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EMaS
CENTRE DE RECERCA
RESEARCH CENTRE

Engineering of Materials and micro/nanoSystems

UNIVERSITAT ROVIRA I VIRGILI

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The Research Centre on Engineering of Materials and micro/nanoSystems, EMaS, is a Research Centre from the Rovira i Virgili University working on the field of science and engineering of new materials and on their nanostructuration with the aim to used them in the design and development of micro and nanosystems.

More than 80 expert researchers in various fields such as physics, chemistry, chemical engineering, optics, photonics, electronic engineering and environmental engineering, set up the EMaS Research Centre.

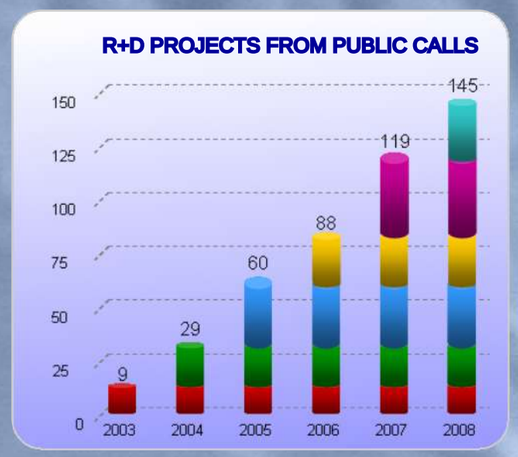
The EMaS Research Centre was initially set up by six founder research groups from various departments and schools of the Rovira i Virgili University: Nanoelectronics and Photonic Crystals(**NePhoS**), Physics and Crystallography of Materials (**FiCMA**), Microsystems and Nanotechnologies for Chemical Analysis (**MiNoS**), Physics and Crystallography of Nanomaterials (**FiCNA**), Heterogeneous Catalysis (**CATHETER**) and Experiments, Computation and Modelization in Fluid Mechanics and Turbulence (**ECoMMFiT**).

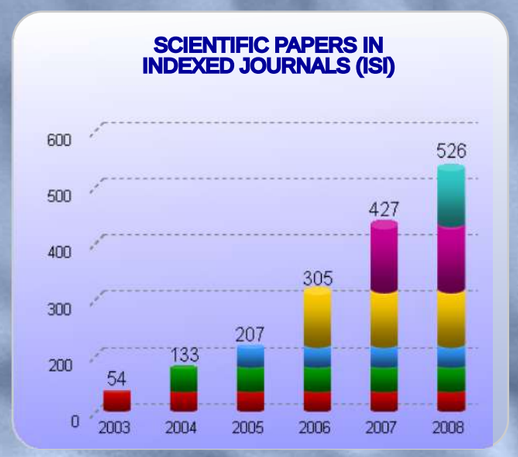
RESEARCH AT EMaS

RESEARCH LINES

RESEARCH GROUP	COORDINATOR	RESEARCH LINES
NePhoS	Lluis Marsal	- Technologies of fabrication and functionalization of “band gap” photonic materials. - Modelization and characterization of “band gap" photonic materials. - Development of physical models for advanced electronic devices: thin layer transistors, nanometric MOSFETs and advanced devices based on Silicon.
FiCMA	Francesc Diaz	- Photonic devices development. - Design, fabrication and characterization of laser crystals, NLO crystals and photonic crystals.
MiNoS	Eduard Llobet	-Design, modelization, fabrication, characterization and testing of new materials for microsensor systems. - Development of pre-concentrator microsystems. - Development of advanced methods for signal conditioning and processing.
FiCNA	Magdalena Aguiló	- Design, fabrication and characterization of epitaxies, nanoparticles and nanostructured materials for optics and photonics.
CATHETER	Jesús Suerias	- Fabrication and characterization of materials with catalytic interest. - Green chemistry and environmental catalysis. - Design of catalytic reactors. - Synthesis and characterization of nanomaterials.
ECoMMFiT	Josep Anton Ferré	- Modelization and simulation of industrial and environmental fluxes. - Modelization of the turbulence. - Heat and material transfer. - Computational and experimental techniques in fluid mechanics.

RESEARCH CONTRIBUTIONS (2003-2008)





APPLICATION FIELDS

- Performing simulation of industrial processes controlled by hydrodynamics (with or without chemical reaction).
- Performing technical studies in the environment field. Prevention and prediction of pollutants dispersion.
- Offering the service of intensive calculatios for simulation or analysis of huge data volumes.
- Assembling and operating industrial equipment models to scale.

