

# ICN ANNUAL REPORT 2011

CREATING A DIMENSION OF INFINITE POSSIBILITIES



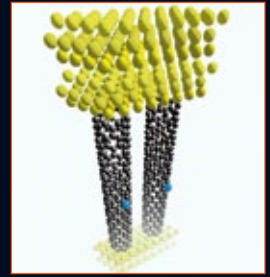
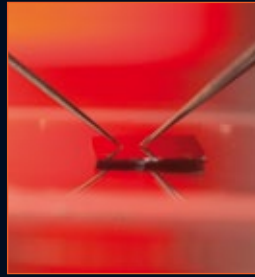
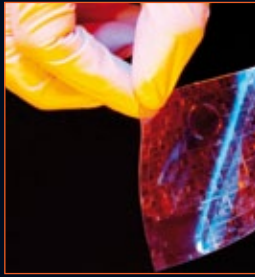
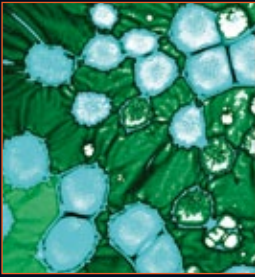
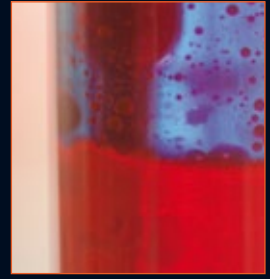
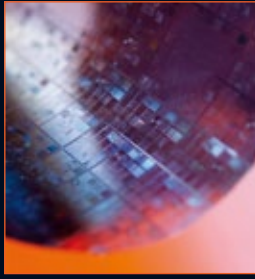
Institut Català  
de Nanotecnologia



Annual Report 2011  
Institut Català de Nanotecnologia  
ICN Communication Department

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# LETTER FROM THE DIRECTOR

# 1



2011 was a splendid year at the Catalan Institute of Nanotechnology (ICN), which continues to grow and improve on all fronts.

Firstly, last year marked the consolidation of ICN's ninth Research Group, the Supramole-

cular NanoChemistry and Materials Group (NANO<sup>UP</sup>), which has strengthened ICN's capabilities in creating new functional architectures for basic research and for industrial collaborations with various companies.

In terms of scientific advances, 2011 was spectacular. All of ICN's Groups and Divisions generated high impact results. Whilst the number of publications in 2011 was nearly the same as in 2010, the average impact factor rose from an already excellent 5.77 to a remarkable 7.81. These results have resonated strongly in the scientific community: in 2011, ICN researchers had a total of 174 international conference appearances (81% were oral presentations, and 51%, invited talks or plenary sessions).

In 2011, ICN researchers amassed various honours. For example, Prof Arben Merkoçi won the 2011 International Association of Advanced Materials (IAAM) Medal; Dr Amèlia Barreiro won the Spanish Royal Physics Society's prize for Best Young Investigator in Experimental Physics; and Dr Daniel Maspoch was named ICREA Research Professor.

ICN continues to attract research projects, especially international ones. In fact, 60% of ICN's research funding corresponds to European projects. Moreover, our success rate in European project applications is around 48%, compared to an EU-wide average of only 21%. Amongst the most prestigious grants awarded in 2011 was a European Research Council (ERC) Starting Grant won by Prof Adrian Bach-told. In terms of highly strategic projects, ICN has a preeminent role in two of the six Pilot Ac-

tions that are competing in the ambitious FET European Flagships programme: Graphene-CA and Guardian Angels.

Despite the recent and lingering economic crisis, ICN has managed to consistently increase its annual budget: from 2006 to 2011, income grew on average by €1.2 million annually. Furthermore, ICN has grown its technology transfer business with private companies, which in 2011 accounted for just over 5% of total income. Consequently, the weight of government contributions to ICN has gradually shrunk: they now account for less than 50% of ICN funding.

At ICN we recognise that society will be demanding ever greater returns on public investment in research. Thus, I would like to highlight our progress in transferring knowledge and technology to the productive sector in 2011. ICN applied for three new patents and signed various contracts with corporate partners. Especially noteworthy was our licensing-out of a patent for delivery of the chemotherapy drug cisplatin via gold nanoparticles, to the start-up Nanotargeting, created expressly for this objective. For drug development in this project, ICN and Nanotargeting work closely with the pharmaceutical company Ferrer.

In addition to research, I would like to underscore our commitment to fostering professional development and further training, to providing our staff members with an array of attractive benefits and to fomenting a culture of teamwork.

I invite you to explore the rest of ICN's Annual Report 2011, in which you will find detailed summaries on our Research Groups, Technical Divisions, and Management—three closely intertwined pillars working together to make ICN a reference for scientific excellence and a model of operational efficiency.

Kindest regards,

Jordi Pascual  
Director



# 2 ORGANISATION AND PEOPLE

## 2.1 Organisation

The Catalan Institute of Nanotechnology (ICN) is a non-profit international research institute located in Barcelona, Spain. It was created in July 2003 by the Ministry of Universities, Research and Information Society of the Catalan Government (DIUE) and the Autonomous University of Barcelona (UAB).

ICN is led by its Director, Dr Jordi Pascual, who reports to the Board of Patrons and is advised by the Scientific Advisory Board, made up of numerous distinguished international scientists.

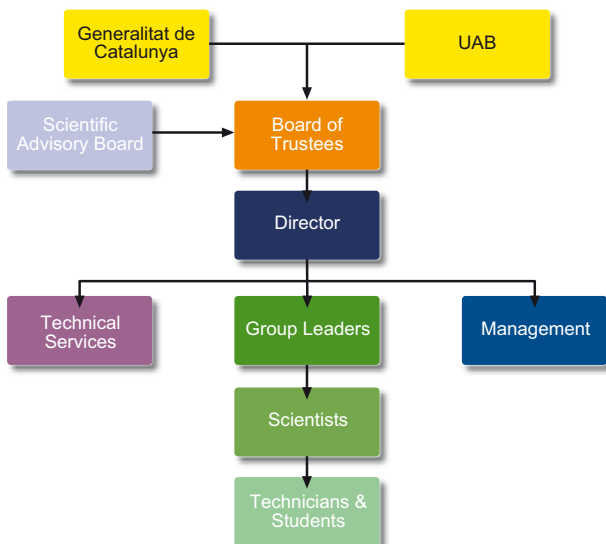
Research activities are directed by Research Group Leaders—senior scientists of international repute that lead research teams focused on their respective areas of expertise, and that are supported by specialised laboratory engineers and technical and administrative staff.

In 2011 ICN increased its number of core Research Groups from eight to nine, thereby expanding its research lines:

- Atomic Manipulation and Spectroscopy Group
- Inorganic Nanoparticles Group
- Magnetic Nanostructures Group
- Nanobioelectronics and Biosensors Group
- Phononic and Photonic Nanostructures Group
- Physics and Engineering of Nanodevices Group
- Quantum Nanoelectronics Group
- Supramolecular Nanochemistry and Materials Group
- Theoretical and Computational Nanosciences Group

During 2011 ICN's three Technical Development & Support Divisions (Electron Microscopy; Nanofabrication; and Nanoscience Instrument Development), created the previous year, strengthened their collaborations with ICN's Research Groups. This enabled greater scientific output, establishment of new infrastructure and awarding of new European projects.

## 2.2 Organisational Chart



## 2.3 Board of Patrons

### **PRESIDENT**

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**Andreu Mas-Colell,**

Minister of Economy and Knowledge, Generalitat de Catalunya

### **VICE-PRESIDENT**

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**Ana Ripoll,**

Chancellor of the Universitat Autònoma de Barcelona (UAB)

### **MEMBERS**

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**Antoni Castellà i Clavé**

General Secretary of Universities and Research, Ministry of Economy and Knowledge, Generalitat de Catalunya

**Josep-Maria Martorell i Rodon**

Director of Research, Ministry of Economy and Knowledge, Generalitat de Catalunya

**Carles Jaime i Cardiel**

Vice Chancellor for Strategic Projects at the Universitat Autònoma de Barcelona (UAB)

**Prof Miquel Salmerón**

Principal Researcher at Lawrence Berkeley National Laboratory; Berkeley, California, USA; appointed by the Generalitat de Catalunya

**Prof Dolores Baró**

Professor of Physics at the Universitat Autònoma de Barcelona (UAB); appointed by the UAB

## 2.4 Scientific Advisory Board 2010

### **PRESIDENT**

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**Prof Miquel Salmerón**

Principal Researcher at Lawrence Berkeley National Laboratory; Berkeley, California, USA

### **MEMBERS**

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**Prof Jeff Bokor**

Department of Electrical Engineering and Computer Sciences, University of California, Berkeley; and Deputy Director for Science, The Molecular Foundry, Lawrence Berkeley National Laboratory

**Prof Fernando Briones**

Professor of Research in the Microelectronics Institute of Madrid (IMM - CSIC); Madrid, Spain

**Prof Manuel Cardona**

Co-founder and emeritus professor of the Max Planck Institut; Stuttgart, Baden-Württemberg, Germany

**Prof Bruno Chaudret**

Director of Laboratoire de Physique et Chimie des Nano-Objets (LPCNO); Toulouse, France

**Prof Sylvia Daunert**

University Research Professor; Distinguished Professor, College of Arts & Sciences; and Gill Eminent Professor of Analytical and Biological Chemistry, University of Kentucky; Lexington, Kentucky, USA

**Prof Bengt Kasemo**

Professor of Physics at the Department of Physics, Chalmers University of Technology; Gothenburg, Sweden

**Prof Jörg P. Kotthaus**

Professor of Experimental Physics at the Ludwig-Maximilians-Universität München; Munich, Bavaria, Germany

**Prof Ernst Meyer**

Professor of the Institut für Physik, University of Basel; Basel, Switzerland

**Prof Anthony Turner**

Head of Biosensors & Bioelectronics Centre IFM, Linköping University; Linköping, Sweden



# 2 ORGANISATION AND PEOPLE

## 2.5 The people of ICN

ICN is defined by its people. From senior researchers to administration staff, ICN personnel work as a team, contributing their creativity, energy, dedication and hard work to further the Institute.

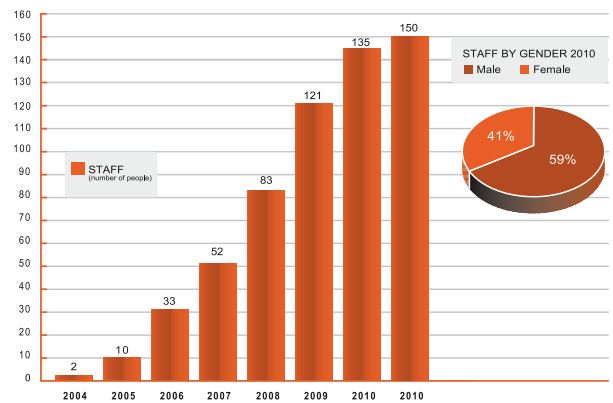
ICN prides itself on being an attractor of talent, seeking to provide an environment and an image of excellence that draws talented scientists, technicians and support personnel from around the world. The Institute has succeeded in this endeavour, as embodied in its highly-qualified scientific staff and demonstrated by its high level of scientific output. Half of the researchers who have completed a doctoral thesis or post-doctoral stay at ICN have moved on to other research organisations, including highly prestigious institutes such as Harvard, Yale, the Max Planck Institut, CNRS and CEA. Thus, ICN is continuously offering new positions for junior scientists.

In response to greater competitive funding and increased scientific hiring in 2010, ICN set for 2011 a target workforce of 150 people (starting from 135). Over the course of the year, ICN achieved this goal. Recruitment reached a historic peak, as the Institute fully consolidated its management and administrative needs and met its human resources objectives.

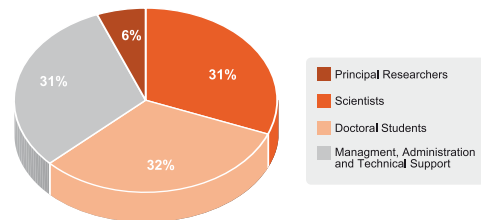
ICN is an equal opportunity employer and seeks a workforce diverse in age, race, nationality and gender. By the end of 2011, ICN personnel represented 32 different nationalities; women comprised 41% of all personnel, a 2.5% increase over the previous year.

## 2.6 Statistics

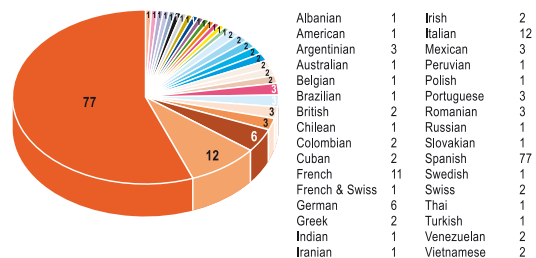
STAFF EVOLUTION 2004-2011



ICN STAFF BY ROLE 2011



ICN STAFF NATIONALITIES 2011





### 3.1 Atomic Manipulation and Spectroscopy Group

Led by ICREA Research Professor Pietro Gambardella, the Atomic Manipulation and Spectroscopy Group investigates fundamental concepts in magnetism and molecular electronics, seeking to control the interplay among the structural, electronic and magnetic properties of nanoscale systems. The Group combines Scanning Tunnelling Microscopy (STM) techniques with magnetotransport experiments and Synchrotron Radiation Spectroscopy in order to link microscopic phenomena to macroscopic observables relevant to understanding and designing new materials and devices.



From L to R: C.O. Avci., C. Krull, S. Godey, A. Murgaza, S. Schirone, K. Garelo, A. Lodi, M. Ollé, C. Nistor, P. Gambardella. Not shown: G. Peschel, J. Kavich, M. Miron, S. Alvarado, S. Matencio, S. Schirone, T. Balashov

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## NEW PROJECTS & MILESTONES

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In 2011, the Group continued its work in two major research projects:

**Materials for Enhanced Spin-Orbit Effects in Spintronics (MESO-ES)**, funded by the Spanish Ministry of Science and Innovation, and **Nanoscale Magnetization Dynamics (NOMAD)**, funded by the ERC.

### MESO-ES

MESO-ES is aimed at investigating the growth, structural and magnetic properties of thin films and nanostructures characterised by enhanced spin-orbit (Rashba and Dresselhaus) interactions. These studies have direct implications for the design of devices that store and process magnetic information.

# 3

## RESEARCH

### 3.1 Atomic Manipulation and Spectroscopy Group

#### NOMAD

The objective of NOMAD is to develop frontier approaches to control the magnetodynamic properties of nanometre-sized molecular and metallic elements. As metal-based materials constitute the mainstay of present magnetic technology, their electric-field actuation would enable simpler, more power-efficient devices for processing magnetic information using electrical signals.

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#### KEY PUBLICATIONS AND INVITED TALKS 2011

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**Perpendicular switching of a single ferromagnetic layer induced by in-plane current injection**, I. M. Miron, K. Garello, G. Gaudin, P.-J. Zermatten, M. V. Costache, S. Auffret, S. Bandera, B. Rodmacq, A. Schuhl, and P. Gambardella, *Nature* **476**, 189 (2011)

**Spin coupling and relaxation inside molecule-metal contacts**, A. Mugarza, C. Krull, R. Robles, S. Stepanow, G. Ceballos, and P. Gambardella, *Nature Comm.* **2**, 490 (2011)

**Coupling single molecule magnets to ferromagnetic substrates**, A. Lodi Rizzini, C. Krull, T. Balashov, J.J. Kavich, A. Mugarza, P.S. Miedema, P.K. Thakur, V. Sessi, S. Klyatskaya, M. Ruben, S. Stepanow, and P. Gambardella, *Phys. Rev. Lett.* **107**, 177205 (2011)

**Mixed-valence behavior and strong correlation effects of metal phthalocyanines adsorbed on metals**, S. Stepanow, P. Miedema, A. Mugarza, G. Ceballos, P. Moras, J. Cezar, C. Carbone, F. de Groot, and P. Gambardella, *Phys. Rev. B* **83**, 220401(R) (2011)

**Self-assembled nanoscale magnetic networks on surfaces: fundamental interactions and functional properties**, C. Carbone, S. Gardonio, P. Moras, S. Lounis, M. Heide, G. Bihlmayer, N. Atodiresei, P. H. Dederichs, S. Blügel, S. Vlaic, A. Lehnert, S. Ouazi, S. Rusponi, H. Brune, J. Honolka, A. Enders, K. Kern, S. Stepanow, C. Krull, T. Balashov, A. Mugarza, and P. Gambardella, *Adv. Funct. Mater.* **21**, (2011)



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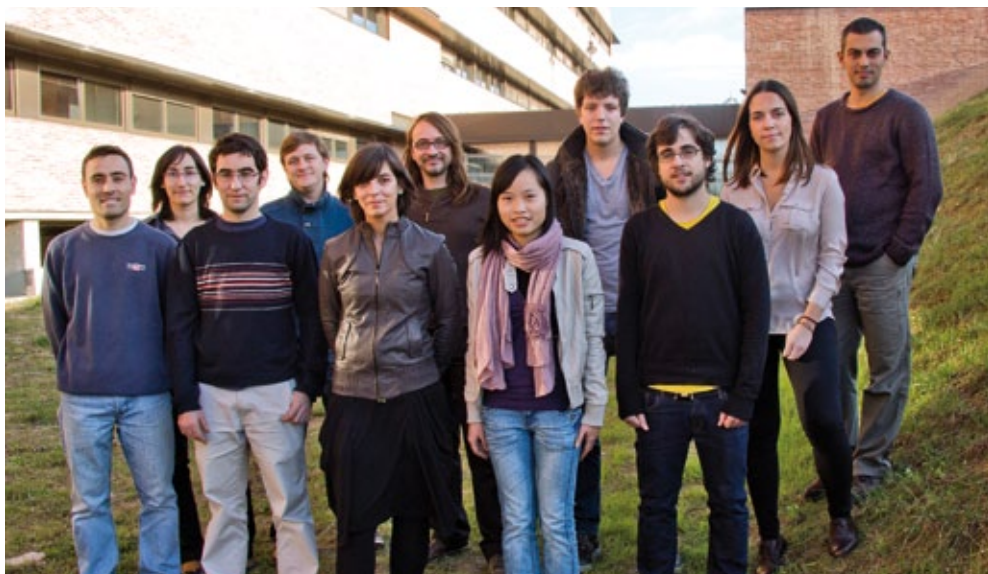
#### OTHER ACTIVITIES 2011

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Prof Gambardella taught two courses for the Master's in Nanotechnology and Materials Science at Universitat Autònoma de Barcelona (UAB):

- Nanoscale Surface Characterization
- Magnetic Properties, and Physics at the Nanoscale

The Inorganic Nanoparticles Group, led by ICREA Research Professor. Víctor Puntès, works on the synthesis, characterisation and application of engineered inorganic nanoparticles. By controlling the size, shape and structure of the inorganic core, and selectively linking biologically active molecules to the nanoparticle surface (either during synthesis or afterwards, once the nanoparticles have been introduced into a biological environment), the Group seeks nanoparticles that target, or otherwise interact with, specific systems (biological, medical, materials, etc.). The Group places special emphasis on the safety, scale-up, applicability and other aspects of nanoparticle engineering and design.



