The Catalan Institute of Nanoscience and Nanotechnology
Contextual Background

- CERCA centres: Non-profit foundations created by the Catalan Government since early 2000’s to promote R&D excellence
- Linked to ICREA programme to attract talent: 240 professorships (41% in CERCA institutes; 293 of 2940 applicants selected; 48% foreign nationality; 62% recruited from abroad)
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- Largest public Science institution in Spain; 3rd largest in Europe
- Basic and Applied R&D; Technology Transfer; Sci/Tech Consulting; Training; Dissemination of Scientific Culture, etc.
- Physical, Natural, Life and Social Sciences; Humanities; and Food/Agriculture
- In Spain: 6% of all R&D personnel → 20% of all scientific production
- Major research infrastructure: laboratories, technical facilities, libraries, databases and public repositories
Mission:
To become an international centre of reference in Nanoscience and Nanotechnology.

Core activities:
• Frontier Basic and Applied Research in N&N
• Technology Transfer
• Public Outreach

Role in Society:
To facilitate the adoption and integration of nanotechnologies in Catalan society and industry.
**ICN2: In numbers**

*(as at April 2014)*

**Annual Budget:** ~€10 million

**Sources:** Patrons & Public Agencies: 43%, Competitive Funding: 52%, Companies: 5%

**Total staff:** ~ 200

- **Demographics:** 44% female, 70% are 35 or younger
- **Researchers:** 170 (130 staff + 40 visiting)
- **Professorships:** 8 ICREA Research Profs and 3 CSIC Research Profs
- **Fellowships:** 6 ERC-SG (3 current + 3 past), 1 Marie Curie, 4 RyC and 2 JdIC
- **Organisation:** 15 Research Groups and 4 Technical Divisions

**Scientific Output:** ~170 indexed publications annually

- ICN2 awarded Severo Ochoa Centre of Excellence, only 18 in all Spain;
- ICN2 is in the top-ten of all Spanish R&D centres in all measures of excellence *(ICONO Scimago Report 2013)*

**Total laboratory space:** ~2,000 m²

**Key facilities:** electron microscopes (SEM, S/TEM, TEM), R2R NIL; FIB; XPS; Nanomoke, wet chemistry labs, access to clean rooms (CNM, UAB, ICMAB)
ICN2: Frontier research

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<tr>
<td>ICN2: Devices and end-products</td>
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<td>Analytical instruments</td>
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Collaboration with Industry
Nanotargeting SL, a biotechnology company that operates in the field of nanoparticles, and pharmaceutical firm Ferrer Grupo SA have signed an agreement to develop a new cancer treatment that uses gold nanoparticles functionalised with Cisplatin.

The idea was conceived by Dr Víctor Puntes (ICN), and developed in collaboration with the University of Santiago de Compostela, the University of Valencia, and Hospital de la Santa Creu i Sant Pau.

The team's research findings have been summarised in a patent application, the rights of which have been acquired by Nanotargeting SL.

The ambitious project is supported by three pillars: the participation of renowned research groups; capital and management provided by experienced business investors; and the invaluable assistance of a powerful pharmaceutical group.
Generalitat of Catalonia and the city halls of Barcelona and Sant Adria de Besos have dedicated a tract of land near Forum, Telefonica R&D and the new UPC Engineering faculty for the establishment of top-level international investment projects in new academic, research and value-added business activity.

The aim is to attract: public and/or private institutions of international renown in the field of knowledge and with a solid relevant history in their area of activity.

- Value-added business activity
- Research institutions
- Higher education institutions

ICN2 and the other leading research centres were expressly invited to submit proposals. The call closed 7th May 2013.

http://www.barcelonakey.cat
Vision

To bring together all the necessary actors –

researchers, testing and certification laboratories, training providers, instrumentation providers, industry consultants and legal experts

- in a participative and collaborative environment to promote the development of expert nanometrology standards, techniques, services and training, at the service of local, European and global industry.
Key Consortium members (proposed)

- The UK’s National Centre for Metrology, responsible for certification and standards,
- Member of international groupings on nanometrology.

- ICN2
  - Largest Nano centre in Spain,
  - Privileged access to Bellaterra Nanocluster (ALBA Synchroton, CNM cleanroom),
  - Full scope from theory to bio to materials.

