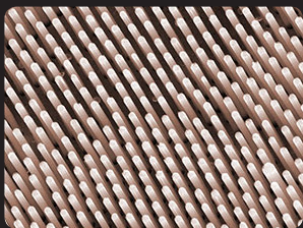


ICN ANNUAL REPORT 2012

CREATING A DIMENSION OF INFINITE POSSIBILITIES



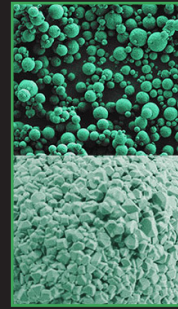
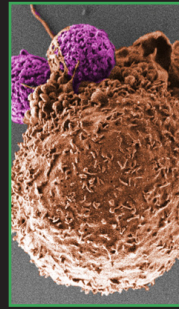
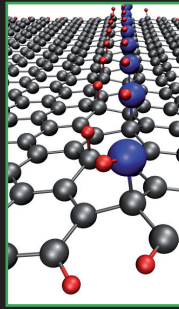
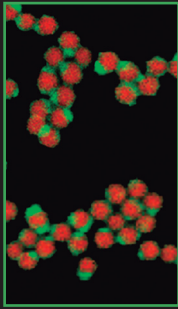
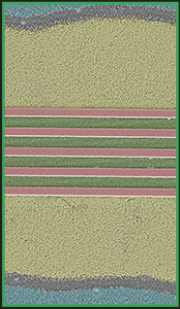
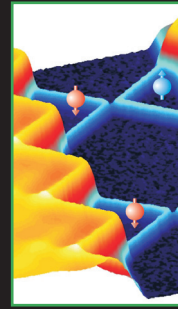
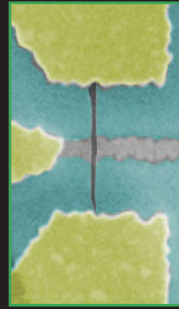
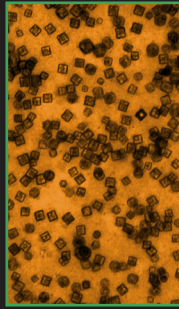
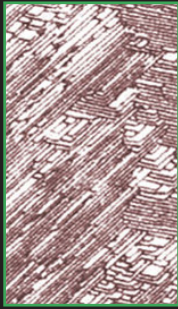
Institut Català
de Nanotecnologia



Annual Report 2012
Institut Català de Nanotecnologia (ICN)
Marketing and Communication Department

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LETTER FROM THE DIRECTOR

1



2012 was a year of change for the Catalan Institute of Nanotechnology (ICN).

Firstly, we have worked hard to prepare for the profound changes that the merger of our Research Groups with those of CSIC will imply. The merger will lead to an increase in scientific personnel and strengthen ICN's scientific impact, economic resources, and competitiveness. Upon its completion, we will change our name to the Catalan Institute of Nanoscience and Nanotechnology (ICN2).

Another major event in 2012 was the change of Director. Dr Jordi Pascual, who began his term in April 2005, stepped down in April 2012. His leadership, hard work and determination were paramount in making ICN a leading centre. On behalf of ICN, I would like to express our deep gratitude to him.

Our agreements with CSIC enabled another important milestone in 2012: we began moving into our new building, on the UAB campus. The structure is a visual testament to our collaboration and integration with CSIC, and has enabled tremendous improvements in working conditions for all the Research Groups. Much of the scientific equipment that we acquired over the past few years was finally installed and is now up and running. Coming together in one building has meant that our staff is no longer dispersed around the campus, which is helping to foster collaboration and unity among all ICN personnel.

Despite the changes in 2012, scientific activity at ICN did not slow down. The number of indexed publications (77) was close to that of the previous year, while the impact factor remained remarkably high (6.65). In 2012 ICN ranked among the top ten Spanish research in-

stitutions for all measures of research quality: it ranked 2nd in Excellence Rate; 7th in Normalised Impact Factor; and 8th in High-Quality Publications (Source: Scimago Institutions Ranking World Report 2012, as quoted by FECyT's ICONO Report 2012).

In 2012 ICN continued to attract competitive funds. Especially noteworthy were two European Research Council (ERC) Starting Grants, awarded to Prof Sergio Valenzuela and also to Prof Gustau Catalán, who joined ICN the same year. ICN was strongly involved in the preparation of two of the six finalist Pilot Actions competing for the European Commission's FET Flagship Programme: Graphene and Guardian Angels.

ICN is constantly endeavouring to increase the economic return on public investments in research. In 2012 we continued our efforts to transfer our research findings to the productive sector. In fact, we set Technology Transfer as one of our main strategic objectives for the future. Thus, we will continue to secure the intellectual property and commercial exploitation rights to research results through patent applications and licensing agreements, and to actively seek R&D collaborations with companies. In 2012 we established several collaborations, some of which have already resulted in research contracts with Spanish and international companies (e.g. Samsung, through a joint agreement with UAB), and some of which will hopefully materialise in 2013.

In summary, 2012 was a challenging but fruitful year for ICN. Despite the difficulties, our staff performed exceptionally well. Thus, I am confident that we are poised for a bright future.

Sincerely yours,

Dr Pablo Ordejón
Director, ICN

A handwritten signature in black ink, appearing to read 'P. Ordejón', written in a cursive style.

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 (DIUE) of the Catalan government, and the Universitat Autònoma de Barcelona (UAB).

ICN is led by its Director, who reports to the Board of Patrons and is advised by the Scientific Advisory Board, made up of distinguished international scientists. In April 2012, ICN Director Dr Jordi Pascual left the Institute. Dr Pablo Ordejón took over as Director the following July.

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.

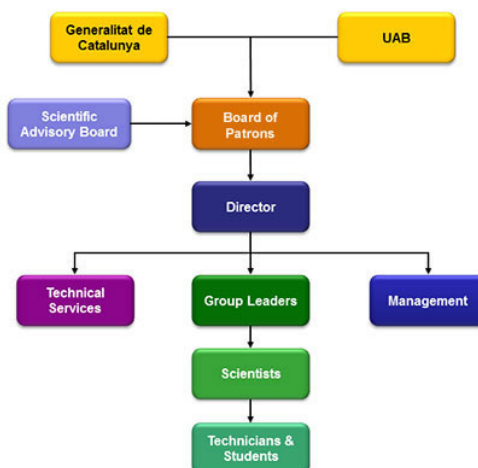
In 2012 the number of Research Groups at ICN remained nine*:

- 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

* In third quarter 2012 the Oxide Nanoelectronics Group joined ICN, and on 31 December the Quantum Nanoelectronics Group moved to the Catalan Institute of Photonic Sciences (ICFO).

During 2012 ICN's three Technical Development & Support Divisions (Electron Microscopy; Nanofabrication; and Nanoscience Instrument Development), created in 2010, consolidated their activities and 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

Andreu Mas-Colell, Minister of Economy and Knowledge, Generalitat de Catalunya

VICE-PRESIDENT

Ana Ripoll, Chancellor, Universitat Autònoma de Barcelona (UAB) (until June 2012)

Ferran Sancho Pifarré, Chancellor, Universitat Autònoma de Barcelona (UAB) (from June 2012)

MEMBERS

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-rector of Strategic Projects, Universitat Autònoma de Barcelona (UAB) (until June 2012)

Lluís Tort Bardolet, Vice-rector of Strategic Projects, Universitat Autònoma de Barcelona (UAB) (from June 2012)

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

Prof Dolors Baró, Professor of Physics, Universitat Autònoma de Barcelona (UAB); appointed by the UAB

2.4 Scientific Advisory Board 2012

PRESIDENT

Prof Miquel Salmerón

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

MEMBERS

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, Microelectronics Institute of Madrid (IMM - CSIC); Madrid, Spain

Prof Manuel Cardona

Co-founder and Emeritus Professor, the Max Planck Institut; Stuttgart, Baden-Württemberg, Germany

Prof Bruno Chaudret

Director, 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, Department of Physics, Chalmers University of Technology; Gothenburg, Sweden

Prof Jörg P. Kotthaus

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

Prof Ernst Meyer

Professor, 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.

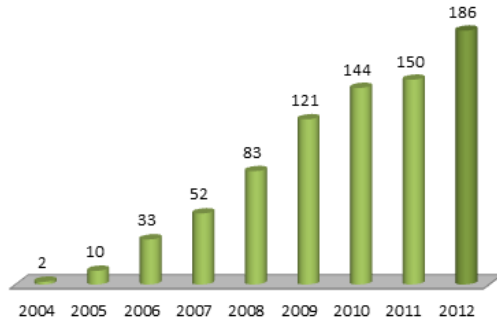
ICN prides itself on being an attractor of talent, seeking to provide an environment and an image of excellence that draws talented scientists, technicians and support personnel from around the world. The Institute has succeeded in this endeavour, as embodied in its highly-qualified scientific staff 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 institutes, CNRS and CEA. Thus, ICN is continuously offering new positions for junior scientists.

In response to greater competitive funding and increased scientific hiring in 2011, ICN set for 2012 a target workforce of 186 people (starting from 150). 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.

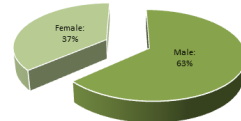
ICN is an equal opportunity employer and seeks a workforce diverse in age, culture nationality and gender. By the end of 2012, ICN personnel represented 38 different nationalities; women comprised 37% of all personnel, a slight decrease from the previous year. Scientific & Technical personnel, and students, represented over 75% of all staff.

2.6 Statistics

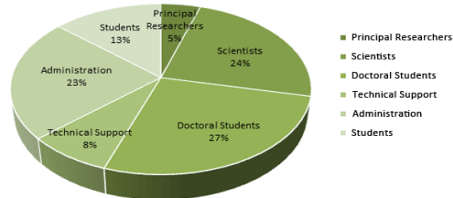
STAFF EVOLUTION: 2004-2012



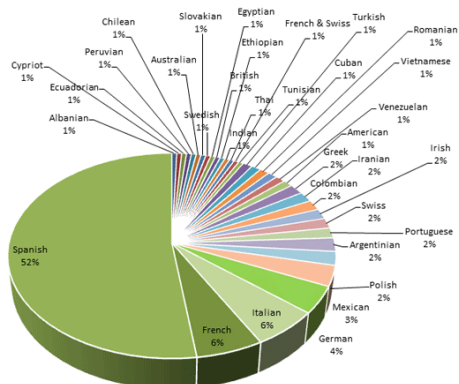
STAFF BY GENDER: 2012



STAFF BY ROLE: 2012



STAFF NATIONALITIES: 2012



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: K. Garelo, C.O. Avci, P. Gambardella, S. Godey, A. Lodi-Rizzini, A. Mugarza, C. Krull, C. Nistor and M. Ollé
Not shown: R.F. Piquere and S. Schirone

NEW PROJECTS & MILESTONES

In 2012 the Atomic Manipulation and Spectroscopy Group focused on two main objectives:

A long-term research goal in the field of new materials concerns the synthesis and study of hybrid metal-organic layers for magnetoelectronic applications. For example, local probe investigations have revealed how the electrical and magnetic properties of very small molecules change in function of their proximity to a metal; how to tailor the epitaxial growth of nano-sized graphene islands on a nickel substrate; and how such graphene islands may act as spin filters for electrons.

A shorter-term research goal concerns a proposal for developing a non-volatile fast magnetic memory for power efficient and scalable microprocessors. This proposal, based on fundamental

3

RESEARCH

3.1 Atomic Manipulation and Spectroscopy Group

observations done at ICN, has evolved into a consortium composed of leading EU players (Spin-tec, the Karlsruhe Institute of Technology, LETI and Singulus GmbH), which has received funding for 3 years to demonstrate the feasibility of the project and fabricate the first memory prototype.

KEY PUBLICATIONS AND INVITED TALKS 2012

Yield and Shape Selection of Graphene Nanoislands Grown on Ni(111), M. Olle, G. Ceballos, D. Serrate, and P. Gambardella, *Nano Lett.*, **12** (9), 4431-4436 (2012)

Exchange biasing single molecule magnets: coupling of TbPc2 to antiferromagnetic layers, A. Lodi Rizzini, C. Krull, T. Balashov, A. Mugarza, C. Nistor, F. Yakhov, V. Sessi, S. Klyatskaya, M. Ruben, S. Stepanow, and P. Gambardella, *Nano Lett.* **12**, 5703 (2012)

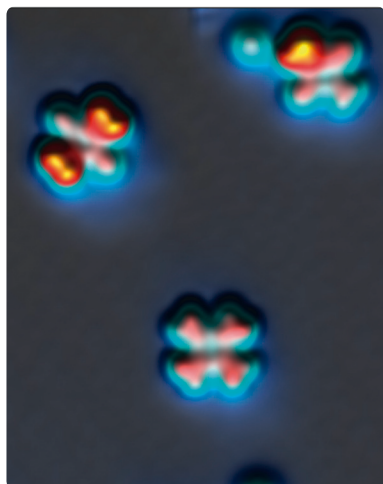
Magnetic properties of planar nanowire arrays of Co fabricated on oxidized step-bunched silicon templates, S.K. Arora, B.J. O'Dowd, B. Ballesteros, P. Gambardella, and I.V. Shvets, *Nanotechnology* **23**, 235702 (2012)

Electronic and magnetic properties of molecule-metal interfaces: transition metal phthalocyanines adsorbed on Ag(100), A. Mugarza, R. Robles, C. Krull, R. Korytar, N. Lorente, P. Gambardella, *Physical Review B*, **85**, 155437 (2012)

Charge Transfer, Electron Correlation, and Spin Coupling at the Interface between Molecules and Metals, P. Gambardella, International Conference of Nanoscience and Technology (ICN+T 2012), Paris, France, 23-27 July, Invited Lecture (2012)

Spin and charge at the molecule-metal interface, A. Mugarza, University of Tokyo, Tokyo, Japan, Invited Lecture (2012)

OTHER HIGHLIGHTS IN 2012



Awards & Honours:

Researcher Can Onur Avci won the European Physical Society (EPS) Poster Prize at the 2012 Joint European Magnetic Symposia (JEMS)

Doctoral theses:

Two doctoral students from the Group defended their theses in 2012: Cornelius Krull, "Synthesis and electronic properties of metal-organic layers", 5 June

Alberto Lodi Rizzini, "Coupling of metal-organic complexes to magnetic substrates investigated by polarized x-ray absorption spectroscopy", 30 November

The Inorganic Nanoparticles Group, led by ICREA Research Professor Víctor Puentes, 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: S. Rubio, N.G. Bastús, M. Busquets, J. Patarroyo, E. Casals, J. Piella and V.F. Puentes

Not shown: J. Comenge, L. García, E. González, S. Goy, E. Izak, V. Jamier, C. López, I. Ojea, N. Tran Thi Thanh and M. Varón

NEW PROJECTS & MILESTONES IN 2012

In 2012 the Inorganic Nanoparticles Group completed several of its on-going projects, such as VALTEC Vacunes, and began many new ones, such as one for the EC's 7th Framework Programme, entitled "Developing New Strategies for the Production of Viable Hybrid Nanocrystals with Applicability in Energy Conversion and (Photo)catalysis".

It licensed out its patent WO 2010/069941 (Bioconjugated gold nanoparticles for drug delivery in cancer treatment) to the recently created biotech company Nanotargeting, S.L. The research behind this initiative was published in a comprehensive paper on the use of nanoparticles for drug

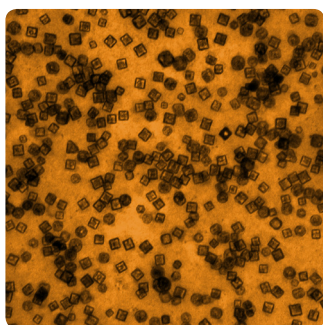
3

RESEARCH

3.2 Inorganic Nanoparticles Group

delivery (specifically, gold nanoparticles to detoxify cisplatin) in the open-access journal *PLoS ONE*, and the creation of the company received widespread media coverage (Spanish national TV [RTVE], and the Catalan newspapers *La Vanguardia* and *Ara*).

The Group also obtained one of the 29 grants awarded from Fundació La Marató for a project entitled “Cerium Oxide nanoparticles as a new therapeutic tool for tissue regeneration in liver diseases”, which was slated to begin in January 2013.



KEY PUBLICATIONS AND INVITED TALKS 2012

Citrate-Coated Gold Nanoparticles As Smart Scavengers for Mercury(II) Removal from Polluted Waters, Ojea-Jiménez, I., López, X., Arbiol, J., & Puentes, V., *ACS Nano*, **6**, 2253–2260 (2012)

Facile Preparation of Cationic Gold Nanoparticle-Bioconjugates for Cell Penetration and Nuclear Targeting, Ojea-Jiménez, I., García-Fernández, L., Lorenzo, J., & Puentes, V. F. *ACS Nano*, **6** (9), 7692–7702, (2012)

Synthesis of Co-Organosilane-Au Nanocomposites via a Controlled Interphasic Reduction, Ojea-Jiménez, I., Lorenzo, J., Rebled, J. M., Sendra, J., Arbiol, J., & Puentes, V. (2012). *Chem. Mater.*, **24** (21), 4019–4027

Physicochemical Characteristics of Protein-NP Bioconjugates: The Role of Particle Curvature and Solution Conditions on Human Serum Albumin Conformation and Fibrillogenesis Inhibition, Goy-López, S., Juárez, J., Alatorre-Meda, M., Casals, E., Puentes, V. F., Taboada, P., et al., *Langmuir*, **28**, 9113–9126 (2012)

Rational Nanoconjugation Improves Biocatalytic Performance of Enzymes: Aldol Addition Catalyzed by Immobilized Rhamnulose-1-Phosphate Aldolase, Ardao, I., Comenge, J., Benaiges, M. D., Álvaro, G., & Puentes, V. F., *Langmuir*, **28**, 6461–6467 (2012)

Carving at the Nanoscale: Galvanic Replacement versus Kirkendall Effect at Room Temperature, V. Puentes, *NaNaX5* (2012) – Nanoscience with Nanocrystals, Plenary Talk, Furingola, Spain, May 2012

OTHER HIGHLIGHTS IN 2012

Books and book chapters:

Inorganic Nanoparticles and the Environment: Balancing Benefits and Risks (chapter), Casals, E., Gonzalez, E., Puentes, V., *Comp. Anal. Chem.*, Vol. 59, *Analysis and Risk of Nanomaterials in Environmental and Food Samples*, 265–290 (2012)

The Reactivity of Colloidal Inorganic Nanoparticles (chapter), Bastús, N.G., Casals, E., Ojea, I., Varon, M., & Puentes, V., *The Delivery of Nanoparticles*, 1-25 (2012)

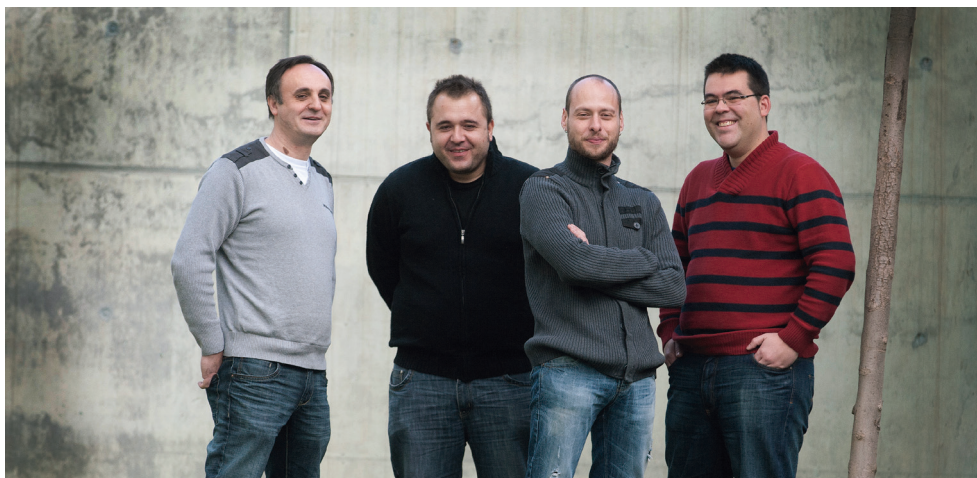
Nanoparticles Before Nanotechnology, Saldaña, J. & Puentes, V. 74 pages (2012)

Awards & Honours:

Dr Neus Gómez Bastús was awarded a Marie Curie Career Integration Grant (CIG), for the new FP7 project described above.

Commercial endeavours: Together with artisans and business people, the Group launched Gold Light Quantum Jewels, a line of jewellery based on its metal nanoparticles research.

Led by ICREA Research Professor 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: Lithographed Magnetic Nanostructures; Magnetic Nanoparticles; and Other Magnetic Systems.



From L to R: J. Nogués, E. Menéndez, J.F. López-Barberà and A. Gómez (*)

Not shown: A. López

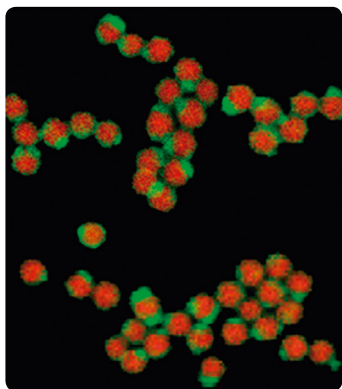
* Began in 2013

NEW PROJECTS & MILESTONES IN 2012

In 2012, the Group continued working on the study of core/shell nanoparticles and magnetic nanostructures in the context of various on-going projects (MAGTUNE and ONDA). It began work on a new project based on magnetic nanowires: MANAQUA.

MANAQUA (Magnetic Nano Actuators for Quantitative Analysis)

The MANAQUA project is a multidisciplinary approach that combines innovative technologies emerging from nanotechnology, biochemistry, and nanorobotics. The MANAQUA project goal is to achieve a technological breakthrough by developing a new method for biological single-molecule measurements. The major technological aim is to develop single-molecule assays by integrating micro-scale cantilevers with functionalised magnetic nanowires (NW) electromagnetically controlled along multiple degrees-of-freedom.



 KEY PUBLICATIONS AND INVITED TALKS 2012

Mesoscopic model for the simulation of large arrays of bi-magnetic core/shell nanoparticles, G. Margaris , K. N. Trohidou, J. Nogués, *Advanced Materials*, **24**, 4331–4336 (2012)

Strongly exchange coupled inverse ferrimagnetic soft/hard, $Mn_xFe_{3-x}O_4$, A. López-Ortega, M. Estrader, G. Salazar-Alvarez, S. Estradé, I. V. Golosovsky, R. K. Dumas, D.J. Keavney, M. Vasilakaki, K.N. Trohidou, J. Sort, F. Peiró, S. Suriñach, M. D. Baró, J. Nogués, *Nanoscale*, **4**, 5138-5147 (2012)

EEL spectroscopic tomography: Towards a new dimension in nanomaterials analysis, Ll. Yedra, A. Eljarrat, R. Arenal, E. Pellicer, M. Cabo, A. López-Ortega, M. Estrader, J. Sort, M.D. Baró, S. Estradé, F. Peiró, *Ultramicroscopy*, **122**, 12-18 (2012)

Distinguishing the core from the shell in MnO_x/MnO_y and FeO_x/MnO_x core/shell nanoparticles through quantitative electron energy loss spectroscopy (EELS) analysis, S. Estradé, Ll. Yedra, A. López-Ortega, M. Estrader, G. Salazar-Alvarez, M.D. Baró, J. Nogués, F. Peiró, *Micron*, **43**, 30-36 (2012)

Neutron diffraction studies of the bi-magnetic nanosystems “core-shell”, I.V. Golosovsky, A. Lopez-Ortega, M. Estrader , E. Pellicer, M. Gonzalez, J. Sort, S. Suriñach, M.D. Baro, and J. Nogués, International Conference on Neutrons in Condensed Matter Studies, St. Petersburg, Russian Federation, Invited Talk (2012)

Heterostructured bi-magnetic soft-hard core-shell nanoparticles, A. Lopez-Ortega, M. Estrader, G. Salazar-Alvarez, S. Estarde, I.V. Golosovsky R.K. Dumas, D.J. Keavney, M. Vasilakaki, K.N. Trohidou, J. Sort, F. Peiro, S. Suriñach, M.D. Baro and J. Nogués, Autumn Meeting, Japanese Society of Applied Physics, Matsuyama, Japan, Invited Talk (2012)

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: M. Guix, C. Mayorga, A.M. López, L.M. Baptista, A. de la Escosura, S. Miserere, À. Chamorro, A. Puig, F. Pino, M. Espinoza, L.J. Rivas, B. Pérez, A. Fomitcheva, E. Morales, M. Cadevall, A. Hussein and A. Merkoçi
Not shown: R. Alvarez, G. Aragay, D. Bas, L. Hlavata, D. Kats, C. Llavina, M. Maltz, A. Mars, D. Martínez, M. Medina, H. Montón, C. Parolo, R. Ponce, D. Quesada, G. Rabost, E. Rodríguez and A. Zamora

NEW PROJECTS & MILESTONES IN 2012

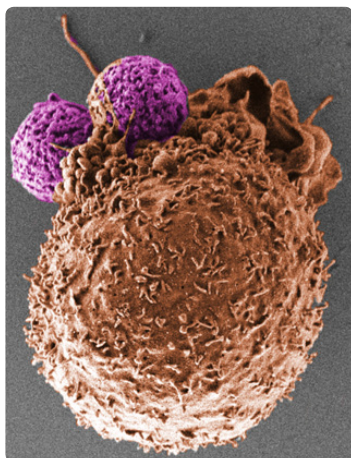
The Nanobioelectronics and Biosensors Group continued with several of its on-going projects and began two new European projects (POC4PETS and PEPTIDE NANOSENSORS) and one national project (NANOHEROES).

Point of care diagnostics for rapid and cheap pathogen detection of companion animals (POC-4PETS): This project is aimed at delivering an innovative set of technologies for sample prepara-

3

RESEARCH

3.4 Nanobioelectronics and Biosensors Group



tion and enrichment for rapid point of care (POC) diagnosis of companion-animal pathologies. The research objective is to identify pathologic agents via different nucleic acid detection technologies: on-site PCR, isothermal amplification and mini-array probing. POC4PETS should help in attaining the CAHP 2007-2013 objective of reducing the direct socio-economic effects of animal diseases.

Development of Electrochemical Peptide Nanosensors for protein and antibody detection (PEPTIDE NANOSENSORS): The principal aim of this project is to develop novel, reagent-less, electrochemical, peptide-based sensors for the detection of multiple diagnostic proteins. The

approach, which will utilise electrochemistry to monitor the binding-induced folding of peptide/polypeptide used as recognition elements, will be rapid, specific, convenient, and critically, selective enough to be employed directly in blood serum and potentially, in whole blood.

NANOMaterials for Highly on-off Electroswitchable Recognitions capabilities with Outstanding ElectroBioSensing applications (NANOHEROES): In this project will combine innovations in pre-concentration, micro- and nanomaterials, micro- and nanofabrication, electro-detection including on/off electro-switching and recognition abilities of various materials.

KEY PUBLICATIONS AND INVITED TALKS IN 2012

Nanomaterials for Sensing and Destroying Pesticides, Gemma Aragay, Flavio Pino, Arben Merkoçi, *Chemical Reviews*, **112**, 5317–5338 (2012)

Cancer detection using nanoparticle-based sensors, A. Turner, A. Merkoçi and M. Perfezou, *Chemical Society Reviews*, **41**, 2606–2622 (2012)

Graphene Oxide as an Optical Biosensing Platform, Eden Morales-Narváez, Arben Merkoçi, *Advanced Materials*, **24**, 3298–3308 (2012)

Simple Monitoring of Cancer Cells Using Nanoparticles, Marisa Maltez-da Costa, Alfredo de la Escosura-Muñiz, Carme Nogués, Leonard Barrios, Elena Ibáñez, Arben Merkoçi, *Nano Letters*, **12** (8), 4164–4171 (2012)

Nanochannels Preparation and Application in Biosensing, Alfredo de la Escosura-Muñiz, Arben Merkoçi, *ACS Nano*, **6** (9), 7556–7583 (2012)

Graphene Based Platforms for Biosensing Applications, Eden Morales-Narváez, Briza Pérez-López, Arben Merkoçi, GRANADA'12, Graphene Nanoscience: from Dirac Physics to Applications, Granada, Spain, 9-13 September, Keynote Lecture (2012)

OTHER HIGHLIGHTS IN 2012

Book chapters:

Electrochemical detection of DNA using nanomaterials based sensors

Sergio Marín, Arben Merkoçi, *Detection of non-amplified genomic DNA*, Chapter 8, 185-202, Springer, (2012)

Nanomaterials-based (bio)sensing systems for safety and security applications

Briza Pérez-López, Arben Merkoçi, "Biosensors for safety and security applications", D.P. Nikolelis (ed.), *Portable Chemical Sensors: Weapons Against Bioterrorism*, 43 NATO Science for Peace and Security Series A: Chemistry and Biology, Springer Science+B, 3, 43-61 (2012)

Nanoparticle induced catalysis for electrochemical DNA biosensors

M. Maltez-da Costa, A. de la Escosura-Muñiz, A. Merkoçi, *Electrochemical DNA biosensors*, 5, 141-162, Pan Stanford, (2012)

Micro and Nanomaterials based detection systems applied in lab-on-a-chip technology

Mariana Medina, Arben Merkoçi, *Handbook of Green Analytical Chemistry*, Chapter 18, 389-405, John Wiley & Son, (2012)

Awards & Honours:

Group Leader Prof Arben Merkoçi was named editor of the journal *Biosensors and Bioelectronics*.

Prof Merkoçi and Prof Jörg P. Kutter (of DTU) co-edited a special Themed Issue of the journal *Lab on a Chip*, entitled "NANO-technologies and -materials for miniaturisation".

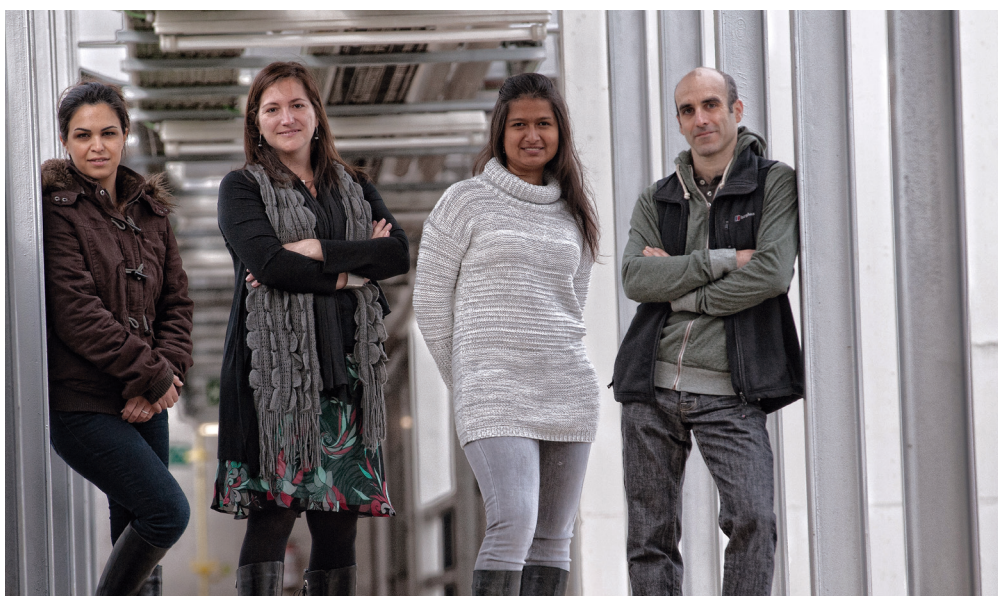
Researcher Marisol Espinoza won the Best Poster prize at the 17th Transfrontier Meeting of Sensors and Biosensors.

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RESEARCH

3.5 Oxide Nanoelectronics Group

Led by ICREA Research Professor Gustau Catalán, the Oxide Nanoelectronics Group aims to explore the emerging phenomena of electronic oxides at the nanoscale. The Group focuses on two areas (Nanodomains & Domain Walls, and Strain & Strain Gradients) related to two main groups of materials (ferroelectrics/multiferroics, and oxides with metal-insulator transitions). Researchers in the Oxide Nanoelectronics Group use techniques such as Atomic Force Microscopy (AFM), Impedance and Dynamic Mechanical Analysis, and high-resolution X-ray Diffraction (XRD).



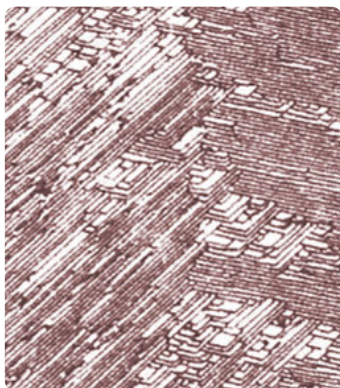
From L to R: S. Sareminaeini, N. Domingo*, J. Narváez* and G. Catalán

* In transition to ICN

NEW PROJECTS & MILESTONES IN 2012

In 2012 Prof Catalán joined ICN as Group Leader of the Oxide Nanoelectronics Group and won an ERC Starting Grant for a new project on Flexoelectricity.

In on-going work in this area, the Group discovered that Flexoelectricity can be used to switch the polarisation in ferroelectric thin films. Based on this finding, they envisioned a new type of memory device, in which a small pressure applied to a nanoscopic tip is converted into readable information. The results were published in *Science* and summarised in a provisional application for a US patent.



KEY PUBLICATIONS AND INVITED TALKS 2012

Domain Wall Nanoelectronics, G. Catalan, J. Seidel, R. Ramesh, J. F. Scott, *Reviews of Modern Physics*, **84**, 119 (2012); Affiliation: CIN2 (CSIC-ICN)

Mechanical Writing of Ferroelectric Polarization, H. Lu, C.-W. Bark, D. Esque de los Ojos, J. Alcalá, C. B. Eom, G. Catalan, A. Gruverman, *Science* **336**, 59-61 (2012); Affiliation: CIN2 (CSIC-ICN)

Magnetotransport at Domain Walls in BiFeO₃, Q. He, C.-H. Yeh, J.-C. Yang, G. Singh-Bhalla, C.-W. Liang, P.-W. Chiu, G. Catalan, L. W. Martin, Y.-H. Chu, J. F. Scott, and R. Ramesh, *Physical Review Letters* **108**, 067203 (2012); Affiliation: CIN2 (CSIC-ICN)

Surface phase transitions in BiFeO₃ below room temperature, R. Jarrier, X. Marti, J. Herrero-Albillos, P. Ferrer, R. Haumont, P. Gemeiner, G. Geneste, P. Berthet, T. Schülli, P. Cevc, R. Blinc, Stanislaus S. Wong, Tae-Jin Park, M.

Alexe, M. A. Carpenter, J. F. Scott, G. Catalan, and B. Dkhil, *Phys. Rev.* **B 85**, 184104 (2012); Affiliation: CIN2 (CSIC-ICN)

From Kittel's Law to Domain Wall Nanoelectronics, Materials Research Society (MRS) Fall Meeting, Boston, Invited Talk, (2012)

Magnetoelectric Boundaries, Royal Society Satellite Meeting on Magnetoelectrics at the Mesoscale, Kavli Royal Society International Centre, Buckinghamshire, UK, Invited Talk, (2012)

OTHER HIGHLIGHTS IN 2012

Book chapters:

Magnetoelectric coupling and multiferroic materials, Gustau Catalan and James F. Scott, *Multifunctional Oxide Heterostructures*, Oxford University Press, 2012

Patents:

Reversal of ferroelectric polarization by mechanical pressure, Alexei Gruverman (University of Nebraska), Haidong Lu (University of Nebraska) and Gustau Catalan (ICREA); Provisional Application for US Patent (# 61708113)

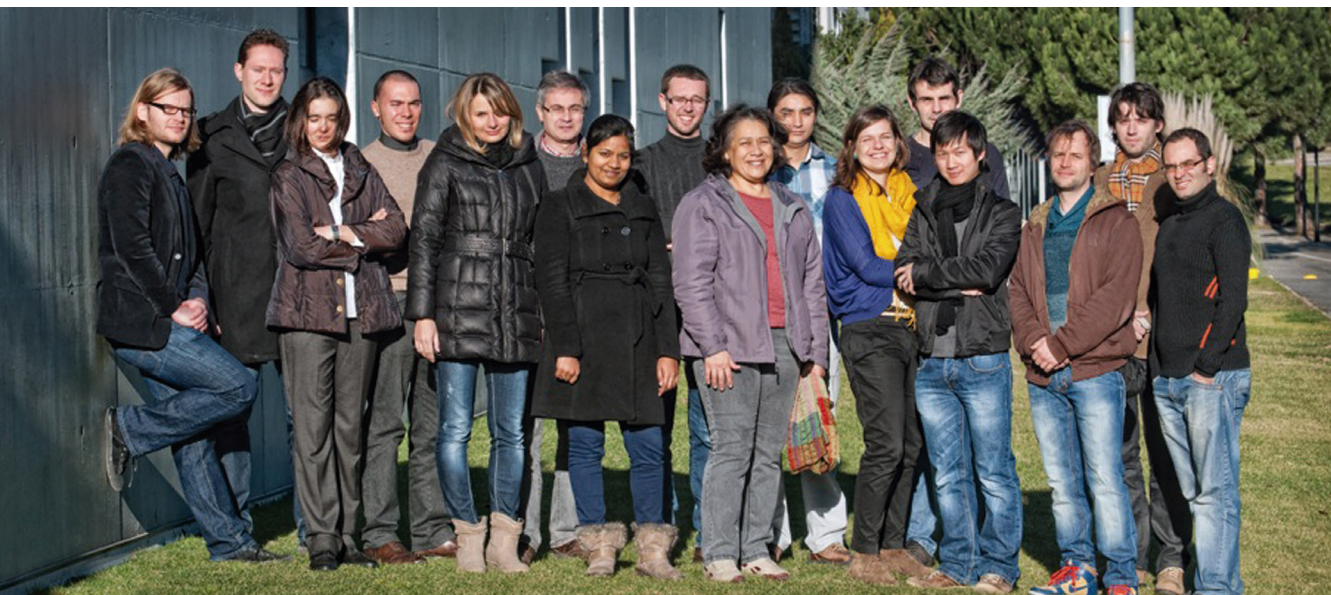
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RESEARCH

3.6 Phononic and Photonic Nanostructures Group

Led by ICREA Research Professor 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 (NIL) and Nanometrology. Their long-term aim is to develop new information technology concepts whereby information processing is achieved with non-charged state variables.

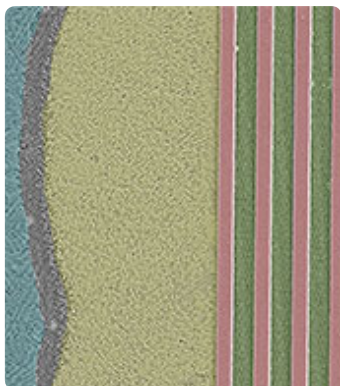
The current has recently been shifting towards the design and fabrication of nanoscale systems used to study electron-phonon-photon interactions for thermo-electric applications such as cooling and energy harvesting. This work involves light scattering characterisation (Raman, Brillouin, THz pump-and-probe) and 3-omega characterisation of suspended membranes (graphene, silicon) and of phononic or phoxonic crystals.



From L to R: B. Graczykowski, M. Wagner, Y. García, A. Francone, M. Sledzinska, F. Alsina, S. Banshali, E. Guillotel, C. Sotomayor Torres, E. Chavez, C. Delgado, J. Gomis, W. Khunsin, M. Kreuzer*, S. Reparaz and D. Navarro
Not shown: E. Armstrong, N. Baruch, J. Cuffe, T. Kehoe, L. Nähle and L. Schneider

NEW PROJECTS & MILESTONES IN 2012

The Group completed three of its on-going projects: NAPANIL (Nanopatterning, Production and Applications Based on Nanoimprinting Lithography), TAILPHOX (Tailoring Photon-Phonon Interaction in Silicon Phoxonic Crystals) and ACPHIN (Study of Confined Acoustic Phonons In Fabricated Nanostructures).



It began two new projects: NANOTHERM (Innovative Nano and Micro Technologies for Advanced Thermo and Mechanical Interfaces) and NANO-RF (Carbon Based Smart Systems for Wireless Applications).

NANOTHERM is aimed at studying novel, nanoscale-controlled materials and structures to acquire a better understanding of the physics underlying the connection between thermal and electrical transports, in order to optimise the design of thermoelectric materials.

NANO-RF is focused on the development of CNT & graphene-based advanced component technologies for the implementation of miniaturised electronic systems for wireless communications and radars in 2020 and beyond.

KEY PUBLICATIONS AND INVITED TALKS 2012

Phonons in Slow Motion: Dispersion Relations in Ultra-Thin Si Membranes, J. Cuffe, E. Chavez, A. Shchepetov, P.O. Chapuis, E.H. El Boudouti, F. Alsina, D. Dudek, J. Gomis-Bresco, Y. Penneç, B. Djafari-Rouhani, M. Prunnila, J. Ahopelto, C.M. Sotomayor Torres, *Nano Letters*, **12**, 3569–3573 (2012)

Ultrafast Relaxation Dynamics via Acoustic Phonons in Carbon Nanotubes, O. A. Dyatlova, C. Köhler, E. Malic, J. Gomis-Bresco, J. Maultzsch, A. Tsagan-Mandzhiev, T. Watermann, A. Knorr, and U. Woggon, *Nano Letters*, **12**, 2249–225 (2012)

Noise-Assisted Crystallization of Opal Films, W. Khunsin, A. Amann, G. Kocher-Oberlehner, S. G. Romanov, S. Pullteap, H. Cheng Seat, E.P. O'Reilly, R. Zentel, and C.M. Sotomayor Torres, *Advanced Functional Materials*, **22**, 1812–1821 (2012)

Electrical Detection of Spin Precession in Freely Suspended Graphene Spin Valves on Cross-Linked Poly(methyl methacrylate), Neumann, I., Van de Vondel, G. Bridoux, M.V. Costache, F. Alzina, C.M. Sotomayor Torres, and S.O. Valenzuela, *Small*, **9**, 156-160 (2012)

Enhanced light extraction in ITO-free OLEDs using double-sided printed electrodes, V. Reboud, A. Z. Khokhar, B. Sepulveda, D. Dudek, T. Kehoe, J. Cuffe, N. Kehagias, M. Lira-Cantu, N. Gadegaard, V. Grasso, V. Labertini, and C.M. Sotomayor Torres, *Nanoscale*, **4**, 3495-3500 (2012)

Nanometrology by image processing and analysis of sub-50 nm 1 and 2D features in BCPs for NIL technology, C. Simao, W. Khunsin, B. Kosmala, N. Kehagias, A. Amann, M. A. Morris, and C. M. Sotomayor Torres, Intel Ireland Research Conference (IIRC), "Silicon and Nanotechnology" strand, 3-4 October 2012, Leixlip, Ireland, Invited Talk (2012)

OTHER HIGHLIGHTS IN 2012

Book chapters:

Nanoimprint Technologies, C. Peroz, V. Reboud, and C.M. Sotomayor Torres, *Nanofabrication: Techniques and Principles*, 117-140 (2012)

Awards & Honours:

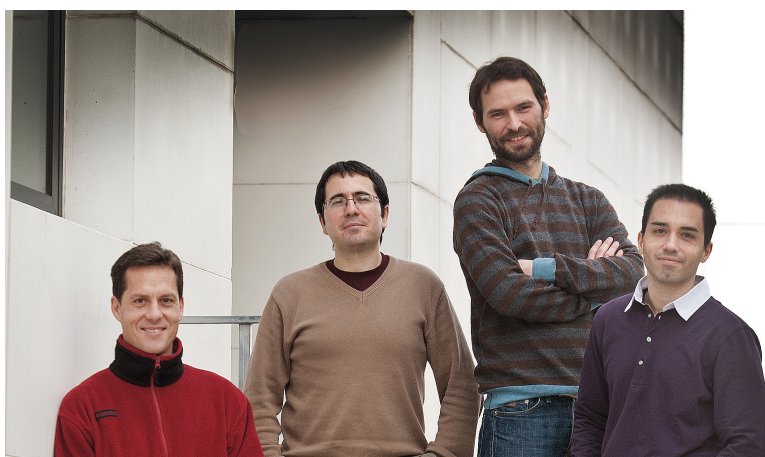
Researcher Claudia Delgado won two awards in 2012: the Spanish Royal Chemistry Society's (RSEQ) NanoMatMol Prize and the Premi Extraordinari de Doctorat en Ciència de Materials of the Universitat Autònoma de Barcelona (UAB).

3

RESEARCH

3.7 Physics and Engineering of Nanodevices Group

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



From L to R: S. Valenzuela, M. Costache, I. Neumann and J. Sierra
Not shown: G. Bridoux and J. van de Vondel

NEW PROJECTS & MILESTONES IN 2012

In 2012 Prof Valenzuela won an ERC Starting Grant to investigate the spin properties of topological insulators.

The Physics and Engineering of Nanodevices Group continued its work on two on-going projects (Transporte de espines y dinámica de la magnetización en nanoestructuras; and NANOFUNCTION) and began one new one: Spin transport and magnetization dynamics in nanostructures.

KEY PUBLICATIONS AND INVITED TALKS IN 2012

Magnon drag thermopile, M.V. Costache, G. Bridoux, I. Neumann and S.O. Valenzuela, *Nature Materials*, **11**, 199 (2012)

Electrical Detection of Spin Precession in Freely Suspended Graphene Spin Valves on Cross-Linked Poly(methyl methacrylate), Neumann, J. Van de Vondel, G. Bridoux, M. V. Costache, F. Alzina, C. M. Sotomayor Torres, and S. O. Valenzuela, *Small*, **9**, 156-160 (2012)

Lateral metallic devices made by a multiangle shadow evaporation technique, Costache, Marius V.; Bridoux, German; Neumann, Ingmar; and Valenzuela, S.O., *J. Vacuum Science & Technology B*, **30** (4) (2012)

Magnon-drag thermopile, Sergio O. Valenzuela, 19th International Conference on Magnetism, Busan, South Korea, Invited Talk (2012)

39th Conference on the Physics and Chemistry of Surfaces and Interfaces, Sergio O. Valenzuela, 39th Conference on the Physics and Chemistry of Surfaces and Interfaces, Santa Fe, United States, Invited Talk (2012)

OTHER HIGHLIGHTS IN 2012

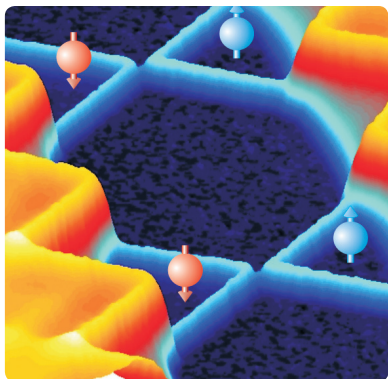
Books and book chapters:

Experimental observation of the spin Hall effect with nonlocal electronic methods, (chapter), S.O. Valenzuela and T. Kimura, Spin Current, Oxford University Press, UK, (2012)

Introduction to the spin Hall effect, (chapter), S.O. Valenzuela, Spin Current, Oxford University Press, UK, (2012)

Spin Current (as editor), S. Maekawa, S.O. Valenzuela, E. Saitoh and T. Kimura, Spin Current, Oxford University Press, UK, (2012)

Lateral metallic nanostructures for spintronics, (chapter), M.V. