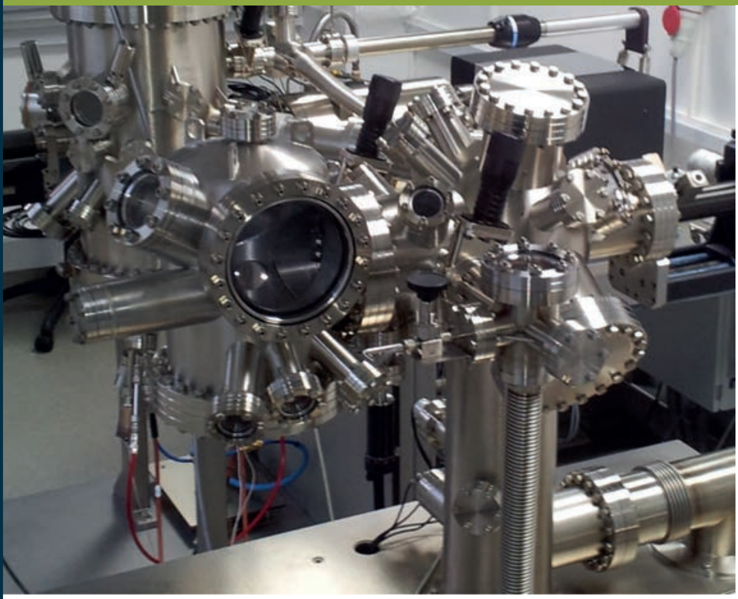
Scanning Probe Microscopy Laboratory

STM and AFM scanning microscope for ultra high vacuum and low temperatures

The equipment is destined to obtain images with atomic resolution by tunneling microscopy techniques (STM) and atomic force microscopy of "tuning fork" and cantilever, at variable temperatures between 50K and 650K, under ultra high vacuum (UHV). The scanning microscope consists of:

- Ultra high vacuum chamber for input, processing and analysis of the surface sample, which contains: preparation and surface analyzing chamber, spherical shape with inner diameter of 220 mm; sample insertion chamber (Fast Entry Chamber) and sample manipulator
- Variable temperature UHV SPM system (Scanning Probe Microscopy), which includes: SPM chamber for STM and AFM modules, STM module, AFM module with cantilever, “tuning fork” type AFM module
- Pumps system to ensure the ultra high vacuum
- Heating system for degassing
- SPM controller
- System of direct transfer of the sample from the existing MBE chamber to the SPM chamber
- STM tips preparation module coupled to the SPM chamber

The system can achieve STM and AFM noncontact images, “tuning fork” type, and STS (scanning tuneling spectroscopy) simultaneously on the same area of the sample.



Scanning Probe Microscopy with Atomic Resolution

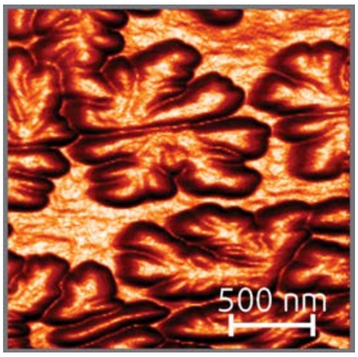
the latest scanning technology equipment under ultra high vacuum

One of the research equipments acquired within the MDFMOLBIO project is a scanning microscope for ultra-high vacuum with STM (Scanning Tuning Microscopy) and AFM (Atomic Force Microscopy) capabilities in the 50K to 650K temperature range.

The installation is manufactured by the Omicron company from Germany and it is going to be installed and coupled to the molecular beam epitaxy system, which was made by the same manufacturer and which has been already installed this spring. The coupling of the two installations offers the advantage of investigating the samples immediately after their fabrication in the molecular beam epitaxy installation, without them having to leave the ultra high vacuum environment.

Besides the classical AFM and STM scanning techniques the scanning microscope benefits from a non-contact AFM technique, named Qplus AFM, which represents the most recent AFM innovation of the Omicron company. This technique uses a metallic scanning tip, hence conductive, which offers the possibility of simultaneously recording a classical AFM image, which gives information about the sample's topography, and a STM image, which gives information about the sample's electrical properties. The interaction between the tip and the sample is one of a non-contact type which determines the resonant frequency of the quartz tuning fork on which the tip is mounted, this parameter being used to control and maintain the distance between tip and sample at very low values.

The very low amplitude of the tuning fork allows the recording of AFM images with very high signal-to-noise ratio, which is particularly useful for low temperature measurements, where one can obtain high resolution images. This research equipment, which is unique in Romania, is an essential tool for one of the main research directions in our department - the study of self-assembled monolayers and the various functionalized molecules or molecular patterns which are deposited on top of them.



High speed non-contact AFM on oxidised Sb crystals on HOPG. [Sample courtesy of Dr. B. Kaiser, TU Darmstadt, Germany; http://www.omicron.de)

Dynamics of Molecular Systems at Femtosecond Scale

an integrated laser system for exploring molecular dynamics and laser interaction with matter

The MDFMOLBIO project included the acquisition of a complex system for the experimental investigation of the ultrafast dynamics of molecular systems in interaction with pulsed laser pulses. The femtosecond laser system emits pulses of 30 to 200 fs duration with a repetition frequency ranging from single pulse to 200 kHz, in the spectral range from 200 to 2600 nm. It consists of a high power femtosecond Laser PHAROS, which can pump an automated harmonics generator (second, third and fourth harmonics) and two (collinear and non-collinear) Optical Parametric Amplifiers (OPA).

This versatile source which can emit simultaneously two or three frequencies, with controlled delay. The combination of pulses is used either in a transient absorption spectrometer or in a fluorescence up-conversion spectrometer, as components of the system. Absorption or fluorescence processes can put in evidence temporal dynamics of excited states with picosecond resolution. The two spectrometers envisage applications in the field of time resolved spectroscopy, photochemistry, photobiology or photophysics, as well as in material science, polymer and semiconductor physics.

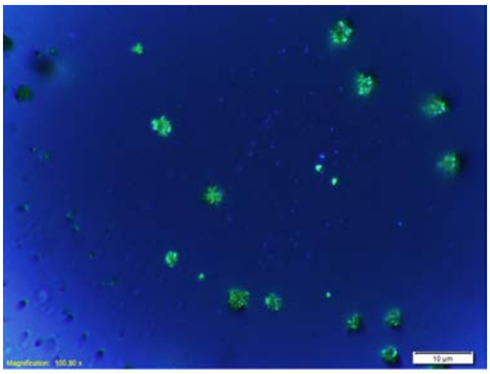
Alternatively the laser power is high enough to induce optical nonlinear processes in solid or liquid media, thus can be used for micromachining, micro- and nano-structuring, writing of Bragg gratings and waveguides, multi-photon polymerization, wafer dicing, transparent material processing, metal microprocessing, etc.

Biomedical applications involving radiation interaction with biological media can be also developed by using this laser system.

For laser photolithography, materials fabrication and processing we have an inverted microscope equipped with XYZ nanopositioning system and super-resolution optical microscopy. Leading-edge microscopy and imaging are also foreseen as applications.

The whole system is under computer control, appropriate instrumentation and software are available for controlling the laser emission, processing data of the transient absorption and fluorescence spectrometers, as well as for controlling the microfabrication processes.

Fluorescence image of carbazole crystals excited by laser radiation. Dimension of crystallites 330-395 nm; magnification 100X.



Postirradiation image of dopped polymer on glass substrate. Magnification 160X.

Laboratory for Processing Molecular Systems with Femtosecond Laser Pulses

Main Laser pump

Central wavelength 1028+/-5 nm
Output Power:
> 6 W @ 10-200 kHz
Pulse duration (FWHM) < 200 fs
Pulse energy >1.0 mJ @1-5 kHz
Pulse repetition frequency from single pulse up to 200 kHz

Second (SH), Third (TH) and Fourth (FH) harmonic generator

Conversion efficiencies
SH >30%, TH >30%, FH >8%

Optical Parametric Amplifiers (collinear)

Tuning range 630-1020 nm and 1040-2600 nm
Tuning range with FH extension 210-255 nm and 260-315 nm
Energy conversion ratio >14%
Bandwidth 120-220 cm^{-1}
Pulse duration 120-200 fs

Optical parametric amplifier (non-collinear)

Tuning range 650-900 nm
Pulse duration < 30 fs

Transient absorption spectrometer

Spectra acquired at 1-2000 Hz
Probe range 480-1100 nm
Temporal resolution < 280 fs
Spectral resolution < 1.5 nm
Standard 1.7 ns delay line

Fluorescence spectrometer

Up-conversion

Spectral range 400-1600 nm
Wavelength resolution 100 cm^{-1}
Delay range 3.4 ns
Delay step 33.3 fs
Time resolution < 300 fs

Time Correlated Single Photon Counting

Wavelength range 185-820 nm
Intrinsic time resolution < 200 ps
Time resolution <1.2 ns

Inverted microscope equipped with:

Multiple optical ports for high resolution CCD camera
Laser and fluorescent light illumination
High NA objectives
High-precision XYZ piezo system for wafer nanopositioning (1 nm resolution)

X-Ray Diffraction Laboratory

X-Ray *SuperNova* dual wavelength diffractometers, with the following main technical specifications:

Tube

- Mo/Cu, 50 kV, 0.8 mA
- Mo microsource: up to 2.5x
- more intense than a standard Mo sealed tube with mono-capillary optics
- Cu microsource: up to 3x more intense than a 5 kW rotating anode with optics

CCD EOS Detector

- CCD chip: *Kodak KAF4320-E*
- Scintillator material: Gadox
- Peltier cooling: –40ºC (three stage cooler)
- Temperature stability: ±0.05ºC (micro-processor PID)
- System noise (so-called read noise): < 10 e- RMS
- Dark current: < 0.05 e-/pix.s
- Readout time (complete duty cycle including chip readout, CDS, analogue-to-digital conversion, transfer detector - PC, disk storage): 0.28 s (4 x 4 binning), 0.46 s (2 x 2 binning), 1.59 s (1 x 1 binning)
- Active area: 95 mm diagonal
- Pixel size on scintillator: 31 µm
- Fibre optic reduction: 1.3 (low)

Four-circle Kappa Geometry

- Sphere of Omega, Kappa, Phi coincidence: 10 µm
- Resolution: 0.00125º for Omega and Theta, 0.0025º for Kappa and 0.005º for Phi
- Scanning speed range: 0.005 to 3.0º/sec
- Scintillating detector angular range: -115 to 157º
- CCD detector to sample
- distance: 45 to 150 mm (depending on the detector)
- Response time: 3 ms

High Performance X- Ray Crystallography

by a dual microsource single-crystal X-Ray diffractometer

In the frame of the MDFMOLBIO project, the X-Ray Diffraction Laboratory was equipped with a *SuperNova* single-crystal diffractometer. This state-of-the-art diffractometer, unique in Romania, combines two Hi-flux Cu and Mo X-ray micro-focus sources with a high performance CCD detector.

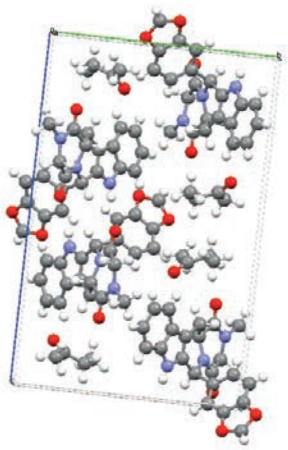
The presence of two microsources, easily switchable, enlarges the area of investigation for a broad range of materials: organic, inorganic, organo-metallic, small molecules and also macromolecules. The diffractometer is equipped with a Cryojet HT (temperature range: 90 - 490K)

The acquisition of the *SuperNova* diffractometer opened the possibility to single-crystal crystallography next to the powder diffraction capabilities that were already available.

Moreover, the X-Ray Diffraction Laboratory became an important part in the high-throughput workflow technology implemented within the project HT-PHARMA (POS CCE 536), focused on crystal engineering of pharmaceutical compounds.

Although the *SuperNova* diffractometer was recently installed (2011), a large number of crystal structures have been determined by single-crystal diffraction. Among these, it is worth mentioning the active pharmaceutical ingredients (polymorphs, hydrates, solvates, salts and co-crystals), natural products and organo-metallic compounds, for which crystal structures were elucidated.

The X-Ray Diffraction Laboratory became an integrating part in different research collaborations including young scientists.



Tadalafil 2-butanone solvate: molecules (left) and elementary cell.

The most sophisticated solid-state NMR experiments accesible at INCDTIM Cluj

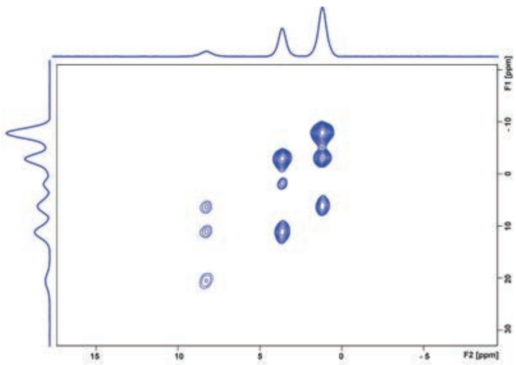
through the acquisition of a dedicated spectrometer incorporating the latest technologies in the field

Nuclear Magnetic Resonance (NMR) Laboratory

The research infrastructure of the NMR Laboratory was completed through the MDFMOLBIO project with a state-of-the-art 500 MHz ss-NMR spectrometer. The equipment is unique in our country, being the first spectrometer fully dedicated to high-power applications on solids: it has a wide-bore cryo-magnet and incorporates the latest generation of ultra-fast Magic Angle Spinning (MAS) technology. By this, a modern NMR facility was created, which opens up the way for new developments in a research field with long tradition at INCDTIM Cluj.

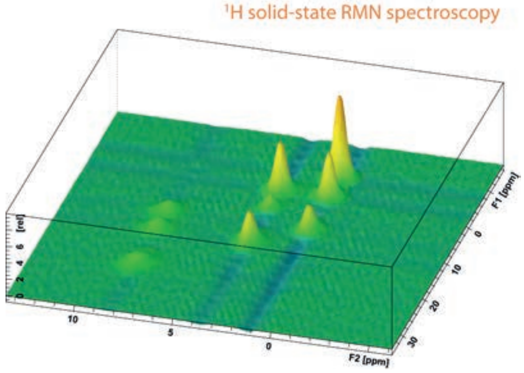
The ss-NMR spectrometer was installed at the end of 2011, being operated by highly qualified research personnel. The new equipment will enhance the research potential of the NMR Laboratory, which has a good record in pioneering advanced ss-NMR methodology. By this aquisition, solid-state NMR spectroscopy is expected to have a greater impact in the Romanian scientific community, especially for users from emerging fields, like structural biology, NMR crystallography, supramolecular chemistry, and advanced materials, where this technique is intensively employed to answer key questions about structure, functionality, and interactions at molecular level. The knowledge- based approach in the pharmaceutical and chemical industry, like rational drug design, and smart materials production, can benefit as well from the new equipment. The NMR Laboratory is also able to provide new training and research opportunities for young researchers.

The acquired ss-NMR spectrometer is configured for a wide range of potential practical applications, that may refer to varoius aspects, for instance the NMR-active nuclear species being addressed (^{1}H, ^{13}C, ^{15}N, ^{2}H, ^{31}P, ^{23}Na, ^{17}O, ^{29}Si, ^{43}Ca, ^{27}Al, ^{25}Mg, etc.), nature of the sample (organic, inorganic), sample morphology (from polycrystalline materials, polymers, gels, zeolites, to complex morphologies such as composite materials, membrane embeded peptides, nano-, or micro-engineered surfaces, etc.).



Ultra-Fast Magic Angle Spinning (MAS)

a revolutionary technology for resolution enhancement in ^{1}H solid-state RMN spectroscopy



A *Bruker Avance III* solid-state (ss) NMR spectrometer was acquired, having the following configuration / main technical performances:

- Wide-bore, ultra-shielded cryomagnet of 11.76 T (500MHz)
- Triple-channel radio-frequency (*rf*) console for high-power applications in solids
- Pulse generating system of latest generation with a timing resolution of 12.5 ns
- Provides < 0.01^{0} phase, and < 0.005 Hz frequency resolution; event time for changing the pulse frequency, phase, or amplitude of 25 ns
- Receiver with a minimal bandwidth of 5 MHz, equipped with control unit for NMR signal accumulation with real-time digital filtering and oversampling technology
- Microimaging unit for applications in materials research

The spectrometer is equipped with a full range of ss-NMR, micro-imaging, and diffusion probeheads:

- Standard CP/MAS ^{15}N-^{31}P / ^{1}H probehead, 4 mm rotors, 15 kHz maximum spinning frequency: suitable for routine applications on organic solids
- Triple-channel CP/MAS probehead, 2.5 mm rotors, 35 kHz maximum spinning frequency: ideal for triple channel experiments on isotopic labelled (bio)solids
- Ultra-fast CP/MAS probehead, 1.3 mm rotors, 67 kHz maximum sample spinning frequency: ideal for high-resolution ss-NMR experiments on ^{1}H
- Micro-imaging probehead with exchangeble ^{1}H birdcage resonators for 5, 15 and 25 mm samples
- *DIFF30* Z-diffusion probehead with 30 G/cm/A, with one selective ^{1}H insert of 5 mm

Chemistry and Biochemistry Laboratory

An *Anton Paar* microwave complex system was acquired, with the following configuration/ main technical performances:

Monomode *Microwave 300* reactor for small-scale sealed vessel:

- One single magnetron, 850 W installed power, unpulsed mode, max. pressure 30 mbar, max. temperature 300°C, magnetic stirring up to1200 rpm, pneumatic system for sealing the reaction vials with volumes of 0.5-20 ml, temperature control *via* IR and/or ruby crystal fiber optic sensor

Multimode *Synthos 3000* reactor for large-scale sealed vessel:

- Two magnetrons, 1400 W installed power, unpulsed mode, max. pressure 80 mbar, max. temperature 400°C, magnetic stirring up to3 rpm, temperature IR sensor and/or immersing probe in one reference vessel, 100 ml PTFE or thick quartz sealed vessels

A complex equipment dedicated to physical, chemical and biochemical experiments:

Micro Spinning Band Column for liquid samples fractional distillation:

- Distillation column with vacuum jacket and Teflon tape in rotation with the driving motor
- Rotating speed for the teflon band up to 2500 rpm
- Alcohol concentrations higher than 93% (w/w); digital control of the vapors divider

Sample preparation and work-up facilities:

- Fume cupboard polypropylene coated and 1000 m³/h air output
- Heating oven at 30-300°C
- Analytical balances with 0.01 mg resolution /0.015 mg repeatability, ultra-precise conductivity and pH meter (Metler)
- Hot plate magnetic stirrers
- 254/365 nm UV irradiation system

Biochemical facilities:

- Safety cabinet, incubator, ultra pure water distiller, ultrasonic homogenizer

High-complexity synthesis and sample preparation facilities

by specific equipment dedicated to sample preparation and treatment for physical, chemical and biochemical experiments

Through the MDFMOLBIO project the infrastructure of the Chemistry and Biochemistry Laboratory was completed with high complexity equipment dedicated to synthesis and sample preparation.

Anton Paar microwave integrated system was acquired in October 2011. It is used for synthesis, extraction and digestion processes in a fast, efficient and reproducible manner. It provides the highest control and safety conditions on the market at this moment.

Microwave 300 is used for development and optimization in research under small-scale sealed vessels conditions. The design of monomode microwave cavity provides utmost field density which allows efficient heating at elevated temperatures even for low-absorbing solvents or powder using silicon carbide technology. It is especially dedicated to microwave assisted organic synthesis, but also is very efficient for extraction and nanoparticles generation processes.

Synthos 3000 is used as tool for upscale standard but also for special applications, which are hardly accessible with conventional instrumentation. It works simultaneously from smooth, low-energy heating ramps up to extreme high-pressure and high-temperature conditions. Its unique cooling system reduces overall process times, suppression of side-reactions and provides excellent, reproducible results. Different rotor types, several kinds of vessels and various sophisticated accessories make *Synthos 3000* a powerful platform in the synthetic laboratory.

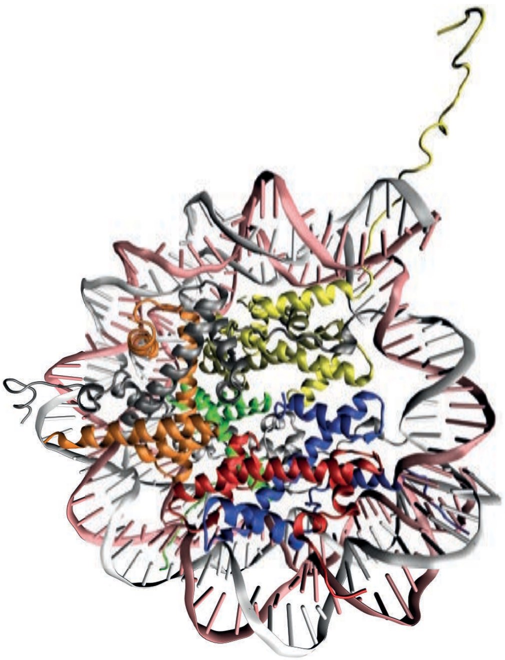
The Micro Spinning Band Column is used to extract ethanol from wine, necessary to determine the deuterium (D) concentration by NMR techniques. The analyses are used to authenticate the wines using ethanol isotopic ratios (D/H). The method refers to the quantitative determination of natural deuterium abundance in ethanol extracted from wine, being able to characterize the geographical origin and possible adulteration of wines.

The equipment dedicated to chemistry and biochemistry laboratory is used for synthesis under conventional conditions, work-up the reaction mixtures, investigation and characterization of the compounds, sample conditioning for biochemical and other type of experiments.

Micro Spinning Band Column.

Design and Characterization of New Functionalities at Molecular Scale

the acquisition of the
High Performance Computing
HPC cluster



Computational physics and chemistry are among most dynamic fields in the contemporary science, offering numerous opportunities for young researchers. With the advent of the density functional theory, the theoretical tools evolved tremendously allowing today ab-initio studies of systems composed of thousands of atoms.

The acquisition of the HPC cluster will boost the ongoing scientific projects while numerous new opportunities will be open due to its state of the art capabilities. Among these applications it worth mentioning:

(i) the design of new molecular structures with applications in the drug industry or non-conventional energies; we emphasize there the study of molecular crystals or the design of structures for the highly efficient conversion of the thermal energy into electric power;
(ii) the study of DNA structure and dynamics;
(iii) molecular electronics and other the potential technological applications of the organic molecules in the information technology.

In the near future our goal is to merge the information produced by the numerical simulation laboratory with the experimental developments. This asks for a substantial increase of the computing power. Therefore, the HPC cluster is built on an InfiniBand technology to allow high quality simulations by massive parallelization of the software to be used.

By taking advantage of the benefits produced by parallel numeric simulation we aim to propose computer driven experiments to successfully complement the exploitation of the department's research infrastructure. Consequently, the scientific visibility of the entire department as well as the quality of the scientific output are expected to benefit from this strategy in the near future.

Molecular Modeling and Numerical Simulations Laboratory

The computing equipment of the laboratory was completed with high-performance workstations for numerical simulations and molecular modeling.
It was acquired an *IBM System x iDataPlex dx360 M4* with the following main technical data:

- File Server for Storage: General Parallel File System (GPFS)
- Storage: 20 TB with SAS 2.0 disks and 10000 rpm
- Two Head Node Servers: CISC x 86 6-core, with 2.93 GHz, and 12 MB L3 cache
- 26 Nodes: Two Intel Xeon Sandy Bridge E5-2665 8-Core 2.4 GHz, 20 MB L3 cache, DDR3 64 GB, 1600 MHz ECC (416 cores)
- 2 Nodes: Two Intel Xeon Sandy Bridge E5-2665 8-Core 2.4 GHz, 20 MB L3 cache, DDR3 64 GB, 1600 MHz ECC + NVIDIA Tesla M2090 GPU (32 cores)
- Network Connection: FDR InfiniBand with 56 GB bandwidth

The widely used Molecular Modeling Softwares, including their last new features, were purchased in order to close up to a more advanced level of the High Performance Computing:

Quantum Chemistry:

Gaussian 09 C01

Molpro 2012.1

Molecular Dynamics:

Amber 12

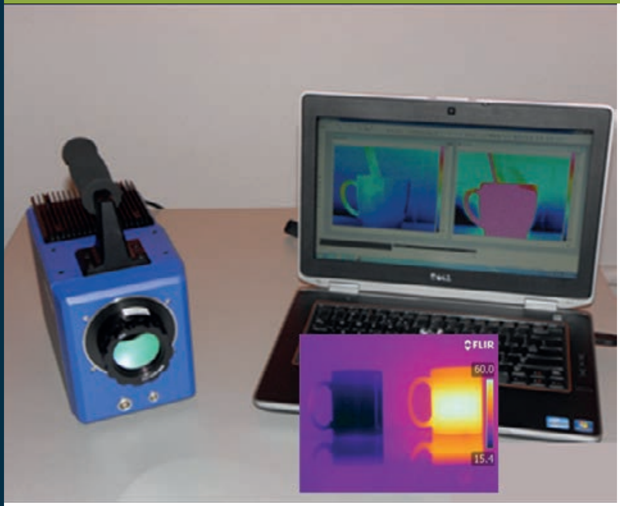
Molecular Visualization:

GaussView 5

Spectroscopy and Photothermal Calorimetry Laboratory

A *SC7200* IR camera was acquired, for carrying out thermal and radiometric measurements and having the following technical performances:

- Detector matrix 320 x 256 InSb elements (30 µm/pitch, spectral response 1.5-5.1 µm) with typical thermal sensitivity of 25 mK/DL, a maximum digital frequency of 178 Hz and a Stirling cooler (MTBF > 8000 h)
- An adjustable frame rate up to 1172 Hz (for a 64*8 matrix) for revealing images of a fast thermal event, having the integration time adjustable by increments of 1 µs
- An external triggering allows the synchronization of the image with the most fleeting of events
- A rotating filter wheel is inserted between the lens and the focal plane allowing instantaneous imaging of sub-spectral bands
- A compensated non-uniformity correction (CNUC), optimized for any “integration time-camera temperature” combination
- A lock-in option can yield either amplitude and phase image of a periodic heat supply, allowing an improved spatial resolution of the IR image
- A 50 mm MWIR lens (FOV 9 x 7.7 cm, minimum focus 0.5 m) and a close-up G1 objective (working distance 300 mm, FOV 9.6 x 7.7 mm) for an increased resolution (1 px = 30 µm)
- Hypercal camera Calibration files for both objectives, operating in the temperature range 5-300^{0}C
- Dedicated software allows thermal images visualization, real-time image acquisition, accurate triggering, lock-in thermography and stress analysis



High-Resolution Infrared Digital Camera

remote temperature sensing for scientific, industrial and medical applications

Description of research topic

The *FLIR SC7200* camera combines extremely high imaging performance and precise temperature measurements (temperature change less than 0.02^{0}C), with powerful tools and software for analyzing and reporting. This combination makes it a suitable device to solve a variety of research, thermal testing and product validation applications such as:

Thermo-physical properties of materials

IR thermography is excellent for a fast characterization of thermal properties of materials such as thermal effusivity and thermal diffusivity. These parameters can be measured in transient conditions by imposing a heat flux on the surface of the material that in time is described by an impulsive or modulated step function. These parameters can be used to identify humidity in buildings, hardness depth profile in polymers, for semiconductors and composites characterization.

Health care

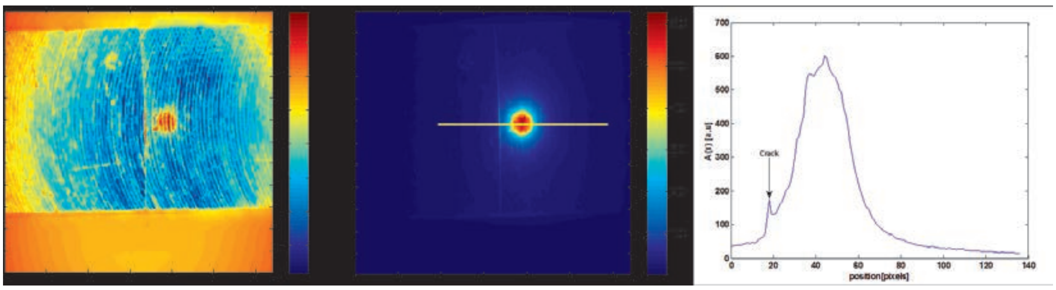
Thermography is a non-invasive diagnostic technique that involves no exposure to radiation. Applications include vascular evaluation, bleed point detection and early tumor tissue identification. Accurate data about the temperature of the human body and skin can provide a wealth of information on the processes responsible for heat generation and thermoregulation, in particular the deviation from normal conditions, often caused by disease.

Agriculture

Thermal imaging could be adopted for studying plant physiology, detection of bruises in fruits and vegetables, diagnosis of seed viability and others pre-harvest and post-harvest operations in agriculture.

Non-Destructive Testing (IR-NDT)

IR-NDT can detect internal defects through an external excitation and the observation of thermal differences on a target surface. Lock-in thermography is a valuable tool for detecting cracks, delaminations and water inclusion in different materials of industrial interest (composites, metals, etc) by analyzing the anomalies of heat flow distribution caused by the presence of a defect or a discontinuity.



Continuous DC image, amplitude image and the profile of the amplitude along a linear crack.

New Spectroscopic Tool for Biomolecular Structural Determination

new approaches to the determination of absolute configuration for chiral pharmaceuticals

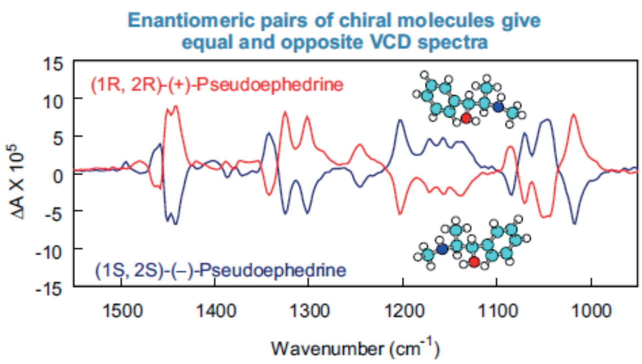
By acquiring the Vibrational Circular Dichroism (VCD) spectrometer, the infrastructure of the Molecular and Biomolecular Physics Department, has been extend with one of the most valuable tool able to characterize the chiral properties of molecules. VCD can be used for many types of analyses related to the structure and conformations of organic molecules. The facility was installed in july 2012, being operated by highly qualified research personnel.

Molecular handedness plays a fundamental role in determining chemical and biological activity. Well-known examples are the nucleotides and amino acids, which in nature occur in one handedness only. Other examples include a large number of compounds that act as medicines in one handedness, but as poisons in the other, sometimes with dramatic consequences. Knowledge of the absolute configuration of chiral molecules is therefore essential in chemistry, biology, and pharmacology.

In descriptive terms, VCD is the coupling of optical activity to infrared vibrational spectroscopy. More specifically, VCD spectra are vibrational difference spectra with respect to left and right circularly polarized radiation.

The essence of VCD is to combine the stereochemical sensitivity of natural optical activity with the rich structural content of vibrational spectroscopy. Vibrational circular dichroism is being increasingly used to determine absolute configuration of optically active molecules. Together with infrared data and supported by computational methods the VCD data allow conclusions on the conformation of a variety of molecules ranging up to large biomolecules. Among the important applications one can mention several of them: determination of absolute configuration, solution-state conformational analysis (small molecules, biomolecules like peptides, proteins, DNA/ RNA, sugars and fibrils), chiral or bio-catalysis, determination of enantiomeric excess, reaction monitoring and solid-phase VCD measurements.

The knowledge based approach in the pharmaceutical and chemical applications, like rational drug design, and smart materials production, can benefit as well from the new equipment.



Btools.com/docs/Biotools_Catalog.pdf.

Vibrational Spectroscopy Laboratory

Chiral IR-2X™ Vibrational Circular Dichroism Spectrometer, with the following configuration / main technical performances:

FT-IR Spectrometer System

- Corner-cube interferometer base 6500 - 800 cm^{-1} range
- Dual Source increases signal-to-noise (S/N) ~ 3.6 x over any singular-source system
- High-sensitivity MCT detector
- Variable resolution: 32 - 1 cm^{-1}

VCD Components and Performances:

- Single PEM - 37 kHz AR-coated ZnSe Photoelastic Modulator with digital controller
- Complete spectral range of measurement 4000 - 850 cm^{-1} (no change of filters required)
- Baseline offset: from zero less than ±2 x 10^{-5} absorbance units
- Noise level: < 10^{-5} ΔA unit for 20 minute collection at 4 cm^{-1} resolution in the spectral range 850 - 1800 cm^{-1}
- Internally calibrated and optically aligned for routine operation

Highlighted strengths

- The spectrometer is equipped with a *SyncRoCell*™, DSP and temperature controller
- *SyncRoCell*™ unique artifact reduction rotating cell for performing FT-IR and VCD measurements on liquid and solid samples
- *Chiral IR-2X*™ using DSP (digital time-sampling) of all signals containing modulated (AC) and IR (DC) signals simultaneously results in a very high signal-to-noise spectra and ability for the 1st time in history of VCD to measure the full region, from 4000 - 850 cm^{-1} with just one measurement
- Pelltier thermostatted cell holder with temperature range –4 to +90°C and precision ±0.3°C

Laboratory for Microwave Techniques and Applications

Design and prototyping system for microwave and electronic circuits:

1. CNC plotter *LPKF Protomat S62*

   0.25 µm resolution
   0.2 mm min. drill hole
   0.125 mm width min. route
   62.000 rpm spindle motor
   Automatic 10 tool change
   2.5D milling process
   Fiducial recognition
   LPKF CircuitCam and LPKF BoardMaster software

2. Bench top hidraulic press *LPKF MultiPress-S*

   Programmable pressure / temperature / time profiles
   280 N/cm^2 max. pressure
   0.125 mm width min. route
   250ºC max. temperature
   About 90 min operating time

3. UV masking process *LPKF Promask*, UV exposer

   60 min processing time
   Four step process
   UV exposure and develop
   Max. 0.2 mm overall resolution

4. Semi-automatic pick and place *Essemtech Expert*

   BGA and Fine-Pitch (0.4 mm) component placement
   Camera vision system
   SA - Control software

5. Soldering oven *LPKF Protoflow-N2*

   Reflow soldering process
   Temperature profile recorder
   Various temperature profiles for reflow or masking processes
   Microsoft Excel spreadsheet

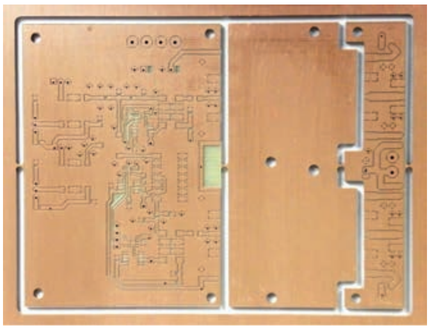
6. Electrogalvanic bath *LPKF Minicontac-RS*

   Reverse Pulse Plating system
   Cleaning, graphite activation and copper deposition baths with programmable current
   0.2 mm min. diameter for through hole plating
   Processing max. 4 layers

PCB fabrication line for prototypes

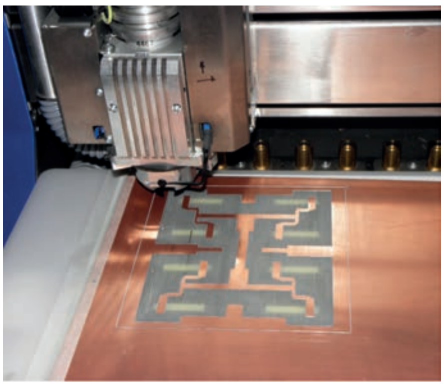
from concept to real world implementation

The Printed Circuit Board line allows to get microwave and electronic circuit prototypes in 24 hours (dual layer) or 72 hours (multilayer) after the design process has been finished, exclusively for research purposes.



The PCB appearance after the milling and cutting process.

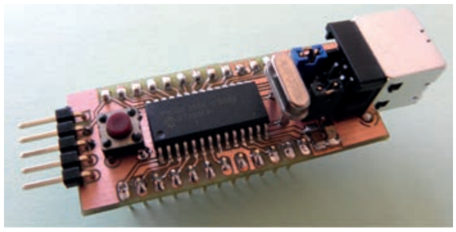
Precision geometry required by the RF and microwave prototypes are acquired by Computer Numerically Controlled process, using top quality carbide routing bits and high speed milling. PCB prototypes manufacturing up to four layers is available for any type of FR4 material, including UV green masking and chemical tinning. Through hole metalization process down to 0.2 mm hole diameter (1.6 mm thickness) is possible thanks to the reverse pulse plating process used by the chemical deposition bath Minicontac-RS. Thus we obtain an uniform layer thickness.



Microstrip-slot line antenna appearance during LPKF Protomat S62 milling process.

Electronic boards can be stuffed with components using manual soldering paste dispense and semiautomatic assembly, both computer assisted. High resolution camera allows a detailed view of the pick and place process. Rework on already manufactured boards or empty PCBs is also possible either using a hot air tool included in the Essemtech Expert equipment or the temperature programmable oven Protoflow-N2.

A professional team offers consulting in the field, as your projects come alive. Our expertise includes design and prototyping for digital electronics, embedded systems, analog electronics, radiofrequency and microwaves.



Miniature embedded system with PIC18F2550 for development applications with USB interface.

915 MHz, two channels, 60 W RF power amplifier prototype for scientific use (microwave diathermy).

Applications of the Microwaves – Mater Interactions

dielectric properties measurements system by microwaves absorption/ spectroscopy in the frequency range of 10 kHz - 325 GHz

The dielectric properties measurements system by microwaves absorption in the frequencies range of 0-325 GHz has the purpose to obtain base research knowleges in the microwaves – mater interactions:

Base research on microwaves complex biological system interactions: genetics waves, microwaves absorption effect on molecular systems.

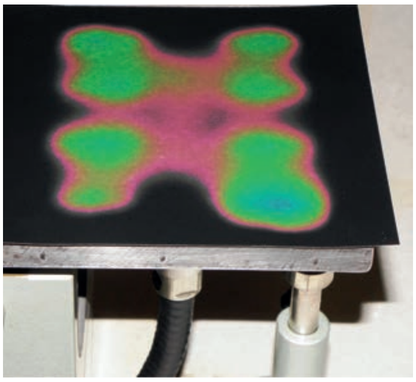
New methods for characterizing and processing of the molecular and biomolecular systems.

Microwaves power unconventional treatments to obtain new materials, composites, metamaterials, treatment technologies, treatment database.

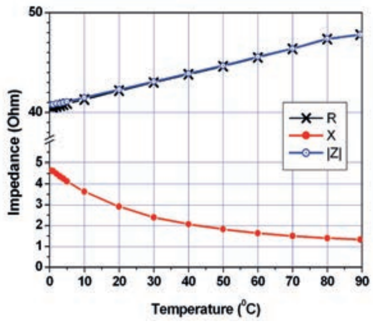
Non-invasive transducers for characterisation of some molecular and biomolecular processes.

New methods to monitorize environmental pollution.

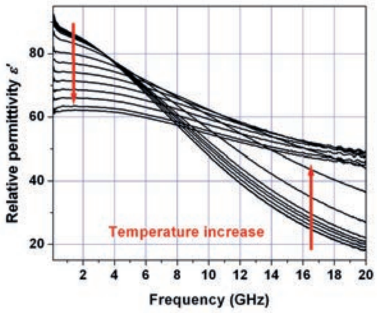
Biological methods to reduce environmental electromagnetic pollution in the field of the major EM poluants.



Temperature/power distribution near 8 slot antenna surface – applicator for medical device.



Water probe impedance versus temperature at 2.462 GHz.



Relative permittivity ε' of water for temperatures between 1-90°C.

This research topic is based on the dielectric loss selectivity of the microwaves absorption in the molecular species, on the direct power transfer of the microwaves in probes and on the noninvasive interaction character.

The relevance of this research field results from the number of the national proiects involved in this area, three of them were managed by our team in the last five years (one is undergoing). This is a field of active research in FP7, EMF-NET, COST-BM0704 and Bilateral Cooperation European programmes.

Laboratory for Microwave Techniques and Applications

MICROWAVE SYSTEM:

1. Microwaves generator *Agilent PSG analog signal generator E8257D*:

   Frequency domain: 250 KHz - 325 GHz

   Output power between 3 µW (–25 dBm) and 150 mW (+22 dBm)

2. Microwaves powermeter *Agilent U2000H*

   Frequency domain: 10 MHz to 18 GHz

   Base microwaves power measurements between 10 nW - 1 W (–50 dBm to +30 dBm)

   External attenuators up to 500 W

3. Spectrum Analyzer *Agilent E4448A PSA* with external modules and accessories

   Frequency domain: 3 Hz - 325 GHz

   Lateral noise in the video band @ 10 kHz: better than –118 dBc/Hz

   Amplitude noise between –140 dBm and –165 dBm in the frequnecy range

4. Millimeter-Wave Network Analyzers

   Frequency domain: 10 MHz to 110 GHz, with extensions up to 1.1 THz

   Source power level better than 0 dBm on the frequencies domain (10 MHz - 110 GHz)

   Dynamic Range > 110 dB,

   without the need for external RF and LO sources

   Industry leading stability less the 1% drift over a 24 hour period

The team

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Purchasing manager:
Eng. Dumitru Chincişan
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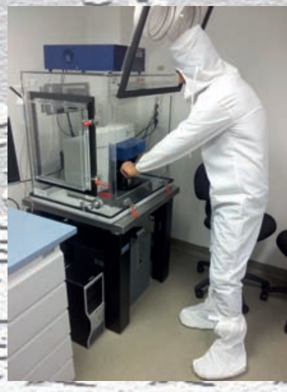

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