- Industry Partners
  - Multinational metrology services, equipment and/or training providers

- Others
  - Equipment providers
  - Engineering Faculty UPC
  - Technology Centres
  - Advanced manufacturing cluster

- NPL
  - The UK’s National Centre for Metrology, responsible for certification and standards,
Overview of ICN2 Groups and Divisions...
ICN2 Research Lines:
15 Research Groups

Nanoscale Manipulation and Characterization
- SPM: STM, AFM
- PES, XRD, ...

NanoBioSensing Devices
- Biosensors
- Bioanalysis
- Biofunctionalization
- Bioelectronics

Theory and Simulation
- Atomistic Simulations
- Electronic Transport

Nanodevice Fabrication and Properties
- Spintronics
- Magnetic Nanostructures
- Oxide Nanoelectronics
- Photonics and Phononics

Chemical Routes to Nanostructures
- Supramolecular Chemistry
- Inorganic Nanoparticles
- Energy-oriented materials
Advanced Electron Nanoscopy, GAe-N Group
ICREA Professor Jordi Arbiol

Structural and Chemical characterization of Materials down to the Atomic Scale and Correlation to their Electronic and Optical properties

Focus areas
• In-situ photonics and plasmonics at the nanoscale
• 3D structure of materials at atomic scale
• 3D atomic modeling
• Growth mechanism studies
• Correlation of the physical and chemical properties of materials and devices with the atomic distribution

Expertise: Plasmonics; Photonics; Optics; Nanomaterials structural and chemical characterization, 3D Atomic Modeling
Advanced Electron Nanoscopy,
GAe-N Group
ICREA Professor Jordi Arbiol

Techniques and Analyses for Industry

Techniques
- Scanning and Transmission Electron Microscopy: SEM - TEM
- Electron Diffraction (SAED, CBED,…)
- Electron Spectroscopies (EDX, EELS, CL,…)
- 3D Atomic Modeling of Nanostructures
- Image Simulation

Analyses
- We offer detailed chemical, morphological and structural analyses of materials at the Nano and Atomic Scales
- 3D analyses of the chemical composition in nanostructures
- Atomic localization of impurities and doping atomic species
Advanced Electronic Materials and Devices
ICREA Prof Jose A. Garrido

Focus areas:

• Fundamental electronic and electrochemical phenomena of novel materials, such as graphene and other 2D’s
• Technology and nanofabrication for advanced electronic devices and systems
• Bioelectronics & Biomedical Technologies: cell bioelectronics, flexible implant, neuroprosthetics
• Electronic & electrochemical biosensors based on 2D materials
• Novel 2D materials for energy storage and conversion

Expertise:
CVD synthesis; Device technology and nanofabrication; flexible technologies; device physics; cell bioelectronics; biosensors; electrochemistry; surface functionalization;
Facilities/Services:
- CVD reactors for graphene and 2D materials
- Confocal Raman spectroscopy
- Electronic and electrochemical characterization of materials and devices
- Bioelectronic lab: patch-clamp, multielectrode and transistor recording units, cell cultures
Atomic Manipulation and Spectroscopy Group
Dr Aitor Mugarza

Electronics and magnetism of nanoscale systems

Focus areas:
• Charge donation and spin manipulation at the single-molecule level
• Study and manipulation of electronic and magnetic phenomena at surfaces
• Materials studies (metal-organic and graphene-based heterostructures)
• Atomic scale interface engineering

Expertise:
Molecular Electronics; Magnetism; Single atom manipulation; Scanning Tunnelling Microscopy; Synchrotron Radiation Spectroscopy
Lattice vibrations and light-matter interaction in nanoscale condensed matter

Focus areas:

• Nanoscale thermal and acoustic effects in films, multilayers, interfaces and device-like nanostructures → management and conversion of heat
• Coupling of light to periodic structures → enhanced light extraction efficiency in displays and light sources
• Directed self-assembly of block-copolymers → next generation of lithography and novel heterogeneous nanomaterial.
• New concepts in nm-scale measurements → novel metrology techniques and instruments

Expertise: Nanophononics; Nanophotonics; Thermoelectrics; Nanofabrication; Nanometrology.
Collaboration with Industry and Technology Centres:

Joint R&D, Analysis, Characterisation and Solutions for industry and Technology Centres:

- Intel Ireland
- THALES Research & THALES Avionics
- microresist technology GMbH
- NILTechnology
- IBM Zurich, Infineon
- CITEDE Ingenieros
- LEITAT, CETEMMSA
- Tecnalia, Innovaalia
- VTT Technical Research Centre of Finland

Patents:

- In-line contactless dimensional nanometrology (mid 2013)
- Software for ordering and defectivity assessment in nm-scale (mid 2013)
Laboratory of Nanostructured Materials for Photovoltaic Energy
Dr Monica Lira-Cantu

Synthesis of photoactive nanomaterials, and design, fabrication and testing of photovoltaic cells

Focus areas
- New solar-cell concepts and device design
- Nanostructured materials for next-generation solar cells (dye sensitized, hybrid and small-molecule organic solar cells)
- All-solution processable devices
- Optical and electrical characterisation
- Outdoor and accelerated stability analyses of solar cells
- Stability studies following ISOS protocols

Expertise
Organic and Inorganic Synthesis; Electrochemistry; Photochemistry; Nanofabrication; Solar Cell Testing;
Collaborations
- IBERDROLA: flexible small molecule organic solar cells
- RISO-DTU, IMEC, ECN, etc.
- Group CONNECT-EU: photonics and printed electronics network
- XARMAE: Catalan Energy Network

Patents
- Seven (four on solar cells)
Synthesis and applications of novel supramolecular materials, and development of surface chemistry by Nanolithography

Focus areas
• Synthesis of new organic and supramolecular superstructures, including Metal-Organic Frameworks (MOFs)
• Femtoscale chemistry via tip-based Nanolithography
• Discovery and development of new techniques for the fabrication of novel nanomaterials

Expertise
Organic Synthesis; Metal-organic synthesis Synthesis; Dip-Pen Nanolithography (DPN); and Micro- and Nanoencapsulation
Services, Commercial Endeavours and Patents

Services offered:
Micro- and Nanoencapsulation of active ingredients for commercial products, and consulting on industrial scale-up

Commercial endeavours based on Micro- and Nanoencapsulation:
• Laundry detergents and softeners with long-lasting scent (non-disclosed company)
• Antifungal paints (Chemipol)
• Slow-release disinfectants and antiseptics (non-disclosed company)

Patents and technology transfer contracts:
• Method for the preparation of metal organic frameworks (2011)
• Metal-organic system for the encapsulation and release of compounds of interest, method for obtaining and uses thereof (2009)
• Technology Transfer Contract signed with the company LUCTA in 2010. Product on market since May 2013
• Technology Transfer Contract signed with the company Chemipol in 2012
Design, fabrication and clinical applications of nanobiosensor devices and lab-on-chip platforms; and technology transfer into commercial products

Focus areas
- Plasmonic and Nanoplasmonic Biosensors
- Silicon nanophotonics Biosensors
- MEMs based-opto-nanomechanical Biosensors
- Biomimetic nano-optomechanical sensors
- Lab-on-chip integration
- Biofunctionalisation of surfaces
- Clinical and Environmental Applications

Expertise: Plasmonics; Integrated Optics and Optoelectronics; Surface Biofunctionalisation; Immunochemistry; Genomics; Bioanalytical Applications; Miniaturisation; and Microelectronics Integration
Services, Commercial Endeavours and Patents

Services offered (through CIBER-BBN):
• Biodeposition: fabrication of custom biochips using Nano eNabler™ surface biofunctionalisation system
• Surface Plasmon Resonance (SPR): real-time, label-free measurements of biomolecular interactions

Commercial endeavours based on biosensors:
• SENSIA, SL (Mondragón Group)
• BIOD, SL
• Technology Transfer Programme of Botín Foundation

Patents: (8 families of patents)
• Interferometer and sensor based on bimodal optical waveguide and detection method PCT/ES08/070142 (2008); CA2760272, CN101842691 Granted (2013), US20100271634 Granted (2012), JP20100533849
Inorganic Nanoparticles Group
ICREA Professor Víctor F. Puntes

Services and Commercial Endeavours

Services offered
• Nanoparticle synthesis (up to gram scale)

Commercial endeavours (company)
• Gold nanoparticles for delivery of cisplatin (NanoTargeting)
• Gold-nanoparticle jewellery (Gold Light)
Design and Fabrication of nanomaterial-based sensors and biosensors for diverse areas of life

Focus areas
• Nanomicrofluidics, Nanochannels and Nanomotors
• Catalytic/carrier nanomaterials
• Paper nanobiosensors
• Graphene and related materials for sensing applications
• Sensors for Health, Environment, and Safety & Security

Expertise
Nanobiosensing Technology; Analytical Chemistry; Electrochemistry; Microprinting; Lab-on-a-Chip Technology; Ink-Jet Printing; Screen Printing; Lateral Flow Technology
Services and Commercial Endeavours
• Vetgenomics (spin-off from UAB) through European project POC4PETS, on point-of-care diagnostics for pets
• Collaboration with Fluigent (France) through European Project NADINE, on nanotechnology for molecular diagnostics and imaging

Patents
• Method for cell identification and quantification with gold nanoparticles through hydrogen ion reduction (2008)
Nanostructured Functional Materials Group

CSIC Research Scientist Daniel Ruiz

Design, synthesis and applications of advanced (supra)molecular systems: colloids, micro/nano-particles and capsules, and surfaces)

Focus areas:
• Smart devices and molecular memories
• Theranostics
• Functional surfaces for improved performance

Expertise:
Organic, Supramolecular and Coordination Chemistry; Self-Assembly of Monolayers & Particles; Dip-Pen Nanolithography; Atomic Force Microscopy; Micro- and Nanoencapsulation; Bio-/Bioinspired Materials
Nanostructured Functional Materials

Services
- Micro- and Nanoencapsulation of active ingredients
- Synthesis of polymeric nanoparticles
- Characterisation of nanomaterials and surfaces
- Microscopy (Optical, Electron and Atomic Force)

Commercial endeavours
Micro- and Nanoencapsulation of photo/thermochromics, fragrances, bioactive systems, self-healing materials, etc.

Patents
- Metallo-organic system for the encapsulation and release of compounds of interest, method for obtaining same and uses thereof
- A process for preparing a material having hydrophobic and/or oleophobic properties and material thus obtained
- Regeneration medium suitable for use in heat exchangers and method associated with said medium
- Recubrimiento con propiedades fotocrómicas, método de obtención de dicho recubrimiento y uso aplicable a artículos ópticos y superficies acristaladas

CSIC Research Scientist Daniel Ruiz
Materials Science, Polymer Chemistry and Electrochemistry for energy-related applications

Focus areas:
• Hybrid nanocomposites for energy storage and conversion (Li batteries, supercapacitors)
• Polymers and hybrids for the development of PEM fuel cells working at high temperatures
• Novel hybrid nanocomposites (metals or metal Oxides + conducting polymers or biopolymers)
• Nanofluids (high-T, heat-transfer molten salts)

Expertise:
Inorganic Synthesis; Crystal Chemistry; Complex Nanoparticles and Nanostructures; Electrochemistry; Polymer Chemistry; and Materials Science
Commercial and Industrial Endeavours
• **Air Products**: Hybrid battery-supercapacitor devices
• **Air Products**: Application of AP Electrolyte as supercapacitor redox shuttle for overcharge protection
• **SOLECO**: New class of absorption surfaces for thermal solar panels
• **Schneider Electric**: New type of organic cathodes

Patents
• Membranas conductoras protónicas basadas en polímeros de tipo polibencimidazol y materiales híbridos y nanocompuestos derivados de los mismos (2003)
• Thermally stable catalysts comprising copper-silver mixed oxides, useful for oxidation of organic substrates, e.g. for the partial oxidation of alcohols (2003)
• Preparación de nuevos catalizadores basados en óxidos de plata y cobre y su uso en reacciones de oxidación (2002)
• Reversible electrochemical cells using hybrid organic-inorganic electrodes formed by organic conducting polymers and active inorganic species (1995)
Characterisation of magnetic materials

Focus areas
• Interactions in magnetic materials: thin films, lithographed nanostructures and core/shell nanoparticles
• Magnetoplasmonic effects in lithographed structures
• Advanced characterisation using neutrons and synchrotron

Expertise
Magnetic Characterisation; Nanoparticle Synthesis; Quantitative Analysis of Diffraction Measurements (X-ray and neutrons); X-ray Magnetic Circular Dichroism
Services

- Characterisation of magnetic materials by magneto-optic Kerr Effect and SQUID magnetometry
- Assistance in synchrotron and neutron measurements
- Synthesis of magnetic nanoparticles
Investigation and exploitation of interfacial phenomena arising from the nanostructuring of surfaces and from the interaction of surfaces with molecules

Focus areas
- Force Probe Microscopy & Spectroscopy
- Interfacial water (structured & confined water, wetting)
- Engineered surfaces (thin films: polymers, LB, etc.)
- Electronic properties of surfaces

Expertise
Surface Science; Atomic Force Microscopy; Synchrotron Radiation-based Electron Spectroscopies; Thin-Film Growth
Commercial Endeavours

- aim4np: European project on on-line Industrial Nanometrology, involving TU Delft (NL), TU Vienna (A), CSIC (E), NTCW (A), VSL (NL), NANOSURF (CH), NANOWORLD (D), SIOS (D), FLUBETECH (E) and other partners
Oxide Nanoelectronics Group
ICREA Professor Gustau Catalán

Study and manipulation of the properties oxide smart materials at the nanoscale
Our activity spans from fundamental research for high impact publications (Science, Nature Materials) to design and characterization of electromechanical devices.

Expertise:
• Ferroelectricity, magnetoelectricity, piezoelectricity, piezoresistance, flexoelectricity*.
• Functionality and phase transitions at the nanoscale.

Unique Facilities:
• Atomic Force Microscopy, including in-situ control of temperature, magnetic field and atmosphere: http://youtu.be/V1zLszaeDIU
• Dynamic Mechanical Analyzer for hardness and piezoelectric test.
• Digital Holographic Microscope for sub-nanometric profilometry and electrobending characterization.

*Flexoelectricity: electricity generated by bending. We have Europe’s only flexoelectricity lab, funded by an ERC grant (1.5M Euros).
Electromechanical device design, characterization and fabrication
Our collaboration with the device company IGS allows turning ideas for electromechanical devices into functional prototypes enclosed in market-ready packaging, in months-time-frame
https://www.youtube.com/watch?v=LGNEDZeH3cs&feature=youtu.be
Charge and electron spin transport in nanoscale solid-state devices

Focus areas:
• Design and fabrication of nanodevices
• Mesoscopic spin and charge transport for future magnetic memories and logic devices
• Thermoelectrics. Spin caloritronics for energy harvesting
• Quantum manipulation and control
• Electronic properties of Graphene, Topological Insulators and Metals

Expertise:
Spintronics; Quantum Control and Computation; Nanomechanics; Thermoelectrics; Nanofabrication.
Physics and Engineering of Nanodevices
*ICREA Prof Sergio O. Valenzuela*

**Facilities/Services:**
- Radiofrequency transport characterization (up to 50 Ghz)
- Ultralow temperature electrical measurements (down to 15 mK)
- Molecular beam epitaxy of metals

**Patents:** 3 (nanoelectromechanical switch x 2; amplitude spectroscopy)
Expertise in Quantum transport in nanomaterials (graphene, topological insulators, nanotubes, nanowires, organic materials, DNA…)

Development of (order N) Quantum Transport Methodologies (Kubo, Hall Kubo, Landauer-Büttiker)

Quantum device simulation

Collaboration with companies

C.R. Physique 10, 283-296 (2009)
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<td><strong>General Scientific Services</strong></td>
<td>Instrumentation for Physical and Chemical Characterization</td>
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<tr>
<td><strong>Nanoscience Instrument Development</strong></td>
<td>Design and development of advanced state-of-the-art instruments for nanoscience and nanotechnology.</td>
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<tr>
<td><strong>Electron Microscopy</strong></td>
<td>Scientific and technical support to the research lines of ICN2 and neighboring research centres</td>
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<tr>
<td><strong>Nanofabrication</strong></td>
<td>Design and development of nanofabrication methods for nanoscience and nanotechnology research and applications.</td>
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<tr>
<td><strong>Nanomaterials Growth</strong></td>
<td>Facility to grow nanostructured materials by means of several growth techniques (PLD, CVD, ...) and characterize them (XDR, PES, ...)</td>
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Common Equipment and Services
Dr Gustavo Ceballos

- Cost effective centralisation of technologies and equipment
- State-of-the-art equipment and technologies
- Highly qualified personnel
- Expertise, advice and training

Common Equipment and Services
# Common Equipment and Services

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<td>Vertex 80 coupled with Hyperion 2000</td>
<td>Bruker</td>
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<td>Tensor 27 coupled with PMA 50</td>
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<td>UV-Vis</td>
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<td>X Ray Diffractometer</td>
<td>X`PERT PRO MRD</td>
<td>Panalytical</td>
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<tr>
<td>X Ray Diffractometer</td>
<td>X`PERT PRO MPD</td>
<td>Panalytical</td>
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<td>Contact Angle Measuring Instrument</td>
<td>Easy Drop</td>
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<td>Optical Microscope</td>
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<td>U410 Premium Freezer</td>
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<td>Haier</td>
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<td>Nano ZS</td>
<td>Malvern</td>
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<td>Inductively Coupled Plasma Mass Spectrometry (ICP-MS)</td>
<td>NexION 300</td>
<td>Perkin Elmer</td>
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<td>Liquid Chromatography with Mass Spectrometry or UV-vis (LC-MS)</td>
<td>Flexar SQ300</td>
<td>Perkin Elmer</td>
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<td>Thermogravimetric Analysis (TGA)</td>
<td>Pyris 1 TGA</td>
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<td>Incubator</td>
<td>W95170</td>
<td>Fisher Scientific</td>
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<tr>
<td>Laminar Flux Cabinet</td>
<td>BIO II A</td>
<td>Telstar</td>
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<tr>
<td>Microplate Reader</td>
<td>Asys UVM340</td>
<td>Biochrom</td>
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Integrated scientific-technical platform and a permanent growing repository of know-how to develop novel scientific instruments for Nanotechnology

Science
Scientific background of the project

Design
Planning and CAD design of precision hardware

Hardware
Precision mechanics and electronics

Software
Data acquisition, instrument control and scientific computing

New and challenging experiments
Instrument Development Division
Dr Gustavo Ceballos

Services
- Projection, design and development of instrumental set-ups for Nanotechnology
- Vacuum Technology
- CAD design
- Cryogenics
Advanced Electron Microscopy techniques for Nanoscience and Nanotechnology research and applications

Expertise

• High resolution imaging (SEM, TEM, Z-contrast STEM)
• Surface sensitive imaging (LV-SEM)
• Chemical analysis at the nanoscale (EDS,EELS,EFTEM)
• Structural characterisation by electron diffraction
• Electron tomography
• In-situ humidity and heating experiments

Type of samples (up to 8”, conducting and isolating)

• Nanoparticles and nanotubes
• Multilayered materials
• Complex heterostructures
• Biological samples (e.g. cells and tissue)
• Organic compounds and drugs
Electron Microscopy Division
Dr Belén Ballesteros

Services

Quanta 650 FEG ESEM
High-resolution imaging
EDX spectroscopy
Composition mapping
In-situ heating experiments
In-situ humidity experiments

Magellan 400L XRSEM
Surface-sensitive imaging
Surface & structure

Tecnai F20 HR(S)TEM
High-resolution TEM
Z-contrast STEM
Chemical analysis by EDX, EELS
Structure determination
3D characterisation
Development of advanced nanomanufacturing technologies for high-tech applications; and lithography for rapid prototyping and cost-effective solutions

Focus areas (support for ICN2 research groups)
- Photonics and phonon engineering
- Biosensors
- Organic electronics
- Heat management

Expertise
Nanoimprint and Nanoprint Lithographies; Roll to Roll Processing; Directed Self Assembly-Graphoepitaxy; and Electron Beam Lithography
Nanofabrication Division
Core competences

Nano devices
- BCP graphoepitaxy
  - 500 nm
- Bi-metallic IDE’s
  - Pt, Au
  - 100 nm
- 2 Photonic crystals
  - ~200 nm

Samples for Nanometrology
- Colloidal crystal growth

Prototyping
- 3-dimensional polymer structuring
- 400 nm wide nanochannels
- Three level structuring
Nanofabrication Division
SoA processing chain

- Master stamp
- Working-stamp generation
- Step and stamp/Upscale
- R2R imprint
- Imprint on flexible polymer
- Imprinted structures

Printing speed: 0.5 to 1 m/min
Resolution: < 50 nm @ 0.6 m/min
Thin film deposition and advanced characterisation

Focus areas
• Thin film and multilayer deposition of complex oxide materials
• Ultrathin film structure characterisation by X-ray Diffraction
• Film surface morphology and microstructure studies

Expertise
Pulsed Laser Deposition; Metal Organic Chemical Vapour Deposition; X-ray Diffraction; Atomic Force Microscopy
Services
Thin film deposition of complex heterostructures
(small area – test probes)
Advanced X-ray characterisation:
• Grazing incidence XRD
• X-ray reflectivity
• High temperature/controlled atmosphere analysis
• surface reactivity: oxidation/reduction kinetics

Materials
• Multifunctional materials (electric/magnetic)
• Optical/hard coatings
• Composite thin films (cer-met)
THANK YOU

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