From L to R. **Front row:** I. E. Casals, J. Comenge, N. Bastús, N. Tran, J. Piella. **Back row:** M. Varón, V. Jamier, V. Puntès, M. Busquets, S. Rubio and I. Ojea. Not shown: C. Lopez and L. Garcia

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## NEW PROJECTS & MILESTONES

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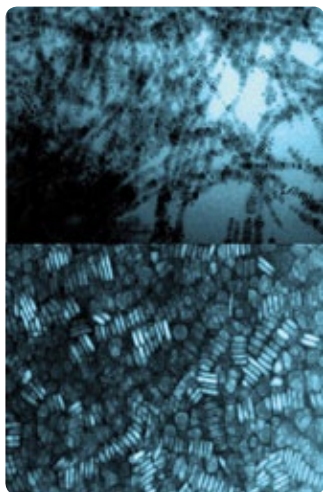
In addition to its several on-going research projects, the Group began participating in QNANO, a competitive grant programme in nanomaterial safety testing that started in February 2011.

Postdoctoral researcher Dr Neus G. Bastús was awarded a Juan de la Cierva Fellowship, the most important Spanish fellowship for junior postdocs, for her project entitled “Synthesis of metal-semiconductor hybrid nanocrystals for energy conversion and catalysis”.

Postdoctoral researcher Dr Isaac Ojea Jiménez was awarded the Ramón Castillejo Scholarship for the Mobility of Young Researchers, to fund a stay at the University of Melbourne (Australia) for

his project “Síntesis avanzada de semiconductores bioconjugados como marcadores fluorescentes para aplicaciones biológicas”.

Lastly, the Group continued to play a leading role in ICN’s Centre for BioNanosafety and Sustainability (CNBSS).




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#### KEY PUBLICATIONS AND INVITED TALKS 2011

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**Carving at the nanoscale: sequential galvanic exchange and Kirkendall growth at room temperature**, E. González, J. Arbiol and V. F. Puntes, *Science*, 334 no. 6061, 1377–1380 (2011)

**Hardening of the Nanoparticle–Protein Corona in Metal (Au, Ag) and Oxide ( $\text{Fe}_3\text{O}_4$ ,  $\text{CoO}$ , and  $\text{CeO}_2$ ) Nanoparticles**, E. Casals, T. Pfaller, A. Duschl, G. J. Oostingh and V. F. Puntes, *Small*, 7, Issue 24, 3479–3486 (2011)

**Pt nanocrystal evolution in the presence of Au(III)-salts at room temperature: spontaneous formation of AuPt heterodimers**, Lim, S. I., Varon, M., Ojea-Jimenez, I., Arbiol, J., & Puntes, V., *J. Mater. Chem.*, 21(31), 11518–11523 (2011)

**Ecotoxicity of, and remediation with, engineered inorganic nanoparticles in the environment**, Sánchez, A., Recillas, S., Font, X., Casals, E., González, E., & Puntes, V. *TrAC Trends in Analytical Chemistry*, 30(3), 507–516 (2011)

**Problems and challenges in the development and validation of human cell-based assays to determine nanoparticle-induced immunomodulatory effects**, Oostingh, G. J., Casals, E., Italiani, P., Colognato, R., Stritzinger, R.,

Ponti, J., Pfaller, T., Kohl, Y., Ooms, D., Favilli, F., Leppens, H., Lucchesi, D., Rossi, F., Nelissen, I., Thielecke, H., Puntes, V. F., et al., *Part. Fibre Toxicol.*, 8(1), 8, (2011)

**Taming physicochemical signatures of inorganic NPs for their biological integration**, Invited talk, Bionano@Nice, eMRS 2011, Symposium O: Bio-materials for imaging, sensing and actuating, Nice, France (May 2011)

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#### OTHER ACTIVITIES 2011

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##### Teaching:

In 2010 Prof Puntes taught in the Nanobiomedicine Module of the Master’s in Nanotechnology and Materials Science at Universitat Autònoma de Barcelona (UAB).

##### Patents:

**Noble metal nanoparticles and their preparation process**, Franco Puntes, V.; González, E.E. (Institut Català de Nanotecnologia, Institutió Catalana de Recerca i Estudis Avançats), Patent # EP 11158024.7 (Priority date: 14-Mar-2011)

**Biogas production**, Franco Puntes, V.; Casals Mercadal, E.; González, E.E.; Font Segura, X.; Sánchez Ferrer, A.; García Mestre, A.; Delgado Ramisa, L. (Institut Català de Nanotecnologia, Institutió Catalana de Recerca i Estudis Avançats, Universitat Autònoma de Barcelona), Patent # EP 11157784.7 (Priority date: 11-Mar-2011)

##### Books:

**“Nanotechnology: Engines On”**, J. Saldaña Cavallé and V. Puntes, ISBN 978-84-615-3293-3 (<http://www.archive.org/details/NanotechnologyEnginesOn>)

Led by Prof Josep Nogués, the Magnetic Nanostructures Group seeks to improve the functional properties of diverse types of magnetic nanostructures. The group combines state-of-the-art lithography and chemical synthesis with structural, morphological and magnetic characterisation to research three areas: of lithographed magnetic nanostructures; magnetic nanoparticles; and other magnetic systems.



From L to R: J.F. López-Barbera, A. López and J. Nogués.

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## NEW PROJECTS & MILESTONES

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In 2011, the Group continued various on-going projects and began work on two new ones: MAGTUNE, and Ordered hetero- and Nano-structures with Epitaxial Dielectrics for magnetic and electronics Applications (ONDA).

### **MAGTUNE**

Tuning the magnetic properties of nanoparticles and lithographed structures by intrinsic and extrinsic parameters

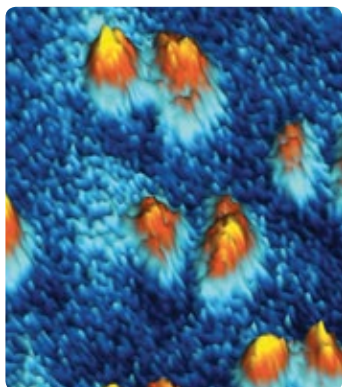
In this project, the Group employs different approaches to tailor and improve the magnetic properties of materials with special emphasis on nanostructures (patterned structures and nanoparticles) and thin-film materials. Different effects (or combinations of effects) are being studied (e.g. exchange interactions between dissimilar materials, shape or light-irradiation) and will be exploited to manipulate magnetic properties. The main goal is to better understand the role of different parameters on magnetic properties. The Group is especially interested in correlating structural



# 3

## RESEARCH

### 3.3 Magnetic Nanostructures Group



parameters (e.g. size or shape), magnetic parameters (e.g. anisotropies) and external stimuli (e.g. resonant light). This obtained knowledge will enable control over the magnetic properties of magnetic systems—namely, through the extra degrees of freedom introduced by the various controlled factors.

#### ONDA

The project brings together Spanish, French and Italian groups with two Russian institutes to study ultrathin nanostructured dielectric materials for advanced electronic applications. The Magnetic Nanostructures Group is involved

in the study of magnetically ordered nano-heterostructures on epitaxial antiferromagnetic fluoride surfaces.

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#### KEY PUBLICATIONS AND INVITED TALKS 2011

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**Designer magnetoplasmonics with nickel nanoferrimagnets**, V. Bonanni, S. Bonetti, T. Pakizeh, Z. Pirzadeh, J. Chen, J. Nogués, P. Vavassori, R. Hillenbrand, J. Åkerman and A. Dmitriev, *Nano Letters*, 11, 5333-5338 (2011)

**Two-, three-, and four-component magnetic multilayer onion nanoparticles based on iron oxides and manganese oxides**, G. Salazar-Álvarez, H. Lidbaum, A. López-Ortega, M. Estrader, K. Leifer, J. Sort, S. Suriñach, M.D. Baró and J. Nogués, *Journal of the American Chemical Society*, 133, 16738-16741 (2011)

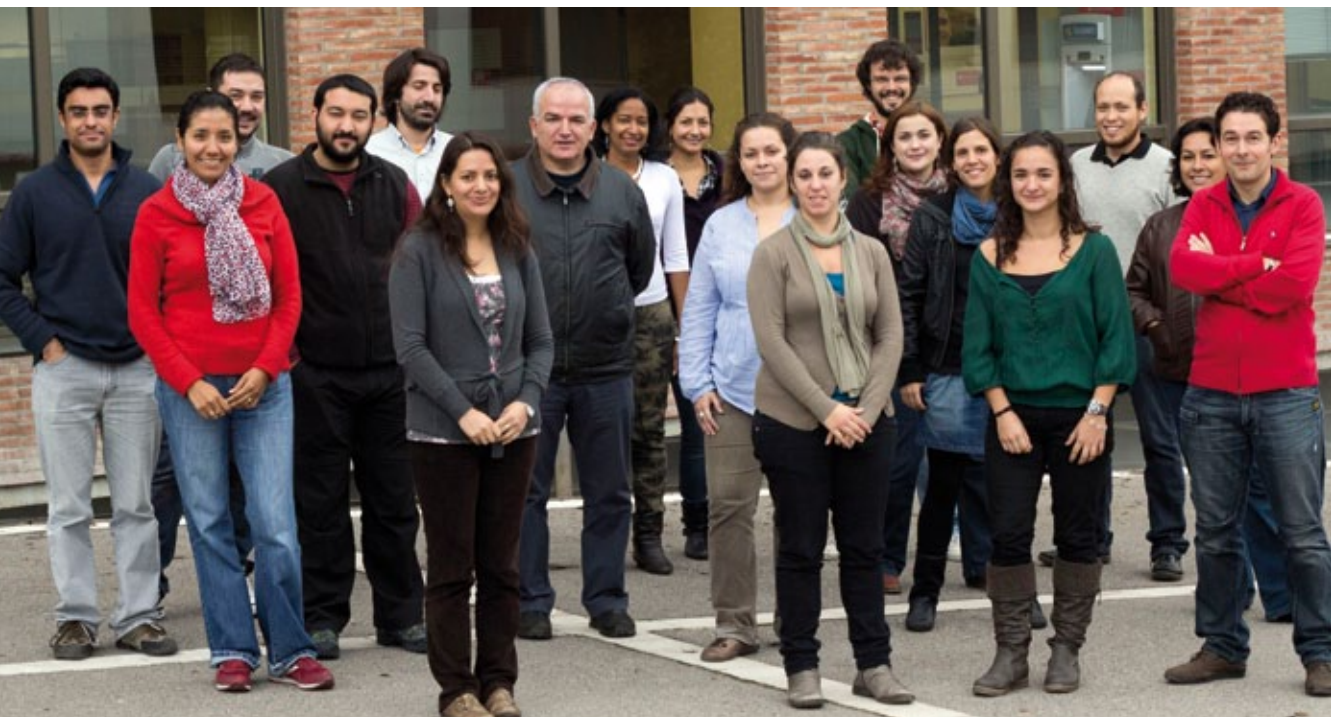
**Plasmonic Nickel Nanoantennas**, J. Chen, P. Albella, Z. Pirzadeh, P. Alonso-González, F. Huth, S. Bonetti, V. Bonanni, J. Åkerman, J. Nogués, P. Vavassori, A. Dmitriev, J. Aizpurua and R. Hillenbrand, *Small*, 7, 2341-2347 (2011)

**Grain boundary segregation and interdiffusion effects in nickel copper alloys: An effective means to improve the thermal stability of nanocrystalline nickel**, E. Pellicer, A. Varea, K. M. Sivaraman, S. Pane, S. Suriñach, M. D. Baró, J. Nogués, B. J. Nelson and J. Sort, *ACS Applied Materials and Interfaces*, 3, 2265-2274 (2011)

**Bi-magnetic core/shell nanoparticles**, M. Estrader, A. López-Ortega, G. Salazar-Álvarez, S. Estarde, J. Sort, F. Peiro, S. Suriñach, M.D. Baró and J. Nogués, Villa conference on interactions among nanostructures 21-25 April, Las Vegas, Nevada, USA, 2011 (Invited Talk)

**Novel structural and magnetic effects in passivated antiferromagnetic transition metal monoxides: inverted antiferromagnetic (AFM)/ferrimagnetic (FiM) core/shell nanoparticles**, J. Nogués, A. López-Ortega, M. Estrader, D. Tobia, E. Winkler, S. Estarde, I. Golosovsky, J. Sort, G. Salazar-Álvarez, F. Peiro, S. Suriñach, R.D. Zysler and M.D. Baró, International Conference on Composites/Nano Engineering, 24-30 July, Shanghai, China, 2011 (Invited Talk)

The Nanobioelectronics and Biosensors Group, led by ICREA Research Professor Arben Merkoçi, endeavours to integrate nanotechnology methods, tools and materials into sensors, including biosensors, which are low-cost, user-friendly and efficient. The Group exploits nanoparticles, nanotubes, nanochannels, graphene and other nanomaterials for innovative, highly sensitive mass-production platforms for diverse applications in everyday life.



From L to R: A. Santiago Afonso, B. Pérez, A. Ravalli, M. Cadevall, C. Mayorga, F. Pino, A. Merkoçi, A. López, M. Medina, L. Rivas, A. Puig, C. Parolo, M. Maltez, H. Monton, G. Aragay, E. Morales, M. Espinoza, A. de la Escosura.

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## NEW PROJECTS & MILESTONES

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In 2011 the Group initiated two new, 3-year projects. The first, entitled “Evaluation of the calcium-sensing receptor as a novel candidate tumor suppressor gene and therapeutic target in neuroblastic tumors”, funded by the CELLEX Foundation, is being done together with Hospital Sant Joan de Déu. The second, “Multifunctional Nanoplatforms For High Sensitive Pollution Control and Purification of Water”, is funded by the Spanish Ministry of Economy and Competitiveness (MEC; previously known as MICINN).



# 3

## RESEARCH

### 3.4 Nanobioelectronics and Biosensors Group



Furthermore, the group attained funding for new projects that will begin 20. The first of these, “Desenvolupament d’un biosensor electroquímic basat en nanopartícules per la detecció ràpida i senzilla de seqüències de DNA”, is a 2-year project subcontracted by the spin-off company Vetgenomics. The second project, “Nanomateriales con alta capacidad de reconocimiento modulable electrónicamente, tipo on-off, para su aplicación en biosensores”, is a 3-year project funded by MEC.

Lastly, Prof Merkoçi won the 2011 Association of Advanced Materials (IAAM) Medal, awarded in recognition of outstanding and notable contribution in the field of Nanomaterials and Nanotechnology.

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#### KEY PUBLICATIONS AND INVITED TALKS 2011

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**Recent Trends in Macro, Micro and Nanomaterials Based Tools and Strategies for Heavy Metals Detection**, Gemma Aragay, Josefina Pons, Arben Merkoçi, *Chemical Reviews*, 111 (5), 3433-3458 (2011)

**Size-dependent direct electrochemical detection of gold nanoparticles: application in magnetoimmunoassays**, Alfredo de la Escosura-Muñiz, Claudio Parolo, Flavio Maran, Arben Merkoçi, *Nanoscale*, 3 (8), 3350 – 3356 (2011)

**Electrochemical interrogation of endocytosis of quantum dots modified with cell penetrating peptides**, S. Marín, S. Pujals, E. Giralt, A. Merkoçi, *Bioconjugate Chemistry*, 22, 180–18 (2011) \* Cover article

**Magnetic and electrokinetic manipulations on a microchip device for bead-based immunosensing applications**, A. Ambrosi, M. Guix, A. Merkoçi, *Electrophoresis*, 32 (8), 861-869 (2011)

**A nanochannel/nanoparticle based filtering and sensing platform for direct detection of a cancer biomarker in blood**, A. De la Escosura-Muñiz, A. Merkoçi, *Small*, 7, 675–682 (2011)

**Magnetic Nanoparticles Modified with Carbon Nanotubes for Electrocatalytic Magnetoswitchable Biosensing Applications**, B. Pérez-López, A. Merkoçi, *Advanced Functional Materials*, 21, 255–260 (2011)

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#### OTHER ACTIVITIES

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##### Teaching:

Prof Merkoçi taught master’s courses on Nanomaterials and Biosensors at Universitat Autònoma de Barcelona (UAB), University of Santo Tomas (Manila, Philippines), and Universidad Autónoma Metropolitana (Mexico DF, Mexico).

Led by Prof Dr Clivia M Sotomayor Torres, the Phononic and Photonic Nanostructures Group investigates the interaction of photons, phonons and electrons in nano-scale condensed matter underpinned by research in nanofabrication, especially nanoimprint lithography and nanometrology. The long term aim is to develop new information technology concepts where information processing is achieved with non-charged state variables. The current activity trend is moving towards the design and fabrication of nanoscale systems for the study of electron-phonon-photon interactions for thermo-electric applications such as cooling and energy harvesting. This involves the use of light scattering characterization (Raman, Brillouin, THz pump-and-probe) and 3-omega characterization of suspended membranes (graphene, silicon) and phononic and photonic crystals.



From L to R: O. Chapuis, W. Khunsin, J. Cuffe, C. M. Sotomayor Torres, S. Bhansali, J. Gomis Brescó, C. Delgado Simão, E. Guillotel, N. Baruch., A. Francone, E. Chávez, F. Alzina Sureda, T. Kehoe, D. Navarro Urios. Not shown: L. Schneider, Y. García, C. Ribéreau

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## NEW PROJECTS & MILESTONES

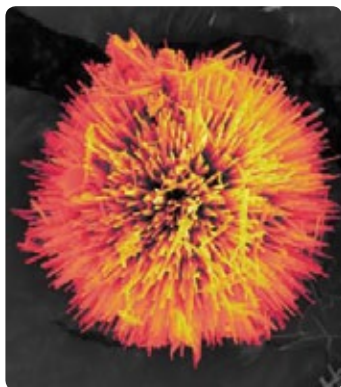
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The Group progressed with on-going research projects, including NanoICT, LAMAND, NANOPOWER and TAILPHOX, and began a new one, known as Nanostructured ThermoElectric Systems for Green Transport & Energy Efficient Applications (NanoTEG), which is aimed at solving crucial cooling and energy-management issues in transport and energy-efficient applications. Strong impact is being sought in four identified application domains: Automotive; Avionics; Power Inverters for UPS and Motor Drives; and LED-Lighting.

# 3

## RESEARCH

### 3.5 Phononic and Photonic Nanostructures Group



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#### KEY PUBLICATIONS AND INVITED TALKS 2011

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**Nanophotonics and Nanophononics Position Paper**, Eds. J. Ahopelto and C. M. Sotomayor Torres, *ENanoNewsletter*, Issue 24, pp 4-34, December 2011, published by the ICT FET project NanoICT

**Surface-directed dewetting of a block copolymer for fabricating highly uniform nanostructured microdroplets and concentric nanorings**, R. Farrell, N. Kehagias, M. T. Shaw, V. Reboud, M. Zelsmann, J. D. Holmes, C. M. Sotomayor Torres, and M. A. Morris. *ACS Nano*, 5 (2), 10731085 (2011)

**The morphology of graphene sheets treated in an ozone generator**, H. Tao, J. Moser, F. Alzina, Q. Wang, and C. M. Sotomayor-Torres, *The Journal of Physical Chemistry C*, 115 (37), 18257–18260 (2011)

**Semiconducting properties of layered cadmium sulphide-based hybrid nanocomposites**, Z. Lopez-Cabana, C. M. Sotomayor Torres, and G. Gonzalez, *Nanoscale Research Letters*, 6 (1), 523 (2011)

**Development of Nanometrology methods for nanopatterning and self-assembly**, C. M. Sotomayor Torres, T. Kehoe, and N. Kehagias, MRS Fall meeting 2011, Boston, USA, 27 Nov. - 2 Dec. 2011 (Invited talk)

**Nanophotonics at the Crossroad**, C. M. Sotomayor Torres, EU ICT Photonics Unit, 28 September 2011, Brussels, Belgium (Invited Lecture)

Led by ICREA Research Professor Sergio O. Valenzuela, the Physics and Engineering of Nanodevices Group focuses on the development of novel devices, primarily spintronics, specifically designed to gain insight into physical properties of materials at the nanoscale, combining state of the art lithographic and chemical methods with magnetic and electrical transport characterisation.



From L to R: G. Bridoux, S. Valenzuela, M. Costache, J. van de Vondel and I. Newmann

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## NEW PROJECTS & MILESTONES

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In 2011, the Group completed the on-going project, “Espectroscopia tunel de electrones polarizados: una nueva herramienta para el desarrollo de memorias magneticas de ultra-alta densidad” (Tunnelling spectroscopy of polarised electrons: a new tool to develop ultra-high density magnetic memory) and began one new project, “Transporte de espines y dinámica de la magnetizacion en nanoestructuras” (Spin transport and magnetisation dynamics in nanostructures).

Additionally, the Group progressed with on-going research project “Beyond CMOS Nanodevices for Adding Functionalities to CMOS (NANOFUNCTION, EU FP7)”, aiming at developing new methods to manage heat in nanoscale structures. Among its most important developments was demonstrating a thermopile to gather information on magnon-electron scattering and magnon-drag effects.

Postdoctoral researcher Dr Marius Costache was awarded a Ramón y Cajal Fellowship, the most important Spanish fellowship for senior postdocs, for the project entitled “Spin transport and magnetisation dynamics in nanostructures”.

# 3

## RESEARCH

### 3.6 Physics and Engineering of Nanodevices Group

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#### KEY PUBLICATIONS AND INVITED TALKS 2011

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**Magnon-drag thermopile**, M.V. Costache, G. Bridoux, I. Neumann and S.O. Valenzuela, *Nature Materials*, online (DOI: 10.1038/nmat3201), (2011)

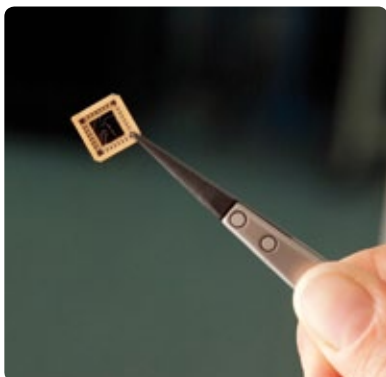
**Enhanced spin signal in nonlocal devices based on a ferromagnetic CoFeAl alloy**, G. Bridoux, M.V. Costache, J. Van De Vondel, I. Neumann and S.O. Valenzuela, *Applied Physics Letters*, 99, 102107 (2011)

**Generation of pure spin currents in a single electron transistor with a superconducting island**, M.V. Costache and S.O. Valenzuela, *Proc. SPIE*, 8100, 81000I (2011)

**Spin currents and spin dynamics in metallic nanostructures**, S.O. Valenzuela, IBM Zurich, 27 May, Zurich, Switzerland, Invited Talk (2011)

**Single electron spin ratchet**, S.O. Valenzuela, Spintech6, 1-5 August, Matsue, Japan Invited Talk (2011)

**Pure spin currents in a single electron transistor**, S.O. Valenzuela, Spintronics IV, SPIE NanoScience + Engineering, August 21-25, San Diego, USA (2011)



Led by Prof Adrian Bachtold, the Quantum NanoElectronics Group specialises in the electrical and mechanical properties of carbon nanotubes and graphene. These structures are so tiny that quantum effects start to play a dominant role. For example, their energy levels are quantised, just like in atoms and molecules. Interestingly, and despite their miniscule size, these structures are large and robust enough to be implemented into a variety of different microfabricated devices, which enables tuning of their quantum properties.



From L to R. **Back row:** A. Eichler and I. Tsioutsios. **Middle row:** M. Sledzinska, J. Moser, A. Afshar and M.J. Esplandiu. **Front row:** P. Weber, J. Guettinger and A. Bachtold.

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## NEW PROJECTS & MILESTONES

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In 2011, the Group continued one on-going European project (RODIN – Suspended Graphene Nanostructures), two on-going Spanish projects (Nanotecnologia con nanotubos de carbono: desde el movimiento controlado a la manipulación electrónica; and SGR) and began one new European project, Mechanical Amplification in Carbon-based NanoElectroMechanical Systems (MACNEMS).

### MACNEMS

This 2-year project, in the EU 7th Framework Programme (FP7), deals with improving the quality factor (Q) in nanomechanical resonators, in order to improve amplification of signals from oscillating Nanoelectromechanical Systems (NEMS). The Group has proposed two strategies to en-



hance a mechanical signal before its conversion into an electrical current: parametric amplification (PA) and self-sustained oscillations (SSO). It has devised a carbon nanotube (CNT) based system for mass detection, for which it has established a target sensitivity of 1 yoctogram, equivalent to the mass of a single proton.

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#### KEY PUBLICATIONS AND INVITED TALKS 2011

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**Nonlinear damping in mechanical resonators made from carbon nanotubes and graphene**, (Highlighted), A. Eichler, J. Moser, J. Chaste, M. Zdrojek, I. Wilson-Rae and A. Bachtold, *Nature Nanotechnology*, 6, 339 (2011)

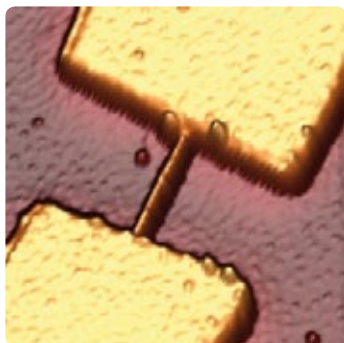
**Parametric amplification and self-oscillation in a nanotube mechanical resonator**, A. Eichler, J. Chaste, J. Moser and A. Bachtold, *Nano Letters*, 11, 2699 (2011)

**Structured Graphene Devices for Mass Transport**, A. Barreiro, R. Rurali, E. R. Hernández and A. Bachtold, *Small*, 7, 775 (2011)

**High-frequency nanotube mechanical resonators**, J. Chaste, M. Sledzinska, M. Zdrojek, J. Moser, A. Bachtold, *Applied Physics Letters*, 99, 213502 (2011)

**Electromechanical resonator made from carbon nanotubes and graphene**, A. Bachtold, RPGR2011, Suwon, South Korea, 2011 (Invited Talk)

**Mechanical resonators based on nanotubes and graphene**, Adrian Bachtold, Train2 Nanofabrication workshop, Belaterra, Spain, 2011 (Invited Talk)





### 3.8 Supramolecular NanoChemistry and Materials Group

Led by ICREA Research Professor Daniel Maspoch, the Supramolecular NanoChemistry and Materials Group (NANO<sup>UP</sup>), founded in 2011, aims to control the supramolecular assembly of molecules, biomolecules, metal ions and nanoscale building blocks at the nanometre level for the design and synthesis of novel functional architectures. The Group employs Supramolecular Chemistry as its central approach to explore new materials and applications in diverse areas, including micro- and nano-encapsulation, drug-delivery systems and contrast agents, as well as to develop novel sensors and magnetic platforms. They also work extensively with high-resolution tip-based lithographic techniques, such as dip-pen nanolithography (DPN), to control the positioning, growth and orientation of supramolecular nanostructures on surfaces.



From L to R: I. J. Ariñez, Imhaz, D. Maspoch, N. Mejías, C. Carbonell, M. González, A. Carné, M.A. Cano, E. Evangelio, M. Rubio, A. Ruyra

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#### NEW PROJECTS & MILESTONES

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In its first year, the Group continued on-going projects that Prof Maspoch had previously been working on at ICN in his time as a Ramón y Cajal Researcher. These include numerous technology transfer and commercial contract projects in encapsulation, biosafety of nanoparticles, and nanotechnology for food safety, as well as extension of previous efforts in development of nanoscale metal-organic frameworks (MOFs). The Group was awarded four new competitive projects in micro- and nano-encapsulation technologies: AUTORREPARA, BIOCIDE<sup>2</sup>LIFE, one VALOR project and one Recercaixa project.

# 3

## RESEARCH

### 3.8 Supramolecular NanoChemistry and Materials Group

#### AUTORREPARA

Development of protective coats for wood based on micro- and nanoencapsulation technologies (funding source: MICINN; call: INNPACTO)

#### BIOCIDE<sup>2</sup>LIFE

Micro- and nanoencapsulated biocides: the next generation of disinfectants with Short + Long<sup>2</sup>Life Antimicrobial Activity (funding source: CERCA; call: PROVAT)

#### Valorisation of a nanoencapsulated phage cocktail for controlling salmonellosis

(funding source: CIDEM-ACC10; call: VALOR)

#### Food security, development of novel phage-based technologies for controlling salmonellosis

(funding source: Obra Social "La Caixa"; call: Recercaixa)

NANO<sup>UP</sup> also provided technological support in micro- and nano-encapsulation to six different companies.

Lastly, the Group also acquired major new equipment in 2011. This included Mini and Nano Spray Dryer instruments; the latter was one among the first to be set up in Spain. Both systems enable miniaturisation and encapsulation of molecular cargo (e.g. peptides, drugs, food ingredients, etc.) in a range from 100 nm to 100  $\mu$ m. NANO<sup>UP</sup> also acquired an NLP 2000 System, an advanced nanolithography instrument that enables rapid design and creation of custom-engineered and functionalised surfaces on the microscale or nanoscale.

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#### KEY PUBLICATIONS AND INVITED TALKS 2011

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**Nanoscale metal-organic materials**, A. Carné, C. Carbonell, I. Imaz and D. Maspoch, *Chemical Society Reviews*, 40, 291-305 (2011)

**Single-crystal metal-organic frameworks arrays**, C. Carbonell, I. Imaz and D. Maspoch, *Journal of the American Chemical Society*, 133, 2144-2147 (2011)

**Coordination polymer nanofibers generated by microfluidic synthesis**, J. Puigmartí-Luis, M. Rubio-Martínez, U. Hartfelder, I. Imaz, D. Maspoch and P.S. Dittrich, *Journal of the American Chemical Society*, 133 (12), 4216-4219 (2011)

**Metal-biomolecule frameworks (MBioFS)**, I. Imaz, M. Rubio-Martínez, J. An, I. Solé-Font, N.L. Rosi and D. Maspoch, *Chemical Communications*, 47, 7287-7302 (2011)

**Controlling the length and location of in situ formed nanowires by means of microfluidic tools**, P. Kuhn, J. Puigmartí-Luis, I. Imaz, D. Maspoch and P.S. Dittrich, *Lab Chip*, 11, 753-757 (2011)

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#### OTHER ACTIVITIES

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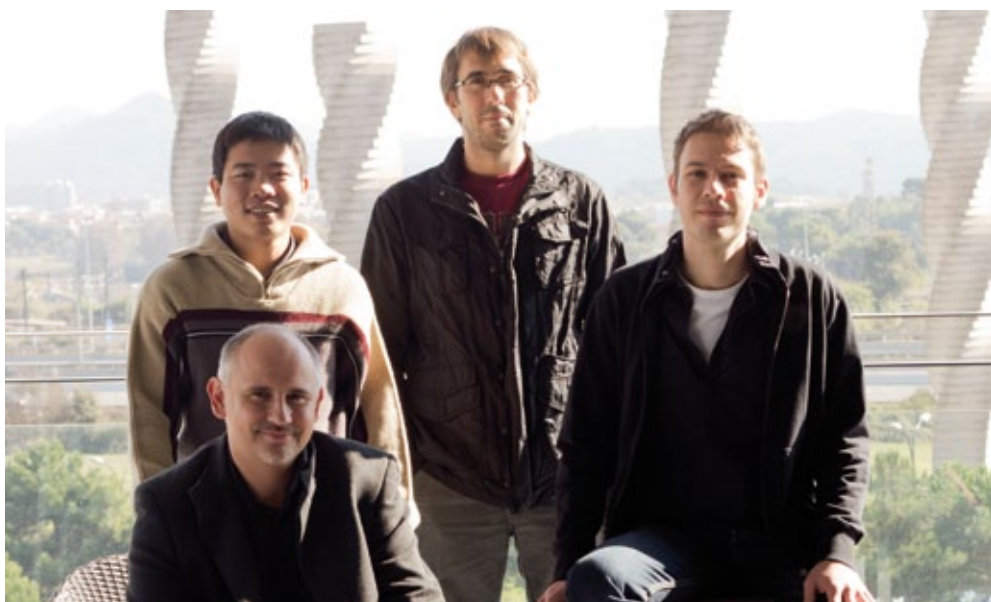
##### Honours:

Dr Daniel Maspoch was appointed ICREA Research Professor in September 2011.

##### Patents:

Method for the preparation of metal organic frameworks, D. Maspoch, I. Imaz, A. Carne, M. Cano-Sarabia, Eur. Appl. EP11183773.8 (2011)

Led by ICREA Research Professor Stephan Roche, the Theoretical and Computational Nanosciences Group theoretically explores exotic quantum transport phenomena in low-dimensional structures and complex materials, including carbon nanotubes, DNA, graphene, organic crystals and topological insulators. Objectives include investigating the effects of chemical and topological disorders, as well as electron-phonon coupling and spin-orbit interactions, on quantum interferences, localisation phenomena, decoherence mechanisms, electromechanical coupling in charge flow, and vibrations of systems. Methodological developments target innovative quantum transport approaches to describe charge, spin, phonon or polaron dynamics in a complex matter.



From L to R: S. Roche, D. Tuan, D. Soriano and F. Ortman

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## NEW PROJECTS & MILESTONES

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In addition to advancing its on-going research projects in 2011, the Group began three new ones: GRAPHENE-CA - Graphene-Driven Revolutions in ICT and Beyond; European Multiscale Simulation for the Computational Era (MULTI-EU-SIM); and Trans-Pyrenees Action on Advanced Infrastructures for Nanosciences and Nanotechnologies (TRAIN<sup>2</sup>).

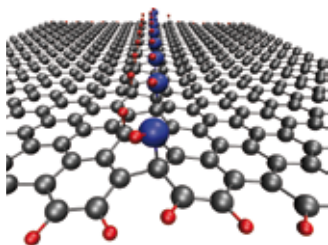
### **GRAPHENE-CA - Graphene-Driven Revolutions in ICT and Beyond**

This FET Flagship Initiatives Preparatory Action is aimed at structuring a Flagship proposal to develop graphene-based information communication technologies (ICTs). Several scientific workshops have been organised, and a full Science and Technology Roadmap has been prepared.

# 3

## RESEARCH

### 3.9 Theoretical and Computational Nanoscience Group



Prof Roche has been in charge of the WP “Dissemination Activities” and has actively by organising two workshops in Madrid.

#### MULTI-EU-SIM

The project aims to gather the simulation research community in Europe to establish a joint vision of multiscale modelling and simulation, to prepare Europe for a leading role in a new era of computational sciences in which multiscale simulation will profoundly change science technology. Prof Roche has participated in events preparation, roadmapping and project dissemination,

seeking to foster a network of European excellence in multiscale simulation for ICTs and beyond.

#### TRAIN<sup>2</sup>

This objective of this project, an initiative of the French Nanoscience Community SUDOE, is to position southwest Europe as a competitive region by pooling existing infrastructures at two levels: nanomaterials preparation and characterisation. The Group is endeavouring to coordinate the general position of ICN on scientific networking as well as implication of ICN members in the project.

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#### KEY PUBLICATIONS AND INVITED TALKS 2011

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**Graphene gets a better gap**, S. Roche, *Nature Nanotechnology*, 6, 8 (2011)

**Magnetoresistance and Magnetic Ordering Fingerprints in Hydrogenated Graphene**, D. Soriano, N. Leconte, P. Ordejón, J.-Ch. Charlier, J.-J. Palacios, S. Roche, *Physical Review Letters*, 107, 16602(4) (2011)

**Polaron transport in organic crystals: Temperature tuning of disorder effects**, F. Ortmann and S. Roche, *Physical Review B*, 84, 180302 (Rapid Communications) (2011)

**Oxygen Surface Functionalization of Graphene Nanoribbons for Transport Gap Engineering**, A. Cresti, A. Lopez-Bezanilla, P. Ordejon and S. Roche, *ACS Nano*, 5 (11), pp 9271–9277 (2011)

**Integer quantum hall effect in trilayer graphene**, A. Kumar, W. Escoffier, J. M. Pomirol, C. Faugeras, D. P. Arovas, M. M. Fogler, F. Guinea, S. Roche, M. Goiran, B. Raquet, *Physical Review Letters*, 107, 126806 (2011)

**Disorder in Graphene: Symmetry breaking and Emerging Transport Properties**, S. Roche, Trends in Nanotechnology International Conference (TNT2011), 21 and 25 November, Invited Talk (2011) from TCAD to atomistic simulation, S. Roche, Th. Poiroux, G. Lecarval, S. Barraud, F. Triozon, M. Persson and Y.M. Niquet. *International Journal of Nanotechnology* Vol. 7, p. 348 (2010)

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#### OTHER ACTIVITIES

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##### Teaching:

In 2011 Prof Roche taught the course Graphene: Fundamentals and Applications, at the Global School of Advanced studies, organised by the US National Science Foundation (NSF), Northwestern University (Chicago, USA) and the CEA (Grenoble, France)

##### Books:

**Quantum Transport in Graphene-based Materials and Devices: from pseudospin effects to performant transistors**, S. Roche, F. Ortmann, A. Cresti, B. Biel and D. Jimenez, Graphene: Synthesis and Applications (ISBN: 9781439861875), Taylor and Francis Books-CRC Press, Chapter 3 (2011)

**Tailoring the physical properties of graphene**, C. G. Rocha, M. H. Rummeli, I. Ibrahim, H. Sevincli, F. Böhrnert, J. Kunstmann, A. Bachmatyuk, M. Pötschke, W. Li, S. A. M. Makharza, S. Roche, B. Büchner, and G. Cuniberti, Graphene: Synthesis and Applications (ISBN: 9781439861875), Taylor and Francis Books-CRC Press, Chapter 1 (2011)

# TECHNICAL DEVELOPMENT AND SUPPORT

## 4.1 Electron Microscopy Division

# 4



Led by Dr. Belén Ballesteros, the Electron Microscopy Division was formed in 2010. It employs electron microscopy techniques for Nanoscience and Nanotechnology research and applications. The Division's chief objective is to provide scientific and technical support to ICN's Research Groups and to neighbouring research centres, as well as to develop and implement novel techniques. The laboratory has been selected by FEI as a Centre of Reference for development of joint experiments and workshops related with electron microscopy.

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### RESEARCH ACTIVITIES & MILESTONES

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In 2011, the Division secured funding for the following projects:

**Acquisition of equipment for electron microscopy sample preparation (FPIC10-4E-108). FEDER and MICINN**

With this project, the Division is seeking to acquire sample-preparation equipment, including a plasma cleaner, an ion mill, a sputter coater, a diamond wire saw and polishing systems.

**Technical Support Personnel Programme (PTA2011-6387-I). MICINN**

The purpose of this project is to fund the contract of the technician Marcos Rosado, who will join the Division in 2012.

**Nanocapsules for targeted delivery of radioactivity (RADDEL).** FP7 European Commission. Marie Curie Initial Training Network

Formal approval was achieved for this project, which involves eleven partners across Europe and will launch in 2012. The network focuses on the design, synthesis, characterisation and pharmacological studies of radioactive nanocapsules for biomedical applications. The role of the Electron Microscopy Division in this project is to characterise (by electron microscopy) the functional nanomaterials generated in the project, which are being developed for use in diagnosis and therapy.

Besides these projects, the Division has actively participated in the project **Transpyrenees Action on Advanced Infrastructures for Nanosciences and Nanotechnologies (TRAIN<sup>2</sup>)**, which involves several centres and at ICN is led by Prof Stephan Roche.

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### SERVICES

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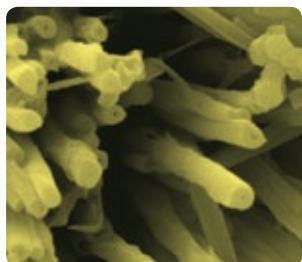
The Division's facilities were acquired during 2010 and are detailed below:

**FEI Tecnai G2 F20 S-TWIN HR(S)TEM** is a 200kV field emission gun (FEG) high resolution and analytical TEM/STEM. The field emission source means this microscope is ideal for applications

# 4

## TECHNICAL DEVELOPMENT AND SUPPORT

### 4.1 Electron Microscopy Division



requiring high coherency, high brightness at high magnification, or small focused probes. It is a versatile and flexible microscope and combines high performance in TEM, EFTEM and STEM modes with ease of operation in a multi-user research environment. The analytical capabilities are provided by an EDAX system for EDS and a last generation Gatan Imaging Filter (GIF Quantum) for EELS and EFTEM analysis. High-resolution electron tomography is performed using a dedicated high-tilt tomography sample holder.

**FEI Magellan 400L XHR SEM** is a Field Emission Scanning Electron Microscope equipped with a newly developed electron column with UC (UniColore) Technology. This microscope features excellent capabilities in the more traditional high energy (15-30 kV) SEM and STEM imaging, but also has an outstanding performance at low beam energies with subnanometer resolution for unmatched surface sensitive imaging.

**FEI Quanta 650FEG ESEM** is a versatile field scanning electron microscope which provides high resolution imaging at low-vacuum and also extended vacuum (environmental) for the characterization of all type of samples (conductive and nonconductive) and performing in-situ dynamic experiments. This microscope features a large chamber compatible with 8 inches wafers.

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#### KEY PUBLICATIONS AND INVITED TALKS 2011

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**Synthesis and stabilization of subnanometric gold oxide nanoparticles on multiwalled nanotubes and their catalytic activity**, L. Alves, B. Ballesteros, M. Boronat, J. R. Cabrero-Antonino, P. Concepción, A. Corma, M. A. Correa-Duarte and E. Mendoza, *Journal of the American Chemical Society*, 133 (26) , 10251–10261 (2011)

**Synthesis conditions, light intensity and temperature effect on the performance of ZnO nanorods-based Dye sensitized solar cells**, I. González-Valls, Y. Yu, B. Ballesteros, J. Oró and M. Lira-Cantú, *J. Power Sources*, 196 (15) , 6609-6621 (2011)

**Heteroepitaxial orientation control of YSZ thin films by selective growth on SrO-, TiO<sub>2</sub>-terminated SrTiO<sub>3</sub> crystal**, A. Cavallaro, B. Ballesteros, R. Bachelet and J. Santiso, *CrystEngComm*, 13, 1625–1631 (2011)

**Sidewall functionalisation of carbon nanotubes with diaryl carbene derivatives**, P. Luksirikul, B. Ballesteros, G. Tobias, M. G. Moloney and M. L. H. Green, *Journal of Materials Chemistry*, 21, 19080-19085 (2011)

**Orbital moment anisotropy of Pt/Co/AlO(x) heterostructures with strong Rashba interaction**, C. Nistor, T. Balashov, J. J. Kavich, A. Lodi Rizzini, B. Ballesteros, G. Gaudin, S. Auffret, B. Rodmacq, S. S. Dhesi and P. Gambardella, *Physical Review B*, 84 (5), 054464 (2011)

**Synthesis and laser immobilisation onto solid substrates of CdSe/ZnS core-shell quantum dots**, E. György, A. Pérez del Pino, J. Roqueta, B. Ballesteros, A. S. Miguel, C. Maycock, A. G. Oliva, *Journal of Physical Chemistry C*, 115 (31), 15210–15216 (2011)

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#### OTHER ACTIVITIES

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**Electron microscopy characterisation of functional carbon nanotubes for biomedical applications**, B. Ballesteros, G. Tobias and M. L. H. Green, *Microscopy at the Frontiers of Science*, Aveiro, Portugal, 2011 (Talk)



# TECHNICAL DEVELOPMENT AND SUPPORT

## 4.2 Nanofabrication Division

# 4



Formed in 2010 and led by Dr Nikolaos Kehagias, the Nanofabrication Division focuses on the design and development of nanofabrication methods and techniques for Nanoscience and Nanotechnology research and applications. The Division's mission is two-fold: to create and provide a flexible nanofabrication platform for processing diverse materials and substrates; and to provide high-quality services to both internal and external users. An important task of the Division is to provide process development, and/or prototyping of novel nanostructures and devices, to enable transfer of research output to commercial foundries. For ICN's Nanofabrication Division, the right combination of lithography techniques and materials is essential to help researchers achieve high-impact results.

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### RESEARCH ACTIVITIES & MILESTONES

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ICN's Nanofabrication Division supports the Institute's research groups in nanoelectronics, nanophononics, nanophotonics, spintronics, nanobioelectronics and biosensors.

2011 was a very active year for the Division, witnessing completion of a joint project with Finnish firm PMTEC on development of roll to roll (R2R) equipment; contracting of a new project from CETEMMSA Technological Centre, and slated for completion by April 2012; and negotiations for a new EU project, called Plastic4future.

The Division also installed a new piece of equipment: a R2R UV-light-assisted nanoimprint lithography tool from PTMTEC.

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### SERVICES

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- Lithography:

Thermal and UV nanoimprinting - Obducat 3 inch

Hot embossing machine

UV nanoimprinting module

SEM/Litho - FEI/Raith

Self-assembly growth set up

R2R UV-light-assisted nanoimprinting

- Deposition:

Ebeam evaporator 1 (Au, Ag, Al, Cr, Ti, Pt, Al<sub>2</sub>O<sub>3</sub>) - AJA International

ITO-Molecular beam epitaxy

Sputter (Au) coater - Edmunds

Spin coater - Laurel

- Characterisation:

Atomic force microscope - Veeco Instruments

Optical microscope - Nikon Eclipse LV100



# 4

## TECHNICAL DEVELOPMENT AND SUPPORT

### 4.2 Nanofabrication Division



Au ball bonder - Delvotek

- General:  
Plasma cleaner - PVA Tepla PS210  
Oven - Memmert  
Hot plates

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#### KEY PUBLICATIONS AND INVITED TALKS 2011

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**Surface-directed dewetting of a block copolymer for fabricating highly uniform nanostructured microdroplets and concentric nanorings**, R. Farrell, N. Kehagias, M. T. Shaw, V. Reboud, M. Zelsmann, J. D. Holmes, C. M. Sotomayor Torres, and M. A. Morris, *ACS Nano*, 5(2), 1073-1085 (2011)

**Direct top-down ordering of diblock copolymers through nanoimprint lithography**, M. Salaun, N. Kehagias, B. Sahlí, T. Baron, J. Boussey, C. M. Sotomayor Torres and M. Zelsmann, *Vacuum Science & Technology B*, 29(6) (2011)

**Low temperature direct imprint of polyhedral oligomeric silsesquioxane (POSS) resist**, N. Kehagias, M. Zelsmann, M. Chouiki, A. Francone, V. Reboud, R. Schoefner, and C. Sotomayor Torres, *Microelectronic Engineering*, 88 (8), 1997-1999 (2011)

**Hybrid three dimensional nanofabrication techniques**, N. Kehagias, European project NaPANIL Industrial Day, 6 April, Berlin, Germany (Invited talk)

**Production and Applications Based on Nanoimprinting Lithography**, N. Kehagias, Nanopatterning, ISFO conference 10-13 July, Thessaloniki, Greece (Invited talk)

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#### OTHER ACTIVITIES

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##### Teaching:

Dr Kehagias taught two courses in 2011:

**Applications of nanoimprint lithography**, for the summer school programme Técnicas de nanofabricación para aplicaciones en Nanotecnología, 6-8 July, 2011, Jaca, Spain

**Nanofabrication techniques for photonic and bio related applications**, at the 5th International Summer School on Nanosciences & Nanotechnologies: Organic Electronics & Nanomedicine, 9-16 July, Thessaloniki, Greece

# TECHNICAL DEVELOPMENT AND SUPPORT

## 4.3 Nanoscience Instrument Development Division

# 4



The Nanoscience Instrument Development Division, formed in 2010 and led by Dr Gustavo Ceballos, focuses on the design, development, improvement and deployment of advanced, state-of-the-art instruments for Nanoscience and Nanotechnology. It aims to create an integrated scientific and technical platform with a highly qualified multidisciplinary team that can address challenging instrumental projects in basic Nanoscience research as well as for Nanotechnology applications. The Division acts as an active collaborator for on-going experimental research efforts within ICN and with neighbouring research institutions, develops new leading-edge instruments and techniques, and provides valuable support for commercial development of the scientific instruments that it develops.

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### RESEARCH ACTIVITIES & MILESTONES

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#### Collaboration between ICN and ALBA:

For a pre-existing collaboration between ICN's Atomic Manipulation and Spectroscopy Group and the Spanish Synchrotron Radiation Facility, ALBA, the Nanoscience Instrument Development Laboratory began designing, building and commissioning a Molecular Beam Epitaxy and Scanning Tunnelling Microscopy (STM) facility for in situ X-ray absorption studies. In the near future, the collaborative development of high-end instrumentation and setups will be extended to other experimental stations at ALBA as well as to other research institutions.

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### SERVICES

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The Division's highly qualified team of experts provides scientific and technical assistance in Applied Physics; Precision Instrumentation; Microengineering; Nanotechnology; Metrology, Scientific Computing; and 3D-design of precision devices, to address challenging instrumental projects in basic Nanoscience research as well as for applied technology.

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### KEY PUBLICATIONS AND INVITED TALKS 2011

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**Spin coupling and relaxation inside molecule-metal contacts**, A. Mugarza, C. Krull, R. Robles, S. Stepanow, G. Ceballos, P. Gambardella, *Nature Comm*, 2, 490, (2011)

**Localization, splitting, and mixing of field emission resonances induced by alkali metal clusters on Cu(100)**, S. Stepanow, A. Mugarza, G. Ceballos, P. Gambardella, I. Aldazabal, A.G. Borisov, and A. Arnau *Physical Review B*, 83 (11), 115101 (2011)

**Mixed-valence behavior and strong correlation effects of metal phthalocyanines, adsorbed on metals**, S. Stepanow, PS. Miedema, A. Mugarza, G. Ceballos, P. Moras, J.C. Cezar, C. Carbone, F.M.F. de Groot, P. Gambardella, *Physical Review B*, 83, 220401 (2011)

**Growth of graphene nanoislands on a Ni(111) surface**, G. Ceballos, Symposium on Surface Science-2011, March 2011, Baqueira-Beret, Spain, 2011 (Talk)

**Growth of graphene nanoislands on a Ni(111) surface**, G. Ceballos, Meeting of the graphene research network Graphene: in Spintronics and Transport, September 2011, Madrid, Spain, (Invited Talk)



### 5.1 Aitor Mugarza

*In 2011 Dr Mugarza focused on studying the growth, electronic and magnetic properties of metal-organic molecules at the interface with metals. In particular, work on the adsorption, self-assembly, and electronic and*

*magnetic properties of metal phthalocyanines (MPC) on Ag(100) led to several publications.*

The local electronic and magnetic properties of individual MPC's adsorbed onto metallic surfaces were ascertained. Anomalous magnetic properties of the molecule were found at the interface with a metal, where spins can be induced at the organic ligand via charge transfer from the metallic substrate. The results from these experiments provided essential information on spin coupling and relaxation channel mechanisms at molecule-metal interfaces.

Modification of the electronic and magnetic properties of metal phthalocyanines by alkali doping: Following the systematic investigation carried out with MPCs, the study extended to manipulation of their electronic and magnetic structure by doping single molecules with Li atoms. A combined STM and XMCD study showed how magnetism in these molecules could be switch on and off, depending on the metal ion of the molecule.

In 2011, Dr Mugarza won a new grant (PI3, from the Spanish government) and began two new projects:

- **Electronic properties of graphene nanoislands grown on nickel (Ni111)**

This project entails investigation of the local electronic properties of graphene nanoislands

of different size, with the aim of correlate these findings to the electronic and magnetic coupling of the islands to the underlying ferromagnet.

- **Electron scattering in materials with strong spin-orbit coupling**

In this project, the effects of the entanglement between spin, and kinetic momentum induced by spin-orbit coupling, on the scattering properties of surface electrons are studied at defects such as atomic steps.

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## HIGHLIGHTS 2011

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**Spin coupling and relaxation inside molecule-metal contacts**, A. Mugarza, C. Krull, R. Robles, S. Stepanow, G. Ceballos & P. Gambardella, *Nature Comm*, 2, 490 (2011)

**Coupling single molecule magnets to ferromagnetic substrates**, A. Lodi Rizzini, C. Krull, T. Balashov, J.J. Kavich, A. Mugarza, P.S. Miedema, P.K. Thakur, V. Sessi, S. Klyatskaya, M. Ruben, S. Stepanow and P. Gambardella, *Physical Review Letters*, 107, 177205 (2011)

**Self-assembled nanoscale magnetic networks on surfaces: fundamental interactions and functional properties**, C. Carbone, S. Gardonio, P. Moras, S. Lounis, M. Heide, G. Bihlmayer, N. Atodiresei, P. H. Dederichs, S. Blügel, S. Vlaic, A. Lehnert, S. Ouazi, S. Rusponi, H. Brune, J. Honolka, A. Enders, K. Kern, S. Stepanow, C. Krull, T. Balashov, A. Mugarza and P. Gambardella, *Advanced Functional Materials*, 21, 1212 (2011)

**Determination of the photoelectron reference plane in nanostructured surfaces**, J. Lobo-Checa, A. Mugarza, J.E. Ortega and E.G. Michel, *New Journal of Physics*, 11, 103013 (2011)

**Localization, splitting and mixing of field emission resonances induced by alkali metal clusters on Cu(100)**, S. Stepanow, A. Mugarza, G. Ceballos, P. Gambardella, I. Aldazabal, A. G. Borisov and A. Arnau, *Physical Review B*, 83, 115101 (2011)

**Mixed-valence behavior and strong correlation effects of metal phthalocyanines adsorbed on metals**, S. Stepanow, P.S. Miedema, A. Mugarza, G. Ceballos, P. Moras, J.C. Cezar, C. Carbone, F.M.F. de Groot, P. Gambardella, *Physical Review B*, 83, 220401 (2011)

**Single-molecule chemistry and spectroscopy by scanning tunneling microscopy**, A. Mugarza, BCNano, 19-23 September, Barcelona, Spain, 2011, (Invited Talk)

**5.2 Carlos F. Sanz-Navarro**

*In 2011 Dr Sanz-Navarro continued his work in developing new Quantum Mechanics / Molecular Mechanics (QM/MM) methods to model the physicochemical properties of chemical and*

*biological processes and systems. He creates these methods using the SIESTA code.*

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**HIGHLIGHTS 2011**

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**An efficient implementation of a QM-MM method in SIESTA**, C.F. Sanz-Navarro, R. Grimali, A. García, E. A. Bea, A. Soba, J. M. Cela and P.Ordejón, *Theoretical Chemistry Accounts*, 8, 825-833 (2011)

**Atomistic simulations of hybrid nanostructured systems**, C.F. Sanz-Navarro, Department of Mathematical Sciences, Loughborough University, November, 2001 (Invited Talk)

**QM/MM simulations of protein immobilization on surfaces via metallic clusters**, C.F. Sanz-Navarro, P. Ordejón and R. E. Palmer, 11th International Conference Computational and Mathematical Methods in Science and Engineering (CMMSE 2001), June, 2011 (Talk)



### 5.3 Marius Costache

*In terms of basic research, Dr Costache focuses on developing new methods to study electron spin and magnetisation dynamics in metallic nanostructures as well as the transport of electron spins through interfaces. In*

*terms of technology, he is interested in developing spin-based devices for novel thermoelectric devices for energy harvesting.*

During 2011, in parallel to basic research, he was involved in setting up the laboratory and active in developing new research lines in one of ICN's youngest groups, the Physics and Engineering of Nanodevices Group. His main scientific results during 2011 are summarised below:

- **Spintronics devices for thermoelectric energy harvesting**

In addition to electrical transport, the thermoelectric properties of magnetic materials are garnering increasing attention as a means to manage heat in nanoscale structures and to control spin information by using heat flow. Dr Costache and his colleagues demonstrated a conceptually new device that enables gathering of information on magnon-electron scattering and magnon-drag effects. This information is crucial to understand the physics of electron-magnon interactions, magnon dynamics and thermal spin transport.

- **Enhanced spin signal in nonlocal devices based on a ferromagnetic CoFeAl alloy**

Over the past decade, spintronics researchers have undertaken an intensive search for a new ferromagnetic material with 100% spin polarisation at room temperature has been. Dr Costache and co-workers studied the spin signal in lateral spin valves based on CoFeAl injectors and detectors and found a ten-fold enhancement in the spin signal compared to

devices fabricated identically with the standard material CoFe. These results suggest that CoFeAl Heusler type compounds are promising candidates as high spin polarised electrodes for future spintronic applications.

Dr Costache also contributed to the discovery of a new method to write magnetic data using current pulses instead of magnetic fields. He is involved in various research projects, including Beyond CMOS Nanodevices for Adding Functionalities to CMOS (EU FP7) and Transporte de espines y dinamica de la magnetizacion en nanoestructuras (Ministerio de Ciencia e Innovación MICINN).

In 2011 Dr Costache, together with B.J. van Wees and S.O. Valenzuela, wrote a chapter for the book entitled **One-Dimensional Nanostructures: Principles and Applications** (to be published by John Wiley & Sons, Inc. in 20).

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## HIGHLIGHTS 2011

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**Magnon-drag thermopile**, M. V. Costache, G. Bridoux, I. Neumann and S. O. Valenzuela, *Nature Materials*, Online (2011)

**Perpendicular switching of a single ferromagnetic layer induced by in-plane current injection**, I. M. Miron, K. Garello, G. Gaudin, P.-J. Zermatten, M. V. Costache, S. Auffret, S. Bandera, B. Rodmacq, A. Schuhl and P. Gambardella, *Nature*, 476, 189-U88 (2011)

**Enhanced spin signal in nonlocal devices based on a ferromagnetic CoFeAl alloy**, G. Bridoux, M.V. Costache, J. Van De Vondel, I. Neumann and S.O. Valenzuela, *Applied Physics Letters*, 99, 102107 (2011)

**Generation of pure spin currents in a single electron transistor with a superconducting island**, M.V. Costache and S.O. Valenzuela, *Proc. Spie*, 8100, 81000I (2011)

**Spintronic nanodevices for energy-harvesting**, M.V. Costache and S.O. Valenzuela, 5th International Workshop on Spin Currents, Sendai International Center, Sendai, Japan, July 25-28, 2011 (invited conference)

**Electron magnon interactions in a metallic ferromagnet**, M.V. Costache and S.O. Valenzuela, Recent Trends in Nanomagnetism, Spintronics and their Applications (RTN-SA), Ordizia, Spain, May 9-13, 2011 (conference)

**Magnon transport in metallic nanostructures**, M.V. Costache and S.O. Valenzuela, Spin Caloritronics III, Leiden (Lorentz Center), The Netherlands, May 9-13, 2011 (invited conference)



#### 5.4 Inhar Imaz

*During 2011 Dr Imaz focused on the design, synthesis and study of new supramolecular nano-materials with new structures and properties, created by new methodologies, for use in drug*

*delivery, diagnostics and other biomedical applications.*

Metal-organic frameworks (MOFs) are a fledgling class of materials in which metal ions are associated to organic ligands. Characterised by exceptional porous architectures with extremely high surface areas (up to 10000 m<sup>2</sup>/g), they offer impressive potential in various applications, including gas storage, catalysis, and gas separation. Very recently, the miniaturisation of MOFs to generate nanoMOFs has enabled use of these materials in biomedical applications—namely, for Drug Delivery and Magnetic Resonance Imaging (MRI). Dr Imaz is endeavouring to find interesting nanoMOFs for each of these areas.

#### • Metal-Biomolecule Frameworks for Drug Delivery

One of the requisites for biomedical use of MOFs is that they must be completely non-toxic. Among strategies to make MOFs safe for humans is to replace the synthetic organic ligands with biomolecules such as amino acids, peptides, proteins and sugars. Thus, Dr Imaz is designing of suitable biomolecules to fabricate new nanoMOFs for encapsulation or absorption of drugs for subsequent drug delivery.

#### • Contrast Agent MOFs

Some advances have been made in the development of MOFs that act as contrast agents for MRI. Dr Imhaz is exploring a new synthetic

strategy based on the use of metallo-macrocylic contrast agents as bridging organic building blocks to connect metal ions, in order to form novel MOFs for specific MRI diagnostic applications. Dr Imhaz studies the stability and dispersion of these compounds in physiological media, as well as their toxicity and, in the case of the contrast agents, their imaging properties for MRI.

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#### HIGHLIGHTS 2011

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##### Selected publications:

**Nanoscale metal-organic materials**, A. Carné, C. Carbonell, I. Imaz and D. Maspoch, *Chemical Society Reviews*, 40, 291-305 (2011)

**Metal-biomolecule frameworks (MBioFS)**, I. Imaz, M. Rubio-Martínez, J. An, I. Solé-Font, N.L. Rosi and D. Maspoch, *Chemical Communications*, 47, 7287-7302 (2011)

**Coordination polymer nanofibers generated by microfluidic synthesis**, J. Puigmartí-Luis, M. Rubio-Martínez, U. Hartfelder, I. Imaz, D. Maspoch and P. S. Dittrich, *Journal of the American Chemical Society*, 133 (4), 4216-4219 (2011)

**Single-crystal metal-organic frameworks arrays**, C. Carbonell, I. Imaz and D. Maspoch, *Journal of the American Chemical Society*, 133, 2144-2147 (2011)

**Three-dimensional open-frameworks base on Ln(III) ions and open/closed-shell PTM ligands: synthesis, structure, luminescence and magnetic properties**, A. Dactu, N. Roques, V. Jubera, I. Imaz, D. Maspoch, J.-P. Sutter, C. Rovira and J. Veciana, *Chemistry - A European Journal*, 17 (13), 3644-3656 (2011)

##### Patents:

**Method for the preparation of metal organic frameworks**, D. Maspoch, I. Imaz, A. Carne, M. Cano-Sarabia, (Patent) Eur. Appl. EP11183773.8

# 5

## COLLABORATIVE RESEARCH

### 5.5 ICN Researchers in Collaborative Groups

Through the CIN2 collaboration with CSIC, ICN has placed numerous of young researchers in Groups led by senior CSIC scientists. This has strengthened Research Groups and enabled researchers to take advantage of the distinct resources made available by each organisation.

In 2011, two ICN researchers collaborated with CIN2 groups led by CSIC personnel:

- **Dr Carlos F Sanz-Navarro**, in the Theory and Simulation Group (led by Dr Pablo Ordejón)
- **Mar Cardellach**, in the Small Molecules on Surfaces in Ambient and Pristine Conditions Group (led by Dr Jordi Fraxedas).

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#### HIGHLIGHTED PUBLICATIONS 2011

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**An efficient implementation of a QM-MM method in SIESTA**, C.F. Sanz-Navarro, R. Grimali, A. García, E.A. Bea, A. Soba, J.M. Cela and P.Ordejón, *Theoretical Chemistry Accounts*, 8, 825-833 (2011)



The Centre for NanoBioSafety and Sustainability (CNBSS) was established in 2009 as a joint initiative of ICN and the LEITAT Technological Centre, two well-known institutions in Nanoscience and Nanotechnology, both located in Catalonia (northeastern Spain). The Centre was created in response to the emerging needs to rationalise and assess the risks of new nanotechnologies.

- **The primary goal of the CNBSS** is to develop new tools and methods to determine the safe and rational use of nanomaterials in products throughout their complete life-cycle. The quantification of risk and environmental impact will facilitate market acceptance of innocuous nanoproducts, and therefore, accelerate their acceptance by society and benefit return on capital investment.
- **The second goal of the CNBSS** is to develop new, safe and sustainable applications of Nanoscience and Nanotechnology in a broad spectrum of fields, including environmental remediation, drug delivery, energy, semiconductors, construction and food. This goal also includes development of metrology, as a fundamental tool needed to facilitate efficient standardisation and regulation, and establishment of standards.
- **Lastly, as its third goal**, the CNBSS aims to promote the use of nanotechnology-based solutions in strategic sectors, via activities such as training, education and dissemination, and by making nanotechnology more available to society and industry.

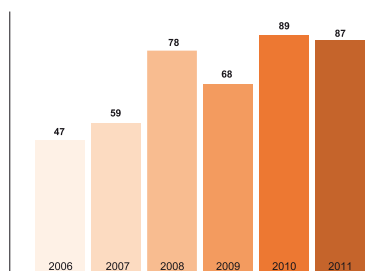
# 6

## SCIENTIFIC OUTPUT

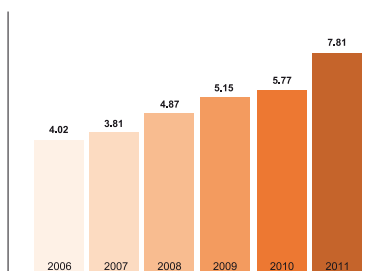
### 6.1 Publications

The number, quality and relevance of publications authored by ICN researchers continue to grow strongly year by year, as illustrated in the following graphs:

EVOLUTION OF ICN INDEXED PUBLICATIONS



EVOLUTION OF ICN AVERAGE IMPACT FACTOR



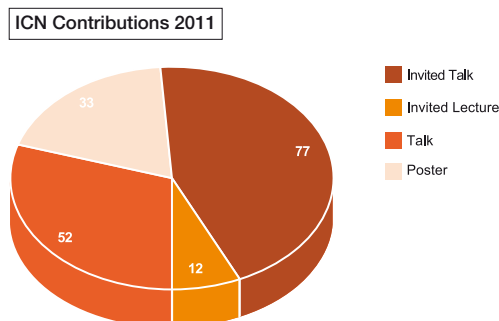
IMPACT FACTOR

Ranking	Journal	Publications	Impact Factor
1	<i>Nature</i>	1	36.10
2	<i>Chemical Reviews</i>	1	33.04
3	<i>Science</i>	1	31.38
4	<i>Nature Nanotechnology</i>	2	30.32
5	<i>Nature Materials</i>	2	29.92
6	<i>Chemical Society Reviews</i>	2	26.59
7	<i>Nano Letters</i>	3	12.22
8	<i>Advanced Materials</i>	1	10.88
9	<i>ACS Nano</i>	3	9.87
10	<i>Journal of the American Chemical Society</i>	4	9.02
11	<i>Advanced Functional Materials</i>	2	8.51
12	<i>Physical Review Letters</i>	5	7.62
13	<i>Small</i>	4	7.34
14	<i>TRAC - Trends in Analytical Chemistry</i>	1	6.60
15	<i>Chemistry of Materials</i>	1	6.40
16	<i>Lab Chip</i>	1	6.26
17	<i>Chemical Communications</i>	2	5.79
18	<i>Chemistry - A European Journal</i>	1	5.48
19	<i>Journal of Materials Chemistry</i>	3	5.10
20	<i>Bioconjugate Chemistry</i>	1	5.00
21	<i>Particle Fibre Toxicology</i>	1	4.91
22	<i>Journal of Physical Chemistry C</i>	3	4.52
23	<i>Analytica Chimica Acta</i>	1	4.31
24	<i>J. Power Sources</i>	1	4.29
25	<i>Langmuir</i>	1	4.27
26	<i>Nanoscale</i>	1	4.11
27	<i>CrystEngComm</i>	2	4.01
28	<i>Analyst</i>	1	3.91
29	<i>New Journal of Physics</i>	1	3.85
30	<i>Analytical and Bioanalytical Chemistry</i>	1	3.84
31	<i>Applied Physics Letters</i>	3	3.84
32	<i>Physical Review B</i>	11	3.77
33	<i>Trends in Food Science &amp; Technology</i>	1	3.71
34	<i>Electrophoresis</i>	1	3.57
35	<i>Journal of Nanoparticle Research</i>	1	3.25
36	<i>ACS Applied Materials and Interfaces</i>	1	2.93
37	<i>Theoretical Chemistry Accounts</i>	1	2.90
38	<i>Nanoscale Research Letters</i>	1	2.56
39	<i>Phil. Trans. Royal Soc. A</i>	1	2.46
40	<i>Material Research bulletin</i>	1	2.15
41	<i>Journal of Applied Physics</i>	3	2.08
42	<i>Surface Science</i>	1	2.01
43	<i>Synthetic Metals</i>	1	1.87
44	<i>Desalination</i>	2	1.85
45	<i>Microelectronic Engineering</i>	2	1.58
46	<i>Physica E: Low-Dimensional Systems and Nanostructures</i>	1	1.30
47	<i>IEEE Transactions on Magnetics</i>	1	1.05

NUMBER OF INDEXED PUBLICATIONS: 87  
AVERAGE IMPACT FACTOR: 7.81

## 6.2 Events in which ICN researchers participated

During 2011 ICN researchers participated at various levels in 174 events related to Nanotechnology.



## 6.3 Events organised by ICN

**1st NANO-TEC Workshop - Identification of the main requirements for future ICT devices**  
Parque de las Ciencias, Granada, Spain, 20 and 21 January, 2011

**Barcelona Nanotechnology Cluster – Bellaterra (BNC-b)**  
Hotel Campus, Bellaterra (Barcelona), Spain, 14 July, 2011

**Phonons and Fluctuations 2011**  
Paris Gare de Lyon Conference Centre, Tour de l'Horloge, Paris, France, 8 and 9 September, 2011

**Graphene Roadmap Consultation Workshop**  
Lancaster Univ., UK, 14-16 September, 2011

**2nd NANO-TEC Workshop - Benchmarking of new Beyond CMOS device/design concepts**  
Hotel Divani Caravel, Athens, Greece, 13 and 14 October, 2011

**GRAPHENE FLAGSHIP - Workshop - Graphene for Future Emerging Technologies**  
CSIC auditorium, Madrid, Spain, 18 October, 2011

**Carbon-based Spintronics International Workshop 2011**  
Max-Planck-Institut, Dresden, Germany, 24 October, 2011

**V Jornada AIN - Aplicaciones Industriales de la Nanotecnología**  
Casa Llotja de Mar, Barcelona, Spain, 24 October, 2011  
185 participants, 13 oral contributions, 4 debates

**NanoSustainability CNBSS Workshop**  
Centre d'Estudis i Recursos Culturals (CERC), Barcelona, Spain, 26 October, 2011  
66 participants

**NanoTOES - Project Meeting**  
Centre d'Estudis i Recursos Culturals (CERC), Barcelona, Spain, 26-28 October, 2011  
66 participants

**TAILPHOX – Project Meeting**  
Barcelona, 18 and 19 November, 2011

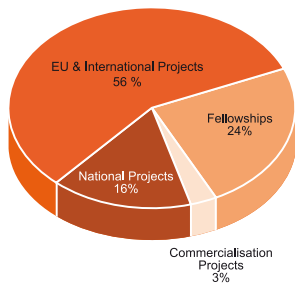
# 7

## PROJECTS & FELLOWSHIPS

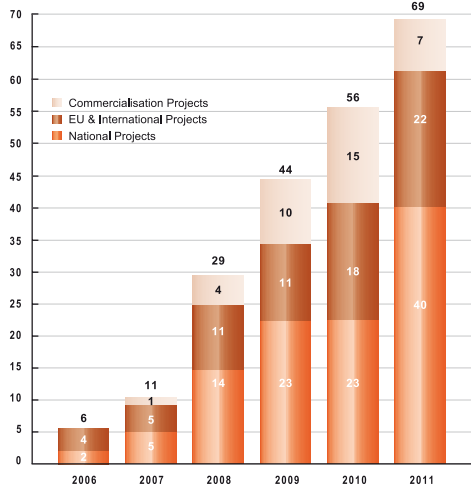
Competitive research funding is vital for ICN's financial viability and serves as an indicator of the quality and international competitiveness of the Institute's research. In 2011 total competitive funding continued to grow, with most new funding stemming from various new national research projects.

ICN measures project funding for fellowships and for projects (classified as National, EU & International, or Commercialisation). The breakdown of competitive funding at ICN for 2011, and the number of active projects at ICN each year from 2005 to 2011, are illustrated in the charts below.

**Breakdown of Competitive Funding in 2011**

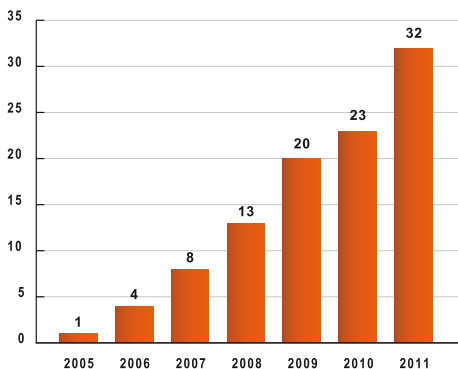


**Number of active ICN projects**

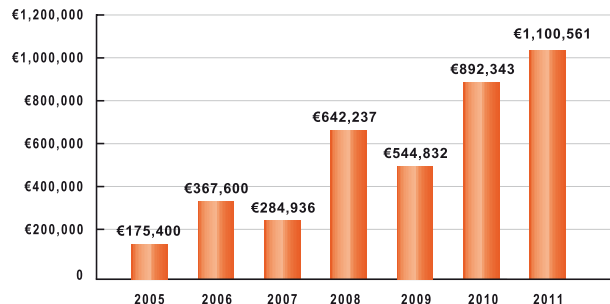


Fellowships are another important part of ICN's research funding strategy. The charts below indicate the number of fellowships and total amount awarded, respectively, for each year since research activity began at ICN (2005 to 2011).

**Funding from fellowships at ICN: 2005 to 2011**



**Funding from fellowships at ICN: 2005 to 2011**



The Management and Services team at ICN performs a wide range of functions and provides numerous support services to ICN's Research Groups, Divisions, providers and visitors. Management is led by ICN's Managing Director, Matias Pueyo, who is supported by the Managing Committee. It comprises the following departments:

**Finance** – responsible for daily accounting activities and travel bookings;

**IT** – responsible for all IT services both for ICN and CIN2;

**General Services** – responsible for building services and general maintenance for both ICN and CIN2;

**Communication** – responsible for internal and external communications and marketing activities;

**Technology Transfer** – responsible for commercial relationships and patents;

**HR** - responsible for managing personnel contracts, training and related issues.

In 2011 ICN grew from 135 to 150 people, with a corresponding increase in activity across all administrative areas. Systems development continued, with an emphasis on expanding hardware infrastructure and providing the team with the human resources that it required to serve users.

## CIN2

CIN2, the collaboration between ICN and CSIC, is managed by Ramon Cosials of the CIN2 Management Team.

## Management milestones

Seeking to provide its existing research staff with the greatest support possible, and to accommodate future expansions in research personnel, ICN fully consolidated its Management and Services team in 2011. The Institute brought to full capacity its departments of General Services, Communication, Technology Transfer and HR, and insourced its most strategic tasks.



From L to R: E. Nieto, M. Balza, A. Rodríguez, M. Pueyo, A. de la Osa, S. Domene, C. Granadero, L. Bellafont, I. Caño, D. Lizanco, C. López, M. Garrés, B. Kogon, J. Reverter, A. Francesch, J. Vela, O. Fernández, S. Bekk, O. Cardenal, C. Domínguez, R. Juan, X. Ros and L. Camarero

# 9

## FINANCE

### 9.1 Financial accounts 2011

The financial statements for 2011 are written in accordance with the Spanish General Accounting Plan 2007.

ICN's operating budget comprises income obtained through contributions from public administrations and agencies, competitive grants, and private companies (from technology transfer). The weighted average annual growth in income since 2005 has been 35%.

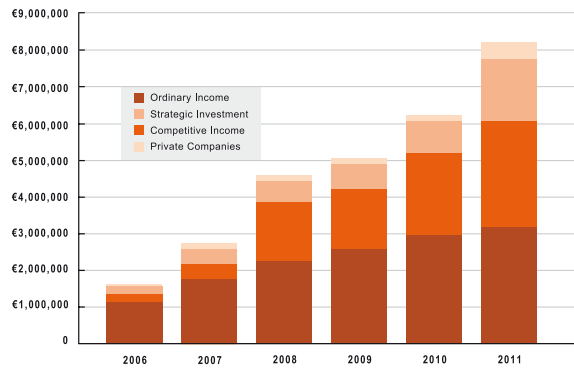
This income funds the Institute's operational activities, which chiefly comprise personnel costs, general operating expenses and depreciation. The annual result for 2011 was a budget surplus of €37,277.

### 9.2 International competitiveness

Among ICN's principal objectives is to be highly competitive at the international level, both in the quality of science it produces and the levels of competitive funding that it secures through national and international grants. To date, ICN has obtained competitive funding from numerous entities, including the European Commission, ACCIÓ, the Spanish Ministry of Education (MICINN) and the Catalan Agency of Support for Universities and Research (AGAUR). ICN is also very active in technology transfer.

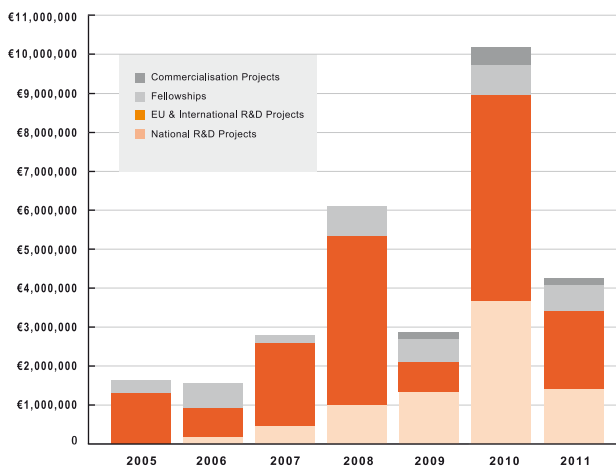
In 2011 total funding from all of these sources reached €4.6 million.

Evolution of ICN funds



2011	
<b>Ordinary Income:</b>	€3,163,929
<b>Competitive Income:</b>	€3,001,973
<b>Strategic Investment:</b>	€1,652,025
<b>Private Companies:</b>	€414,870
<b>Total Income</b>	<b>€8,232,798</b>

Evolution of ICN Competitive Funding Approvals 2005-2011





**9.3 Income**

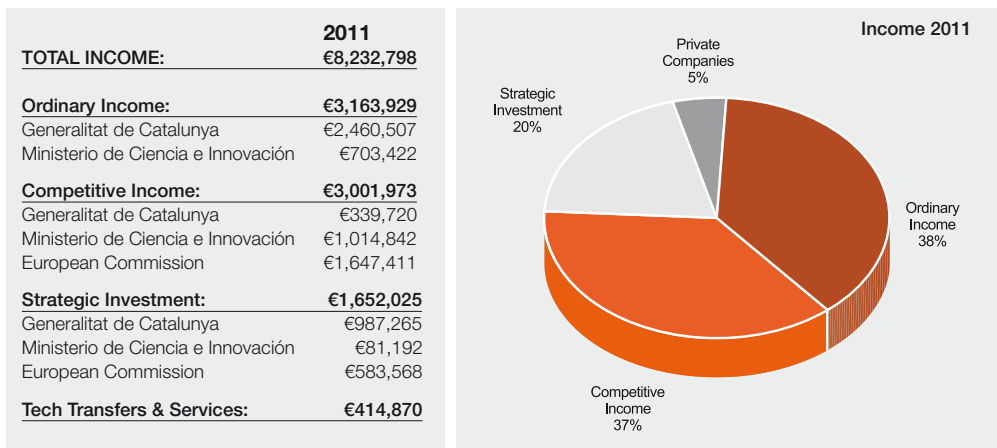
ICN's total revenue for 2011 was €8,232,798. This money chiefly stemmed from four sources:

**Ordinary Income:** funds ICN's management structure and services

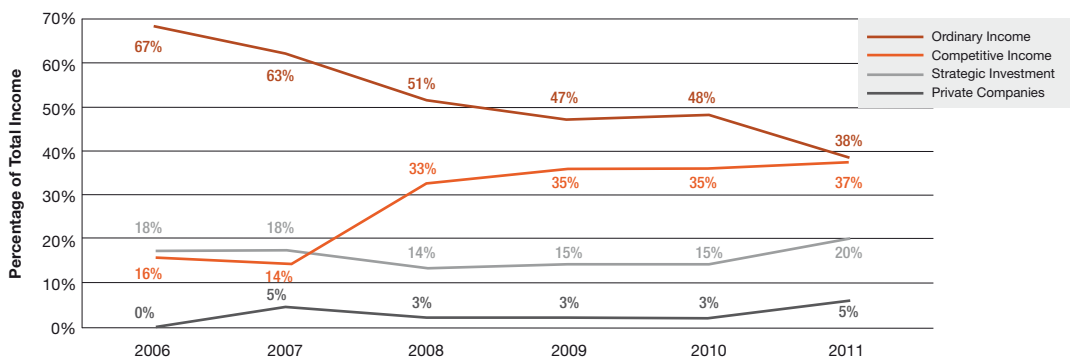
**Competitive Income:** income which funds research projects and is obtained through competitive funding from the European Union, ministries and regional governments

**Strategic Investment:** income which funds ICN's technological infrastructure and is obtained from the EU or the Generalitat

**Private Companies:** income from technology transfer, events and activities funded by private companies.



**Evolution of Income Sources**

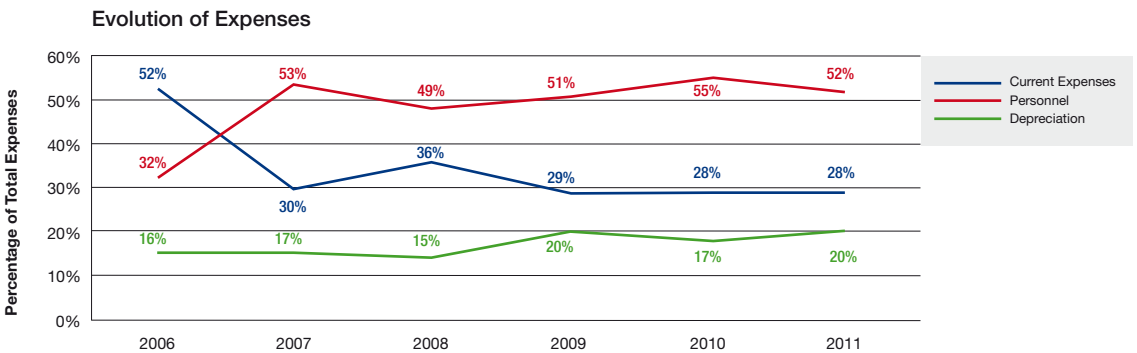
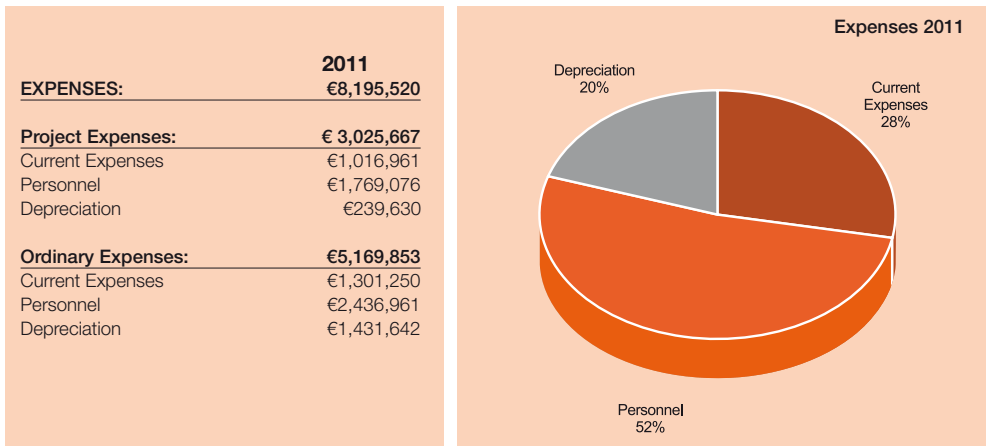


### 9.4 Expenses

ICN's total expenditure for 2011 was €8,195,521. It can be broken down into two main types of expense:

**Project Expenses:** required to do research and technology transfer. They comprise current expenses, staff costs and depreciation of equipment and facilities;

**Ordinary Expenses:** monies to fund management structure and services. They comprising current expenditure, staff costs and depreciation.

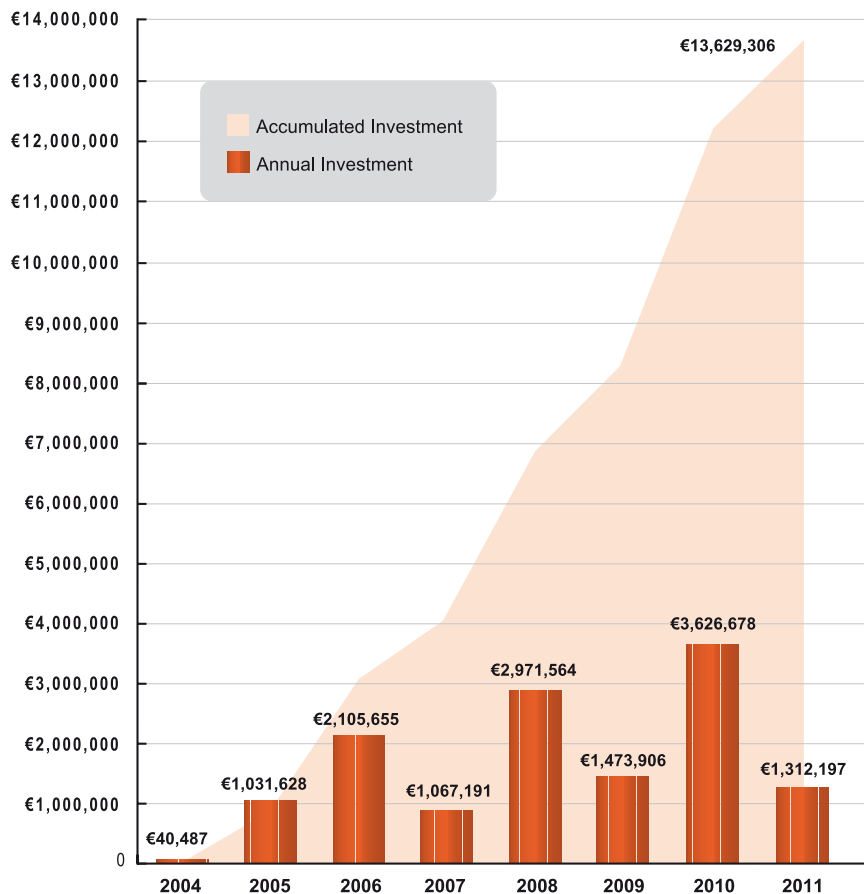


# FACILITIES AND EQUIPMENT 10

By the end of 2011, ICN's accumulated investment in scientific equipment, common services and general infrastructure was €13.6 million.

Expenditure for the year was €1.3 million. The main scientific equipment acquired comprise an NLP200 Nanolithography Platform, a HASSP-THZ spectrometer, and an AFM Module suitable for low temperature.

Evolution of ICN investments



# 11 TECHNOLOGY TRANSFER

In 2011 the Technology Transfer Office furthered its efforts to maximise ICN's research results through intellectual property and patents, commercial contracts, public sector collaborations and other endeavours.

## HIGHLIGHTS 2011

### INTELLECTUAL PROPERTY AND SPIN-OFFS

- Five new in-house technologies evaluated for patenting
- Three European priority patent applications filed
- Three patents expanded internationally, via the Patent Cooperation Treaty (PCT)
- Three patents expanded to the USA
- Second ICN licensing agreement signed (first ever from an in-house patent), for ICN patent 01/08, "Conjugates comprising nanoparticles coated with Platinum containing compounds", with the company Nanotargeting, S.L.
- Technology protected by ICN patent 01/08 chosen by the US National Cancer Institute (NCI) for accelerated pre-clinical study (funded by them) on delivery of the chemotherapy drug cisplatin by gold nanoparticles.

### COMMERCIAL CONTRACTS

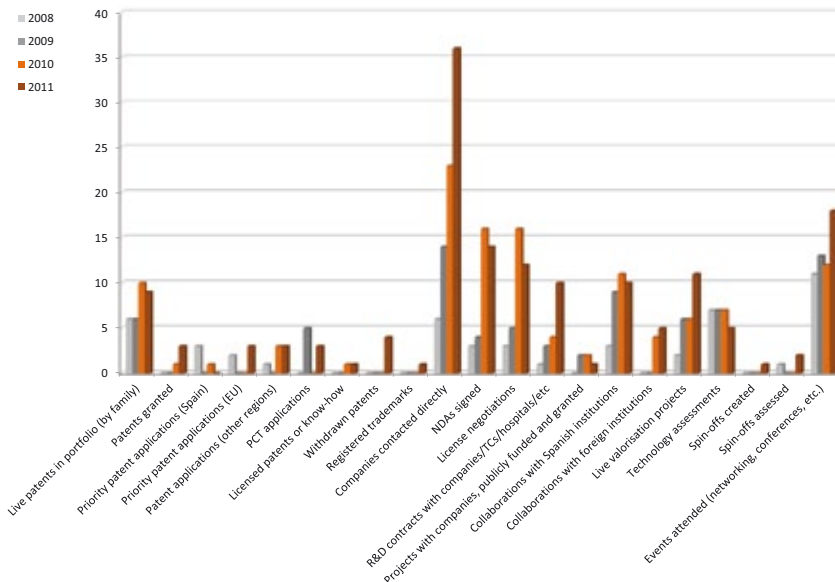
- Ten new R&D contracts with Spanish companies
- Fourteen new Non-Disclosure Agreements (NDAs) for possible licensing of ICN technologies and/or patents

### PUBLIC-SECTOR R&D PROJECTS & CONTRACTS

- One INNPACTO project granted from the Spanish Ministry of Economy and Competitiveness (MEC; previously known as MICINN), to be completed by ICN and a corporate partner
- One PROVAT project granted from the CERCA system, to be completed by ICN and a corporate partner

### OTHER HIGHLIGHTS

- \$100,000 Global Development Grant from the Bill & Melinda Gates Foundation awarded to UAB to evaluate the project that led to ICN patent 07/09, "Biogas Production"
- Proposal submitted for INNOEMPRESA project in collaboration with a corporate partner
- Working contacts established with numerous entities: CSEM, UCLA-CNSI, NCI-NCL, IBM and the Bill & Melinda Gates Foundation.



Beyond ICN's principal mission to be a centre of scientific excellence and frontier research in Nanoscience and Nanotechnology, the Institute also has a social responsibility in scientific dissemination and education. As a publicly-funded research institute, ICN is committed to serving, and engaging with, the public at all levels.

Sparking the interest of young people in Nanoscience and Nanotechnology, and providing them with the tools they need to pursue careers in these fields, is paramount to ensure ICN's future success in the research arena. Furthermore, educating the general public about these areas is essential to guaranteeing that they can understand the implications of the Institute's research and its consequent developments.

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## HIGHLIGHTS 2011

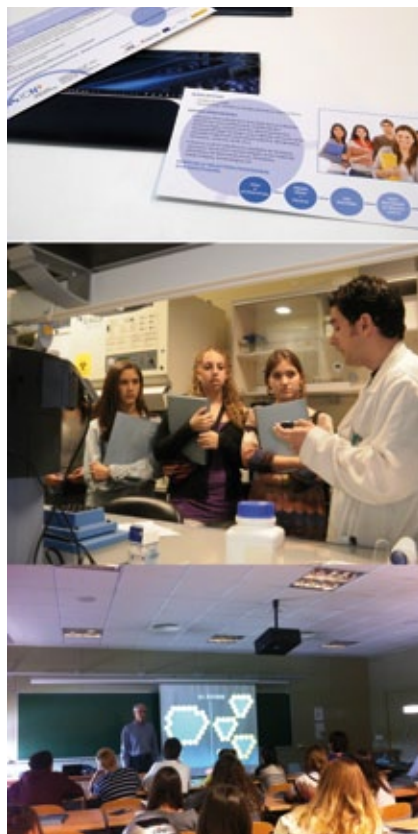
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2011 was a very active year for ICN in terms of public outreach. The Institute participated in several major initiatives and events, including:

- **Dimensió Nano:** ICN was awarded a grant from the Fundació Espanyola para la Ciència y la Tecnologia (FECYT) to create a large-scale, interactive museum exhibit to teach the public about Nanoscience and Nanotechnology. The exhibit, a collaboration between the Institute, science & technology events firm La Mandarina de Newton and the museum mNACTEC, is slated to run at mNACTEC from June 2012 to June 2013.

- **Communicating Nano:** ICN launched this multifaceted scientific communication network, in which it collaborates with creative talent at schools, universities, training centres and other entities on projects in audio-visual communications, graphic design and illustration, scientific translation and IT.

- **Saló de l'ensenyament 2011:** ICN had an interactive stand at this event, the Catalan government's annual job fair for students and professionals.



# 12 PUBLIC OUTREACH



- **Escolab 2011:** Groups of secondary school children visit ICN labs to learn about Nanoscience and Nanotechnology and to ask researchers questions.

- **Festa de la ciència 2011:** ICN had an interactive stand at this science fair, held annually in Barcelona and geared toward the general public.

- **Programa joves i ciència 2011:** High school students performed short research stays in the laboratories of four ICN groups.

- **UAB's Nanoscience and Nanotechnology undergraduate programme:** Various ICN Group Leaders teach and do other activities for this degree programme, such as giving laboratory tours and talks to visiting students.

- **Science exhibit "Això que investigues per a què serveix?" ("Why is your research important?"):** This exhibit, organised by the Catalan Association for Scientific Communication (ACCC) and dedicated to specific research areas that are underrepresented in the media, included a section

on some of the science done at ICN.

- **Science exhibit "Aquí els nostre invents" ("A look at our inventions"):** This exhibit, organised by ACCC, featured work by ICN Group Leader Prof Víctor Puentes.

- **"15 vídeos de sectors" ("15 videos from different sectors"):** ICN created a short film on Nanoscience and Nanotechnology for this video compilation project, an initiative of Barcelona Activa.

- **Talk on the 2011 Nobel Prize in Physics, at UAB:** ICN Group Leader Prof Stephan Roche gave a talk on the prestigious award.



Department	Position
Jordi Pascual	Director
Cristina Granadero	Director's Assistant

#### ATOMIC MANIPULATION AND SPECTROSCOPY GROUP

<i>Pietro Gambardella</i>	<i>ICREA Research Professor and Group Leader</i>
Aitor Mugarza	Ramon y Cajal Researcher
Alberto Lodi Rizzini	Doctoral Student
Can Onur Avci	Doctoral Student
Corneliu Nistor	Postdoctoral Researcher
Cornelius Krull	Doctoral Student
Gina Peschel	Student
Jerald Kavich	Postdoctoral Researcher
Kevin Garello	Postdoctoral Researcher
Marc Ollé	Doctoral Student
Mihai Miron	Postdoctoral Researcher
Santos Alvarado	Visiting Scientist
Sonia Matencio	Doctoral Student
Stefano Schirone	Student
Sylvie Godey	Technician
Timofey Balashov	Postdoctoral Researcher

#### INORGANIC NANOPARTICLES GROUP

<i>Víctor Puntès</i>	<i>ICREA Research Professor and Group Leader</i>
Alberto López	Doctoral Student
Cecilia López	Group Project Manager
Edgar Emir González	Doctoral Student
Eudald Casals	Doctoral Student
Isaac Ojea	Postdoctoral Researcher
Joan Comenge	Doctoral Student
Jordi Piella	Doctoral Student
José Francisco López-Barberá	Doctoral Student
Lorena García	Doctoral Student
Marta Estrader	Postdoctoral Researcher
Martí Busquets	Doctoral Student
Miriam Varón	Doctoral Student
Neus Gomez	Postdoctoral Researcher
Ngoc Tran Thi	Doctoral Student
Sofia Rubio	Doctoral Student
Vincent Jamier	Project Manager
Zoe Anna Megson	Doctoral Student

# 13

## APPENDIX

### 13.1 Personnel (by department)

#### Department

#### Position

#### MAGNETIC NANOSTRUCTURES GROUP

<i>Josep Nogués</i>	<i>ICREA Research Professor and Group Leader</i>
Alberto López	Doctoral Student
José Francisco López-Barberá	Doctoral Student
Marta Estrader	Postdoctoral Researcher

#### NANOBIOELECTRONICS AND BIOSENSORS GROUP

<i>Arben Merkoçi</i>	<i>ICREA Research Professor and Group Leader</i>
Adaris Maria López	Doctoral Student
Alfredo de la Escosura	Postdoctoral Researcher
André Santiago Afonso	Doctoral Student
Andrea Ravalli	Doctoral Student
Anna Fomitcheva	Student
Anna Puig	Group Project Manager
Briza Pérez	Postdoctoral Researcher
Carmen Clotilde Mayorga	Postdoctoral Researcher
Claudio Parolo	Doctoral Student
Edén Morales	Doctoral Student
Flavio Pino	Doctoral Student
Gemma Aragay	Postdoctoral Researcher
Helena Montón	Doctoral Student
Irene Xochilt	Student
Laura Maria Chiara	Doctoral Student
Lenka Skantarova	Doctoral Student
Lourdes Josefina Rivas	Doctoral Student
Luis Miguel Baptista	Doctoral Student
Maria Guix	Doctoral Student
Mariana Medina	Doctoral Student
Marisa Maria V.	Doctoral Student
Marisol Espinoza	Doctoral Student
Miquel Cadevall	Doctoral Student
Sandrine Miserere	Postdoctoral Researcher
Sergio Marín	Postdoctoral Researcher

#### PHONONIC AND PHOTONIC NANOSTRUCTURES GROUP

<i>Clivia Sotomayor-Torres</i>	<i>ICREA Research Professor and Group Leader</i>
(Pierre) Olivier Chapuis	Postdoctoral Researcher
Achille Francone	Postdoctoral Researcher
Claudia Delgado	Postdoctoral Researcher
Colombe Ribéreau-Gayon	Student

# APPENDIX 13

## 13.1 Personnel (by department)

Department	Position
Daniel Navarro	Postdoctoral Researcher
Emigdio Chávez	Doctoral Student
Erwan Guillotel	Project Manager
Francesc Alzina	Senior Researcher
John Cuffe	Doctoral Student
Jordi Gomis	Postdoctoral Researcher
Lars Schneider	Laboratory Engineer
Noemi Baruch	Group Project Manager
Sweta Bhansali	Doctoral Student
Timothy Kehoe	Postdoctoral Researcher
Worawut Khunsin	Postdoctoral Researcher
Yamila García	Postdoctoral Researcher

### PHYSICS AND ENGINEERING OF NANODEVICES

<i>Sergio O. Valenzuela</i>	<i>ICREA Research Professor and Group Leader</i>
German Bridoux	Postdoctoral Researcher
Ingmar Neumann	Doctoral Student
Joris Van De Vondel	Postdoctoral Researcher
Marius Costache	Ramon y Cajal Researcher

### QUANTUM NANOELECTRONIC DEVICES GROUP

<i>Adrian Bachtold</i>	<i>Group Leader</i>
Alexander Eichler	Postdoctoral Researcher
Ali Afshar	Doctoral Student
Ioannis Tsioutsios	Doctoral Student
Joel Moser	Postdoctoral Researcher
Johannes Guettinger	Postdoctoral Researcher
Julien Chaste	Postdoctoral Researcher
Marianna Sledzinska	Doctoral Student
Miguel Del Álamo	Student
Peter Weber	Doctoral Student
Santiago José Cartamil	Student

### SUPRAMOLECULAR NANOCHEMISTRY & MATERIALS GROUP (NANO<sup>UP</sup>)

<i>Daniel MasPOCH</i>	<i>ICREA Research Professor and Group Leader</i>
Àngels Ruyra	Doctoral Student
Arnau Carné	Doctoral Student
Carlos Carbonell	Doctoral Student
Emi Evangelio	Postdoctoral Researcher

# 13

## APPENDIX

### 13.1 Personnel (by department)

Department	Position
Inhar Imaz	Ramón y Cajal Researcher
Isabel Solé	Doctoral Student
Javier Ariñez	Doctoral Student
Juan Antonio Asensio	Doctoral Student
Marta González	Project Technical Manager and Group Administrator
Marta Rubio	Doctoral Student
Mary Cano	Postdoctoral Researcher
Nereida Mejías	Doctoral Student

#### **THEORETICAL AND COMPUTATIONAL NANOSCIENCE GROUP**

<i>Stephan Roche</i>	<i>ICREA Research Professor and Group Leader</i>
David Soriano	Postdoctoral Researcher
Frank Ortmann	Postdoctoral Researcher
Van Tuan Dinh	Doctoral Student

#### **ELECTRON MICROSCOPY DIVISION**

Belén Ballesteros	Division Leader
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#### **NANOFABRICATION DIVISION**

Nikolaos Kehagias	Division Leader
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#### **NANOSCIENCE INSTRUMENT DEVELOPMENT DIVISION**

Gustavo Ceballos	Division Leader
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#### **CSIC**

Carlos Sanz	Ramon y Cajal Researcher
Javier Saiz	Doctoral Student
Mar Cardellach	Doctoral Student

#### **MANAGEMENT & SERVICES**

Matias Pueyo	Managing Director
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#### **MANAGEMENT & SERVICES - CIN2 Unit**

Ramon Cosialls	CIN2 Manager
Dulce Tienda	CIN2 Director's Assistant

#### **MANAGEMENT & SERVICES - Communication**

Boaz Kogon	Communication and Strategy Manager
Ana de la Osa	Events Officer
Laura Camarero	Communication and Management Committee Assistant

Department	Position
<b>MANAGEMENT &amp; SERVICES - Finance &amp; Projects</b>	
Lluís Bellafont	Finance and Projects Manager
Elma Antón	Accounts Payable
Emma Nieto	Finance and Accounting
Inmaculada Caño	Travel and Expenses Services
Judit Vela	Finance and Accounting
Marta Balza	Funding and Projects Coordinator
Sandra Domene	Purchasing Services
Silvia Degli Abbati	Assistant
Stewe Bekk	Funding and Projects Controller
<b>MANAGEMENT &amp; SERVICES - General Services</b>	
Xavier Ros	General Services Manager
Astrid Francesch	Assistant
Carlos Germán Domínguez	Maintenance Technician
Francisco Javier Valenzuela	Maintenance Technician
<b>MANAGEMENT &amp; SERVICES - HR &amp; Education</b>	
Rosa Juan	Human Resources & Education Manager
Anabel Rodríguez	Assistant
Maria Montserrat Garrés	Internal Communication Officer
<b>MANAGEMENT &amp; SERVICES - IT</b>	
David Lizcano	IT Manager
Jordi Hernando	IT Assistant
Oliver Fernández	Assistant
Oscar Cardenal	Systems Engineer
<b>MANAGEMENT &amp; SERVICES - Technology Transfer</b>	
Jordi Reverter	Technology Transfer Manager
Cristina López	Technological Transfer Officer
<b>TECHNICIANS</b>	
Albert Llobet	Technician
Libertad Solé	Technician
Xavier Borrisé	Technician
Pablo García	Technician

**Most relevant publications (by impact factor)**

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**Perpendicular switching of a single ferromagnetic layer induced by in-plane current injection**, I. M. Miron, K. Garello, G. Gaudin, P.-J. Zermatten, M. V. Costache, S. Auffret, S. Bandera, B. Rodmacq, A. Schuhl, and P. Gambardella, *Nature*, 476, 189 (2011)

**Recent Trends in Macro, Micro and Nanomaterials Based Tools and Strategies for Heavy Metals Detection**, Gemma Aragay, Josefina Pons, Arben Merkoçi, *Chemical Reviews*, 111 (5), 3433-3458 (2011)

**Carving at the nanoscale: sequential galvanic exchange and Kirkendall growth at room temperature**, E. González, J. Arbiol and V.F. Puntes, *Science*, 334, 6061, 1377-1380 (2011)

**Nonlinear damping in mechanical resonators made from carbon nanotubes and graphene, (Highlighted)**, A. Eichler, J. Moser, J. Chaste, M. Zdrojek, I. Wilson-Rae and A. Bachtold, *Nature Nanotechnology*, 6, 339 (2011)

**Graphene gets a better gap**, S. Roche, *Nature Nanotechnology*, 6, 8 (2011)  
Magnon-drag thermopile, M.V. Costache, G. Bridoux, I. Neumann and S.O. Valenzuela, *Nature Materials*, online (DOI: 10.1038/nmat3201), (2011)

**Nanoscale metal-organic materials**, A. Carné, C. Carbonell, I. Imaz and D. Maspoch, *Chemical Society Reviews*, 40, 291-305 (2011)

**Spin coupling and relaxation inside molecule-metal contacts**, A. Mugarza, C. Krull, R. Robles, S. Stepanow, G. Ceballos, and P. Gambardella, *Nature Comm.* 2, 490 (2011)

**Parametric amplification and self-oscillation in a nanotube mechanical resonator**, A. Eichler, J. Chaste, J. Moser and A. Bachtold, *Nano Letters*, 11, 2699 (2011)

**Oxygen Surface Functionalization of Graphene Nanoribbons for Transport Gap Engineering**, A. Cresti, A. Lopez-Bezanilla, P. Ordejon and S. Roche, *ACS Nano*, 5 (11), 9271-9277 (2011)

**Single-crystal metal-organic frameworks arrays**, C. Carbonell, I. Imaz and D. Maspoch, *Journal of the American Chemical Society*, 133, 2144-2147 (2011)

**Coordination polymer nanofibers generated by microfluidic synthesis**, J. Puigmartí-Luis, M. Rubio-Martínez, U. Hartfelder, I. Imaz, D. Maspoch and P.S. Dittrich, *Journal of the American Chemical Society*, 133 (12), 4216-4219 (2011)

**Surface-directed dewetting of a block copolymer for fabricating highly uniform nanostructured microdroplets and concentric nanorings**, R. Farrell, N. Kehagias, M. T. Shaw, V. Reboud, M. Zelsmann, J. D. Holmes, C. M. Sotomayor Torres, and M. A. Morris. *ACS Nano*, 5 (2), 10731085 (2011)



**Integer quantum hall effect in trilayer graphene**, A. Kumar, W. Escoffier, J. M. Poumirol, C. Faugeras, D. P. Arovas, M. M. Fogler, F. Guinea, S. Roche, M. Goiran, B. Raquet, *Physical Review Letters*, 107, 126806 (2011)

**Magnetoresistance and Magnetic Ordering Fingerprints in Hydrogenated Graphene**, D. Soriano, N. Leconte, P. Ordejón, J.-Ch. Charlier, J.-J. Palacios, S. Roche, *Physical Review Letters*, 107, 16602(4) (2011)

**Coupling single molecule magnets to ferromagnetic substrates**, A. Lodi Rizzini, C. Krull, T. Balashov, J.J. Kavich, A. Mugarza, P.S. Miedema, P.K. Thakur, V. Sessi, S. Klyatskaya, M. Ruben, S. Stepanow, and P. Gambardella, *Physical Review Letters*, 107, 177205 (2011)

**Self-assembled nanoscale magnetic networks on surfaces: fundamental interactions and functional properties**, C. Carbone, S. Gardonio, P. Moras, S. Lounis, M. Heide, G. Bihlmayer, N. Atodiresei, P. H. Dederichs, S. Blügel, S. Vlaic, A. Lehnert, S. Ouazi, S. Rusponi, H. Brune, J. Honolka, A. Enders, K. Kern, S. Stepanow, C. Krull, T. Balashov, A. Mugarza, and P. Gambardella, *Adv. Funct. Mater.* 21, 1212 (2011)

**Controlling the length and location of in situ formed nanowires by means of microfluidic tools**, P. Kuhn, J. Puigmartí-Luis, I. Imaz, D. Maspoch and P.S. Dittrich, *Lab Chip*, 11, 753-757 (2011)

**Hardening of the Nanoparticle–Protein Corona in Metal (Au, Ag) and Oxide (Fe<sup>3</sup>O<sub>4</sub>, CoO, and CeO<sub>2</sub>) Nanoparticles**, E. Casals, T. Pfaller, A. Duschl, G. J. Oostingh and V. F. Puntes, *Small*, 7, Issue 24, 3479–3486 (2011)

**Structured Graphene Devices for Mass Transport**, A. Barreiro, R. Rurali, E. R. Hernández and A. Bachtold, *Small*, 7, 775 (2011)

**Metal-biomolecule frameworks (MBioFS)**, I. Imaz, M. Rubio-Martínez, J. An, I. Solé-Font, N.L. Rosi and D. Maspoch, *Chemical Communications*, 47, 7287-7302 (2011)

**Pt nanocrystal evolution in the presence of Au(III)-salts at room temperature: spontaneous formation of AuPt heterodimers**, Lim, S. I., Varon, M., Ojea-Jimenez, I., Arbiol, J. and Puntes, V., *J. Mater. Chem.*, 21(31), 11518–11523 (2011)

To view the full list of publications from 2011, visit ICN's website ([www.icn.cat](http://www.icn.cat)).

**EU & INTERNATIONAL PROJECTS 2011**

**Project Title:** Microscopic role of magnetism in high temperature superconductivity

**Principal Researcher:** ICREA Research Professor Pietro Gambardella

**Funding:** National Science Foundation (USA)

**Project Title:** NOMAD - Nanoscale Magnetisation Dynamic

**Principal Researcher:** ICREA Research Professor Pietro Gambardella

**Funding:** European Commission - Seventh Framework Programme (FP7)

**Project Title:** QNANO

**Principal Researcher:** ICREA Research Professor Víctor Puentes

**Funding:** European Commission (FP7-INFRASTRUCTURES)

**Project Title:** NANOPOLYTOX Toxicological impact of nanomaterials derived from processing, weathering and recycling of polymer nanocomposites used in various industrial applications.

**Principal Researcher:** ICREA Research Professor Víctor Puentes

**Funding:** European Commission

**Project Title:** NANOTOES - Nanotechnology: training of experts in safety

**Principal Researcher:** ICREA Research Professor Víctor Puentes

**Funding:** European Commission

**Project Title:** ONDA - Ordered hetero- and nano-structures with epitaxial dielectrics for magnetic and electronic applications

**Principal Researcher:** ICREA Research Professor Josep Puentes

**Funding:** European Commission

**Project Title:** Multifunctional Nanoplatforms for High Sensitive Pollution Control and Purification of Water

**Principal Researcher:** ICREA Research Professor Arben Merkoçi

**Funding:** MICINN

**Project Title:** NADINE - Nanosystems for the early diagnosis of neurodegenerative diseases

**Principal Researcher:** ICREA Research Professor Arben Merkoçi

**Funding:** European Commission

**Project Title:** Nanoparticle-based sensors for detection of chemical and biological threats

**Principal Researcher:** ICREA Research Professor Arben Merkoçi

**Funding:** NATO

**Project Title:** Nanostructured ThermoElectric Systems for Green Transport & Energy Efficient Applications (NanoTEG)

**Principal Researcher:** ICREA Research Professor Dr Clivia M. Sotomayor-Torres

**Funding:** European Community

**Project Title:** LAMAND

**Principal Researcher:** ICREA Research Professor Dr Clivia M. Sotomayor-Torres

**Funding:** European Commission

**Project Title:** NANOFUNCTION - Beyond CMOS nanodevices for adding functionalities to CMOS

**Principal Researcher:** ICREA Research Professor Dr Clivia M. Sotomayor-Torres

**Funding:** European Commission

**Project Title:** NanoPOWER - Nanoscale energy management for powering ICT devices

**Principal Researcher:** Dr Pierre Olivier Chapuis

**Funding:** European Commission

**Project Title:** NANOTEC - Ecosystems technology and design for nanoelectronics

**Principal Researcher:** ICREA Research Professor Dr Clivia M. Sotomayor-Torres

**Funding:** European Commission

**Project Title:** NaPANIL - Nanopatterning, Production and Applications based on Nanoimprinting Lithography

**Principal Researcher:** ICREA Research Professor Dr Clivia M. Sotomayor-Torres

**Funding:** European Commission - Seventh Framework Programme (FP7)

**Project Title:** SEAL - Semiconductor equipment assessment leveraging innovation

**Principal Researcher:** Dr Timothy Kehoe

**Funding:** European Commission

**Project Title:** TAILPHOX - TAILoring photon-phonon interaction in silicon PHOXonic crystals

**Principal Researcher:** ICREA Research Professor Dr Clivia M. Sotomayor-Torres

**Funding:** European Commission - Seventh Framework Programme (FP7)

**Project Title:** Mechanical Amplification in Carbon-based NanoElectroMechanical Systems (MACNEMS)

**Principal Researcher:** Prof Adrian Bachtold

**Funding:** European Commission - Seventh Framework Programme (FP7)

**Project Title:** RODIN - Suspended graphene nanostructures

**Principal Researcher:** Prof Adrian Bachtold

**Funding:** European Commission - Seventh Framework Programme (FP7)

**Project Title:** Graphene-Driven Revolutions in ICT and Beyond (GRAPHENE-CA)

**Principal Researcher:** ICREA Research Professor Stephan Roche

**Funding:** European Commission

**Project Title:** European multiscale simulation for the computational era (MULT-EU-SIM)

**Principal Researcher:** ICREA Research Professor Stephan Roche

**Funding:** European Commission

**Project Title:** Transpyrenees Action on Advanced Infrastructures for Nanosciences and Nanotechnologies (TRAIN2)

**Principal Researcher:** ICREA Research Professor Stephan Roche

**Funding:** SUDOE Territorial Cooperation Programme

**Project Title:** Multiscale Charge-Transport Simulation of Organic-Based Materials and Devices (TRANSSIM)

**Principal Researcher:** ICREA Research Professor Stephan Roche

**Funding:** European Commission

### NATIONAL PROJECTS 2011

**Project Title:** NANOBIOEMED - NANOTEchnologies in BIOMEDicine

**Principal Researcher:** V. PUNTES, J. PASQUAL, E. MENDOZA, A. MERKOÇI

**Funding:** Spanish Ministry of Science and Innovation (MICINN)

**Project Title:** NANOWAVE-Nanowire based Microwave Emitters for Use in Monolithic Microwave Integrated Circuits

**Principal Researcher:** ICREA Research Pro-

fessor Pietro Gambardella

**Funding:** Spanish Ministry of Science and Innovation (MICINN)

**Project Title:** SGR

**Principal Researcher:** ICREA Research Professor Pietro Gambardella

**Funding:** Agència de Gestió d'Ajuts Universitaris i de Recerca (AGAUR)

**Project Title:** Study of the optoelectromechanic properties of individual molecules and the effect of electrodes coupling and the interaction with other molecules in their integration into real devices

**Principal Researcher:** Ramón y Cajal Researcher Dr Aitor Mugarza

**Funding:** Spanish Ministry of Science and Innovation

**Project Title:** CNBSS

**Principal Researcher:** ICREA Research Professor Víctor Puentes

**Funding:** Spanish Ministry of Science and Innovation (MICINN)

**Project Title:** Design of inorganic conjugated nanoparticles: new tools for cancer treatment

**Principal Researcher:** ICREA Research Professor Víctor Puentes

**Funding:** Spanish Ministry of Science and Innovation (MICINN)

**Project Title:** SGR

**Principal Researcher:** ICREA Research Professor Víctor Puentes

**Funding:** Agència de Gestió d'Ajuts Universitaris i de Recerca (AGAUR)

**Project Title:** Modulación de las propiedades magnéticas de nanopartículas y estructuras

litografiadas, mediante parámetros intrínsecos y extrínsecos (MAGTUNE)

**Principal Researcher:**

**Funding:** Spanish Ministry of Science and Innovation (MICINN)

**Project Title:** Evaluation of the calcium-sensing receptor as a novel candidate tumor suppressor gene and therapeutic target in neuroblastic tumors

**Principal Researcher:**

**Funding:** CELLEX Foundation

**Project Title:** Development of novel nanomaterial based targeting approaches as emerging universal platforms with interest to develop biosensors.

**Principal Researcher:** ICREA Research Professor Arben Merkoçi

**Funding:** Spanish Ministry of Science and Innovation (MICINN)

**Project Title:** SGR

**Principal Researcher:** ICREA Research Professor Arben Merkoçi

**Funding:** Agència de Gestió d'Ajuts Universitaris i de Recerca (AGAUR)

**Project Title:** Nanobiosensors for tumoral markers

**Principal Researcher:** ICREA Research Professor Arben Merkoçi

**Funding:** Ministry of Science and Innovation

**Project Title:** WARMER - Water Risk Management in euRope

**Principal Researcher:** ICREA Research Professor Arben Merkoçi

**Funding:** Agència de Gestió d'Ajuts Universitaris i de Recerca (AGAUR)

**Project Title:** Water multifunctional processing system based on nanoplateforms for ultra-sensitive detection and purification of environmental pollutants

**Principal Researcher:** ICREA Research Professor Arben Merkoçi

**Funding:** Spanish Ministry of Science and Innovation (MICINN)

**Project Title:** ACHPIN - Study of confined acoustic phonons in fabricated nanostructures

**Principal Researcher:** ICREA Research Professor Dr Clivia M. Sotomayor-Torres

**Funding:** Ministry for Science and Innovation

**Project Title:** nanoTHERM - Tailoring electronic and phononic properties of nanomaterials: towards ideal thermoelectricity

**Principal Researcher:** ICREA Research Professor Dr Clivia M. Sotomayor-Torres

**Funding:** Ministry for Science and Innovation

**Project Title:** SGR

**Principal Researcher:** ICREA Research Professor Dr Clivia M. Sotomayor-Torres

**Funding:** Agència de Gestió d'Ajuts Universitaris i de Recerca (AGAUR)

**Project Title:** "Transporte de espines y dinámica de la magnetización en nanoestructuras" (Spin transport and magnetisation dynamics in nanostructures)

**Principal Researcher:** ICREA Research Professor Sergio Valenzuela

**Funding:** MICINN

**Project Title:** "Espectroscopia tunel de electrones polarizados: una nueva herramienta para el desarrollo de memorias magnéticas de ultra-alta densidad" (Tunnelling spectroscopy of polarised electrons: a new tool to develop

ultra-high density magnetic memory)

**Principal Researcher:** ICREA Research Professor Sergio Valenzuela

**Funding:** MICINN

**Project Title:** SRTS - Polarized electrons tunnel spectroscopy: a new tool for the development of ultra-high density magnetic memories

**Principal Researcher:** ICREA Research Professor Dr Sergio O. Valenzuela

**Funding:** Spanish Science and Innovation Ministry (MICINN)

**Project Title:** DESPRO NANO - Long lasting disinfectants

**Principal Researcher:** ICREA Research Professor Daniel Maspoch

**Funding:** Spanish Ministry of Science and Innovation

**Project Title:** MOLCHIP - Molecular Chips

**Principal Researcher:** ICREA Research Professor Daniel Maspoch

**Funding:** Spanish Ministry of Science and Innovation (MICINN)

**Project Title:** NANOQUA - Use of nanospheres as vehicles for immunostimulant administration in aquaculture

**Principal Researcher:** ICREA Research Professor Daniel Maspoch

**Funding:** Fundación Ramón Areces

**Project Title:** NANO-SCENT - Controlled release of fragrances

**Principal Researcher:** ICREA Research Professor Daniel Maspoch

**Funding:** Spanish Ministry of Science and Innovation

**Project Title:** Safety food - development of

# 13

## APPENDIX

### 13.3 Projects

novel technologies based on phages for controlling salmonellosis

**Principal Researcher:** ICREA Research Professor Daniel Maspocho

**Funding:** Obra Social La Caixa, Programa Recercaixa

**Project Title:** AUTORREPARA - Desarrollo de Recubrimientos Protectores para Madera con Capacidad de Autorreparación mediante el empleo de Tecnologías de Micro- y Nanoencapsulación

**Principal Researcher:** ICREA Research Professor Daniel Maspocho

**Funding:** MICINN

**Project Title:** Valorització d'un còctel fàgic mitjançant tècniques de nanoencapsulació pel control de la salmonel·losi

**Principal Researcher:** ICREA Research Professor Daniel Maspocho

**Funding:** AGAUR

#### TECHNOLOGY TRANSFER PROJECTS 2011

**Project Title:** CISPLATIN

**Principal Researcher:** ICREA Research Professor Víctor Puentes

**Funding:** ACC1Ó (Generalitat of Catalonia)

**Project Title:** In vivo evaluation of potential nanoconjugates as adjuvant for flu vaccines

**Principal Researcher:** ICREA Research Professor Víctor Puentes

**Funding:** ACC1Ó (Generalitat of Catalonia)

**Project Title:** Diagnostic system for detecting breast cancer

**Principal Researcher:** ICREA Research Professor Arben Merkoçi

**Funding:** ACC1Ó (Generalitat of Catalonia)

**Project Title:** Evaluation of the biocompatibil-

ity and toxicity of micro and nanoparticles.

**Principal Researcher:** ICREA Research Professor Daniel Maspocho

**Funding:** ACC1Ó (Generalitat of Catalonia)

**Project Title:** Evaluation of the encapsulation of fragrances, clothes adhesion and friction liberation of metalorganic micro-and nanoparticles for softeners.

**Principal Researcher:** ICREA Research Professor Daniel Maspocho

**Funding:** ACC1Ó (Generalitat of Catalonia)

#### COMMERCIALISATION PROJECTS 2011

**Project Title:** Development of fragrance-encapsulation systems for laundry products

**Principal Researcher:** ICREA Research Professor Daniel Maspocho

**Funding:** Private company

**Project Title:** Encapsulation of biocides in metal-organic micro- and nanosystems to extend their biocidal activity

**Principal Researcher:** ICREA Research Professor Daniel Maspocho

**Funding:** Private company

**Project Title:** Encapsulation of fungicides in metal-organic, micro-and nanosystems

**Principal Researcher:** ICREA Research Professor Daniel Maspocho

**Funding:** Private company

**Project Title:** Evaluation of the encapsulation of fragrances, clothes adhesion and friction liberation of metal-organic micro-and nanoparticles for softeners

**Principal Researcher:** ICREA Research Professor Daniel Maspocho

**Funding:** Commercial contract





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