EQUIPMENT

- Specialised own set of programs to compute fluid mechanics and measure heat and mass transport.
- Particle Image Velocimetry system for measuring the flux rate in complex systems.
- Planar Laser Induced Fluorescence (PLIF) equipment for diagnosing mixing processes in fluxes.
- High velocity video camera (250 images/second).

OTHER INFORMATION

The group has experience with testing industrial equipment models with flux problems to scale for the chemical industry. The group also has experience with contracts to numerically model high pressure and/or temperature processes for the chemical industry. ECoMMFiT also have experience with impact prediction problems of pollutants dumps to the sea and to the atmosphere. The group has elaborated a prediction set of programs of fluid flux and mass and/or heat transport in industrial equipments. The team group regularly publishes in specialized journals.

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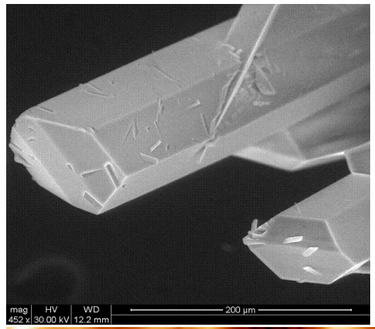

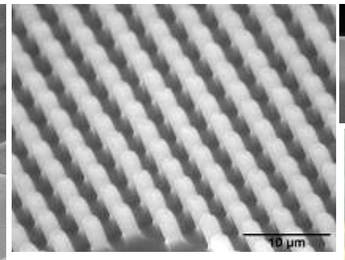

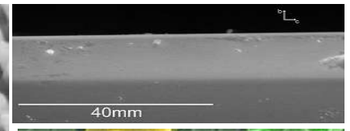

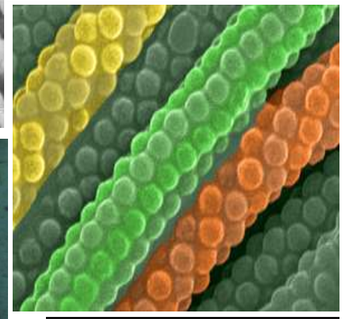

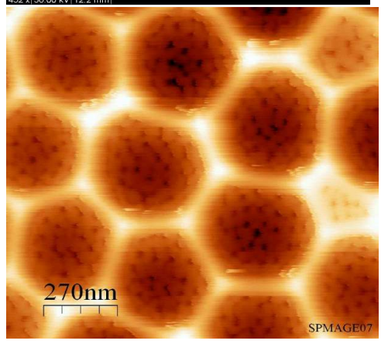

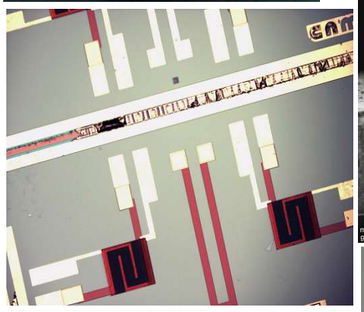

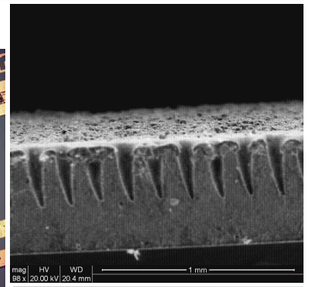

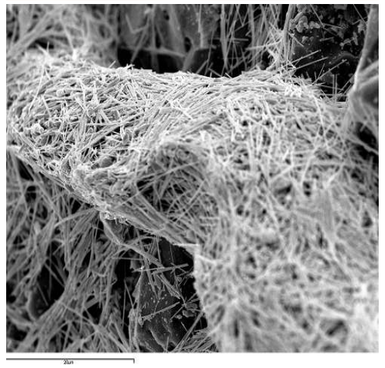

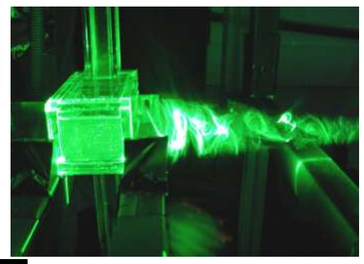

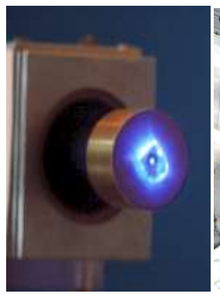

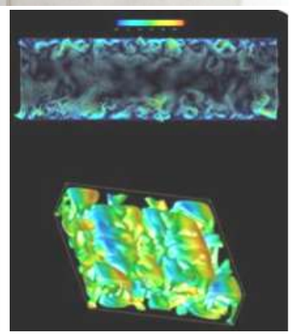

EMaS
Engineering of Materials and micro/nanoSystems Research Centre

A centre for materials and micro/nanotechnology research

HISTORY OF EMaS

After the favourable assessment of theCommission of Academic Ordination and Research on 18th April 2007, the Government Council of the Rovira i Virgili University (URV) on the 2nd May 2007, approved to initiate the process to create the Research Centre on Materials and micro/nanoSystems, EMaS. The Council entrust the EMaS team with the elaboration of the strategic plan for the centre.

The Government Council of the Rovira i Virgili University (URV) on the 10th July 2008 approved the strategic plan and the internal rules of EMaS.

The EMaS Research Centre was definitively created with the signature of the agreement to impulse the centre development between the Rovira i Virgili University and the Centre on the 22nd September 2008.

THE EMaS MISSION

The EMaS mission is doing research, technologyand knowledge transfer and training in the field of new materials and mciro/nanosiystems, especially those related to the development of new technologies for health, energy, communications, sustainable chemistry and the environment.

- Research mission: the initial research framework of EMaS was configured by the current research lines of each of the six founder research groups which contribute with those research lines related to the EMaS research field. This framework will be extended and/or adapted to those research fields boosted by the Programme Framework of the European Union, National Research Plan, etc and to those fixed by the Direction Council of EMaS and the Rovira i Virgili University.

- Technology transfer mission: is an own activity of EMaS the transfer of technology and knowledge to the productive sector in the fields commented above of health, energy, communications, sustainable chemistry and the environment.

- Training mission: an important objective of EMaS is the training of PhD and postdoctoral researchers in the scientific and technological framework of the centre. EMaS want to create an own doctorate and master programme. to contribute to this education.

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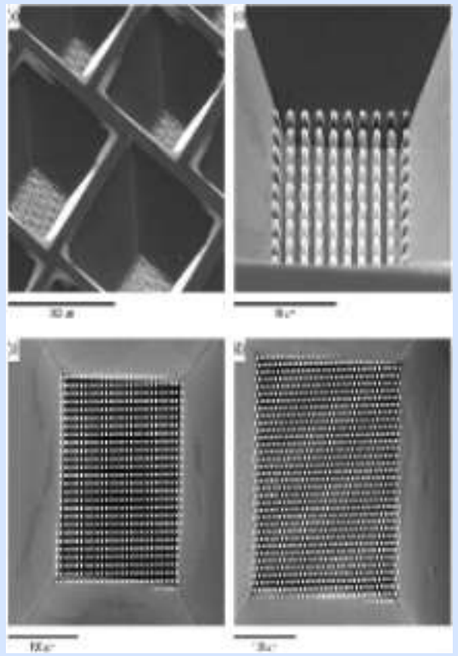
Nanoelectronics and Photonic Crystals Research Group



The research activity of the NePhoS group is devoted to the study of electronic and photonic devices based on the silicon technology. The current revolution in the field of communications and new technologies has generated a great demand of new devices and systems able to process faster the information with a lower energy-consuming and a minimum size.
The task of the group can be divided in 3 parts: the first one is devoted to photonic crystals. Photonic crystals are structures with a periodic refraction index which allow controlling efficiently the light transmission without losses. The propagation of light is much faster than the electric signal and it can transmit therefore more information. The research group has worked on the design, simulation and characterization of photonic devices based on silicon photonic crystals. The second part is devoted to the development of a technology based on macroporous and nanoporous silicon. The idea is to fabricate photonic crystals through the arrangement of micropores using a material very used in electronics like silicon. The infiltration of pores of materials with non linear properties would give rise to dynamic or active photonic crystals. Nanoporous structures through porous alumina can also be fabricated. The third part is devoted to the development of physical models of electronic advanced devices. The continuous integration and miniaturization of electronic devices demands new models.

ACTIVITY LINES

- Design, modelization and characterization of lineal and non-lineal photonic crystals.
- Development of a technology based on arranged macroporous and nanoporous silicon. A technology based on arranged nanoporous alumina is also developed. The optic and electric properties and the application of these materials in microsystems are studied.
- Development of physical models of advanced electronic devices: thin film transistors (TFTs), nanometric sized MOSFETS and hetereounion devices based on silicon.

APPLICATION FIELDS

- Design, synthesis and characterization of materials and catalytic converters and their application to industrial processes of hidrodecolouring, hydrogenation, oxidation and polymerization of fine chemistry regarding the environment.
- Treating industrial effluents with a high organic and/or chlored compounds charge with medium oxygen demand levels (DQO).
- Studying reactions at the laboratory and in the industrial plant.
- Instrumental analysis of solid and liquid materials.
- Development of catalytic sensors.
- Treating contaminated effluents with nitrates and nitrites.

OTHER INFORMATION

The group has experience with contracts in the industrial chemical sector. CATHETER has generated 8 patents during the last 12 years which have been or are currently running:
A catalytic converter which selectively hydrogenates adiponitrile to 6-aminocapronitrile (III) (P9501856).
A catalytic converter which selectively hydrogenates adiponitrile to 6-aminocapronitrile (II) (P9501855).
A catalytic converter which selectively hydrogenates adiponitrile to 6-aminocapronitrile (I) (P9501854).
A nickel catalytic converter which selectively hydrogenates 6-aminohexanonitrile (89 02378).
A catalytic converter which selectively hydrogenates adiponitrile (89 01745).
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EQUIPMENT

- Equipment of continuous and discontinuous reactions in laboratory and pilot plants.
- Physical adsorption of nitrogen: Micromeritics ASAp 2000.
- Infrared: Bruker Equinox 55
- Thermobalance: Labsys/Setaram TG DTA/DSC.
- Desorption at a programmed temperature: Fison Gtmd 150.
- Chemical adsorption of hydrogen: Micromeritics Pulse Chemisorb 2010.
- Electronic microscope Jeol jsm-35 c.
- X- ray diffraction: Siemens d 5000
- Mass detector: Tpdro 1100011
- Liquids chromatograph HPLC.
- Organic matter analyser (TOC).
- Reduction, oxidation and desorption at a programmed temperature (TPR/D/O).
- Microwave

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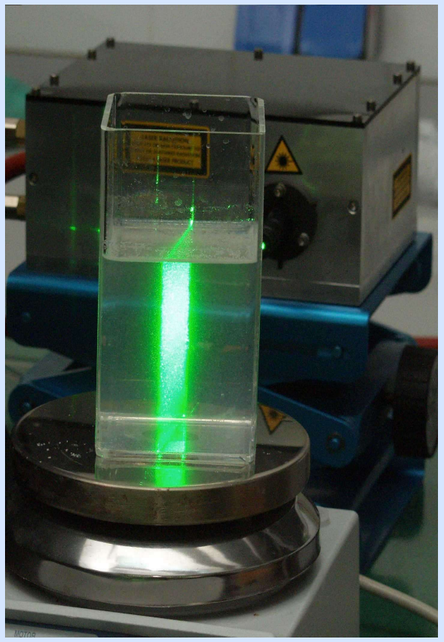
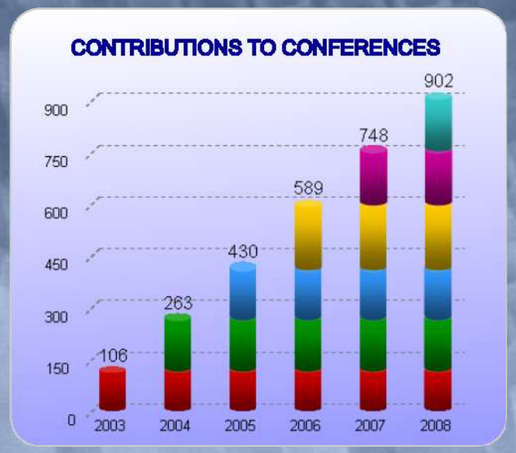
Experiments, Computation, and Modelization in Fluid Mechanics and Turbulences Research Group





ACTIVITY LINES

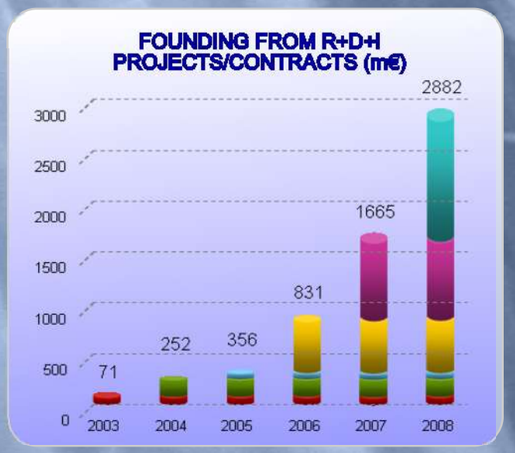
The research group ECoMMFiT (Experiments, Computation and Modelization of Fluid Mechanics and Turbulences) uses computing and experimental tools to create mathematical models for analysing any kind of processes involving fluids. These models allow preventing the behaviour of fluids and determining their effects in heat and mass transport.

The research done in the group includes from the study of the refrigeration of electric components by forced convection to the big scaled fluxes of the environment related to e.g. pollutants dispersion and the prevention of accidental dumps to the sea.

The group have also a huge experience with using statistical data and to acquire and process images.

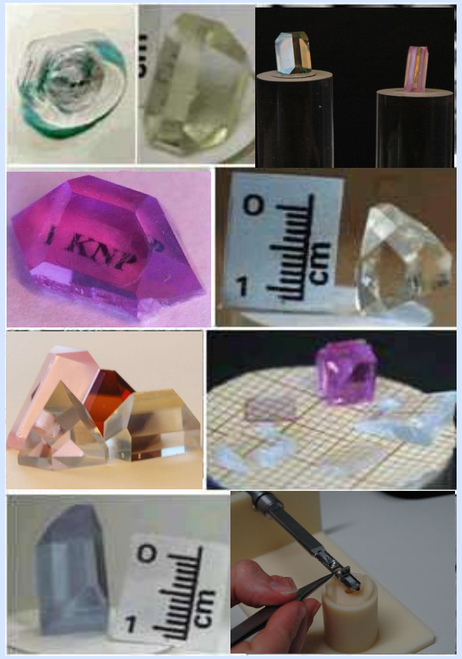
- Development and application of Large Eddy Simulation (LES) codes to predict mass and heat transport in natural and/or industrial fluxes.
- Study of flux structures and whose effect on mass and heat transport and chemical reactions.
- Characterization of turbulent fluxes using Particle Image Velocimetry (PIV) techniques.
- Turbulence analysis using Pattern Recognition techniques and Fuzzy Clustering.

TECHNOLOGY TRANSFER (2003-2008)



Física i Cristal·lografia de Materials
FiCMA
Universitat Rovira i Virgili

Physics and Crystallography of Materials Research Group



ACTIVITY LINES

The research group FiCMA studies the physical, chemical, and crystallographic properties of any material. The mechanical, magnetic, thermal, acoustic and optical properties can be measured in the group's laboratories. A part from this expertise, the FiCMA group is specialized in the genesis and characterization –physical and crystallographic- of new volumic, epitaxial and nanostructured materials to be used in laser and photonic devices. The group work also in superconductor and ionic superconductor materials and in porous semiconductor materials whit energetic applications. The research performed in this group has developed and internationally patented new solid state laser materials -blue and green lasers- which have been already transferred to the industry. The use of these materials in data storage equipments will allow essentially increasing their capacity. The potential market of these lasers is related to audio, video, printing, computing products, etc.

- Chemical, physical and crystallographic characterization of materials.
- Synthesis and characterization of new optic materials (laser, non-linear optics,…).
- Development of new solid state laser materials.
- Synthesis of epitaxial materials with optic and photonic applications.
- Synthesis of nanostructured optical materials.
- Synthesis and characterization of superconductor materials.
- Synthesis and characterization of nanoporous semiconductor materials.
- Synthesis and characterization of new ionic superconductor materials.

APPLICATION FIELDS

- Synthesis of nanoparticles of optical materials to fabricate ceramic materials.
- Synthesis and crystal growth of nanoparticles using different methods.
- Sintering of nanoparticles to fabricate transparent ceramic materials.
- Crystallographic characterization of materials: characterization of crystallization zones, polymorphs identification, thermal and mechanical texturation of materials, and dilation of materials.
- Preparation and treatment of surfaces. Identification of texture of materials.
- Development of technologies of energy generation: development of new nanoporous semiconductor catalytic converters for hydrogen production by water molecule breaking.
- Development of new hydrogen storage devices based on nanoporous semiconductors.
- Nanostructuring and characterization optical materials to be applied as photonic crystals.
- Nanostructuring and characterization laser and non lineal optical materials to be applied in integrated phonics.

OTHER INFORMATION

The group has experience with contracts in the public and private sectors in all fields related to materials. The team group has experience with the use of synchrotron light sources and neutron reactors for materials characterization.

EQUIPMENT

- Furnaces for thermal treatments.
- Equipments of high temperature crystal growth
- Temperature programmers EUROTHERM.
- Diamond automatic saw STRUERS.
- Polish machine Logitech PM5.
- Spectrophotometer UV-Vis-NIR, Cary 500- Varian.
- Refraction index measurement equipment METRICON.
- Antivibrations optical table, TMC.
- Emission spectrophotometer.
- Optical Parametric Oscillator (OPO).
- Monochromator HR460 Jobin Yvon-Spex.
- Infrared cool Detector Hamamatsu R5509-72 and visible PMT.
- Amplifier lock-in EG&G 7265DSP
- Non lineal optical properties measurement equipment with Nd laser.
- Nd:YAG Laser.
- Ti:zafir Laser.
- He-Ne Laser.
- Various diode lasers.
- Cryostat with closed circuit of 6 K Leybold RDK 6-320.
- Cryostat with closed circuit of 10 K Oxford instruments.
- Impedances bridge HP-4284A.
- Oscilloscope HP-54616B de 500 Mhz.
- Lock-in with various performances.
- Piezoelectricity measurement equipment.
- Confocal and interferometric microscope.
- Mill of agate balls.
- Differential i thermal analysis.
- Layer coating equipment by Spin-coater.
- X-ray powder and texture diffractometers D5000, Siemens.

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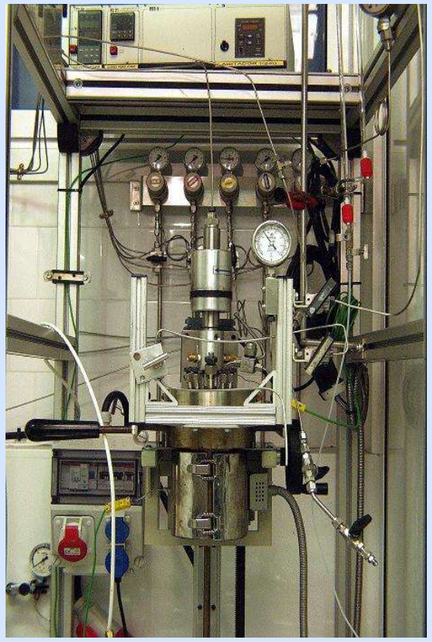
CATÀLISI HETEROGÈNIA

Heterogeneous Catalysis Research Group



ACTIVITY LINES

Heterogeneous catalytic converters are substances that accelerate the chemical reactions having a different physical state from that of the reactants. This type of catalytic converters minimize the generation of subproducts and so of residues. This feature supposes great economic and environmental advantages for the production industry and for any technological process regarding the environment.

The Heterogeneous Catalysis group works with the aim to synthesize new materials and study their properties to develop new heterogeneous catalytic converters to be applied in chemical reactions of interest. The growing tendency of the pharmaceutical industry to use heterogeneous catalytic processes to minimize residues is a good example of the environmental advantages of heterogeneous catalytic converters.

- Hidrodecolouring of chloroaromatics.
- Selective conversion of CFC en HFC.
- Selective hydrogenation of mononitriles and dinitriles.
- Catalytic oxidation of organic matter in aqueous phase. Elimination of the organic charge (DQO) and of nitrites from aqueous industrial residues.
- Catalytic hydrogenation of nitrates and nitrites in water.
- Development of new catalytic materials to be applied in organic compound sensors (VOC).
- Catalytic conversion of methanol in light olefins in supercritical conditions.
- Catalytic and partial hydrogenation of poliolefins.
- Enantioselective hydrogenation.
- Isomerization of terpenes.
- Selective oxidation of olefins to obtain epoxyds and aldehydes.
- Aldolic condensation reactions.
- Selective hydrogenation of carbon tetrachloride to chloroform.
- Nitrogen-oxygen separation.

APPLICATION FIELDS

- Design, simulation and modelling of electronic and photonic devices with high performances: thin film transistors (TFTs), nanometric sized MOSFETS, photonic crystals, wave guidelines, optic filters, active lents, etc.
- Development of applications of electronic and photonic devices: optical fibber, active filters.
- Electrical and optical characterization of electronic and photonic devices.
- Advising in the knowledge fields of the group.
- Organization of training courses for experts in their knowledge fields.

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OTHER INFORMATION

Currently, the group participate in the research projects:
- Photonic crystals and gas sensors based on macroporous silicon TEC2005-02038.
- Tuneable photonic crystals based on silicon TEC2006-06531.
- Catalan Network of Materials and Photonic Devices.
- Research supported by one European Network of Excellence (SINANO).
- Techniques of characterization and modelling of nanoscale MOSFETs for RF and microwave applications TEC2005-06297.

NePhoS is a consolidated research group by the Generalitat de Catalunya (SGR-00359). The group is experienced in giving courses on optical fibber for professionals from the industry. It collaborates with national and international research groups.

EQUIPMENT

- Spectrograph Spectra-Pro 150. Spectral characterization, reflexion and transmission measurements in the NIR-Visible-UV range.
- Spectrometer FTIR Bruker Model Vertex 70 with global and tungsten sources covering the NIR-MIR range (from 830 nm and 25 nm). Detectors DLaTGS at room temperature and MCT refrigerated with liquid nitrogen to increase its sensibility. Reflectance accessory with variable angle between 12º and 90º.
- Photoluminescence equipment Avantes, with pulsed xenon light source Avalight-XE, optical fibber FC-UV600-2 and miniaturized spectrometer AvaSpec 2048.
- Optical microscope Zeiss Axio Imager with lenses form 25x to 500x, with bright and dark field illumination and polarised light.
- Chemical desk, electrochemical cells, electronic equipment of control and measurements, etc.
- Parameter analyser HP4145B allowing tracing the current-n tension features.
- Capacitymeter HP4280A allowing measuring capacity versus time and tension.
- Impedance analyser HP4192A allowing measuring the dependence between capacity and frequency.
- Electrometer Keithley 619 which measures highly resistive elements.
- Tip equipment Karl-Süss PM5 for micrometric devices measurements.
- Cryogenic measurements equipment and temperature controller (80 K 730 K).
- Microelectronic design software Medici.

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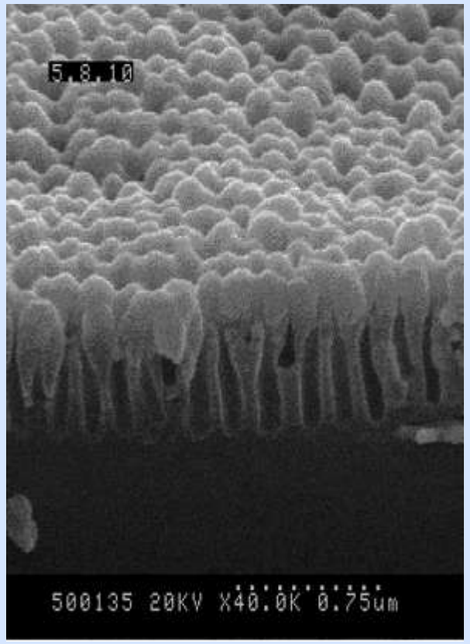
Microsystems and Nanotechnologies for Chemical Analysis Research Group



The MiNoS research group is fundamentally working in the design, fabrication and characterization of chemical microsystems which are applied to measure volatile compounds. During the fabrication of the components (sensor matrixes, microconcentrators, microreactors, etc) the power consume is minimized by using silicon micromechanized substrates. The active layers are synthesized and deposited using nanotechnologies which leads to nanostructured materials (carbon nanotubes, metallic oxides, polymers, etc) with an excellent active layer.

The group is also working in the development of applications of multisensor and gas/smell spectroscopy (GC-MS) systems.

ACTIVITY LINES

- Development of micro and nano technologies for gas chemical microsystems using nanostructured materials.
- Research in advanced signal processing algorithms for multisensor systems and for data coming from mass spectrometry and NMR.
- Development of multisensor systems applications and electronic nose.

APPLICATION FIELDS

- Design and fabrication of microsystems for detection of gas and toxic or explosive vapours at concentration of ppb in the fields of security and environment.
- Detection and classification of complex volatile compounds and/or aliment's smells, perfumery products, products from biological processes, etc.

EQUIPMENT

- Gas sensor characterization equipment.
- Automated laboratory for developing multisensor systems for detection and classification of smells.
- Equipment GC-MS.
- Laboratory of synthesis and deposition of micrometric and nanometric active layers (carbon nanotubes, metallic oxides, polymers, etc)
- Laboratory of electronic devices.

OTHER INFORMATION

The research team is composed by around twenty people (professors, students, researchers, technicians, etc). This group receives funding from the European Union, from the National and European governments and industry and private organizations. MiNoS is a consolidated group by the Generalitat de Catalunya. The group team regularly publish in the best journals of the field and has international patens, some of those are licensed. The group has also experience with technology transfer projects to the industry.

CONTACT DETAILS

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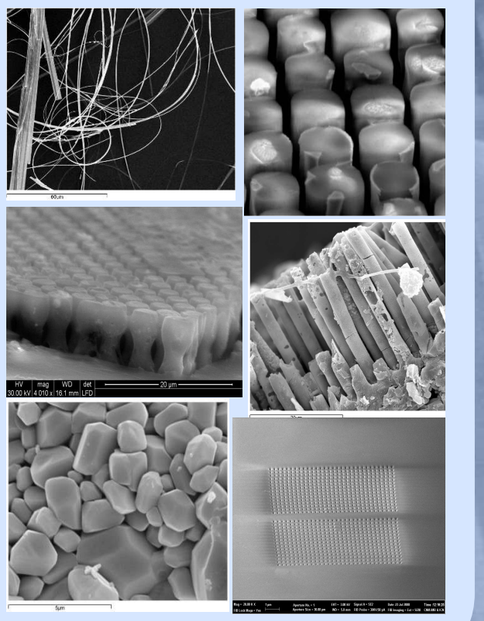
EMaS
CENTRE DE RECERCA
RESEARCH CENTRE

Physics and Crystallography of Nanomaterials Research Group



ACTIVITY LINES

The research group FiCNA is specialized in the synthesis, crystal growth and physical, chemical and crystallographic characterization of dielectric and semiconductor materials nanometric sized or nanostructured. The group studies the optical, luminescent and structural properties of these materials. The main research fields of the group are: epitaxial layers of optical materials with laser or non linear optical properties, synthesis and crystal growth of nanoparticles of materials with optical properties, sintering of these nanoparticles, nanostructuring of thin layers to develop photonic crystals and materials for integrated photonics, and synthesis and characterization of nanoporous materials with energetic applications. The applied research of the group covers also the structural characterization of these materials using big equipments like synchrotron and neutron light sources in high resolution neutron diffraction and x-ray absorption and topography.

- Synthesis and characterization of nanoparticles.
- Microstructuring of materials and their characterization.
- Development of ceramic materials with photonic applications.
- Synthesis of epitaxial materials with optic and photonic applications.
- Development of nanostructured photonic crystals.
- Synthesis and characterization of nanoporous semiconductor materials.

APPLICATION FIELDS

- Development of technologies and applications in the field of lasers and non linear optics: performance of thermal treatments of materials, crystallographic oriented cutting and polishing of materials, and preparation of surfaces of high optical quality.
- Crystallographic characterization of materials: characterization of crystallization zones, polymorphs identification, thermal and mechanical texturation of materials, and dilation of materials.
- Evaluation of physical processes related to materials.
- Preparation and treatment of surfaces. Identification of the texture of materials.
- Development of equipments including superconductor materials.
- Development of technologies of energy generation: development of combustible batteries including ionic superconductor materials, development of new nanoporous semiconductor catalytic converters for hydrogen production by water molecule breaking, and development of new hydrogen storage devices based on nanoporous semiconductors.

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OTHER INFORMATION

The group has experience with contracts in public and private sectors in all fields related to materials. FiCMA has generated an international patent: “Growth and applications of KYb(WO4)2 single crystals doped with lanthanides (P200100219)” and has developed the utility model: “Equipo de Detección de Vetas Blancas en Vidrio REFLECTASOL”.

The team group has synthesized and characterized superconductor materials which allow energy transport without losses.

EQUIPMENT

- Furnaces for thermal treatments.
- Equipments of high temperature crystal growth
- Temperature programmers EUROTHERM.
- Diamond automatic saw STRUERS.
- Polish machine Logitech PM5.
- Spectrophotometer UV-Vis-NIR, Cary 500- Varian.
- Refraction index measurement equipment METRICON.
- Antivibrations optical table, TMC.
- Emission spectrophotometer.
- Optical Parametric Oscillator (OPO).
- Monochromator HR460 Jobin Yvon-Spex.
- Infrared cool Detector Hamamatsu R5509-72 and visible PMT.
- Amplifier lock-in EG&G 7265DSP
- Non lineal optical properties measurement equipment with Nd laser.
- Nd:YAG Laser.
- Ti:zafir Laser.
- He-Ne Laser.
- Various diode lasers.
- Cryostat with closed circuit of 6 K Leybold RDK 6-320.
- Cryostat with closed circuit of 10 K Oxford instruments.
- Impedances bridge HP-4284A.
- Oscilloscope HP-54616B de 500 Mhz.
- Lock-in with various performances.
- Piezoelectricity measurement equipment.
- Confocal and interferometric microscope.
- Mill of agate balls.
- Differential i thermal analysis.
- Layer coating equipment by Spin-coater.
- X-ray powder and texture diffractometers D5000, Siemens.

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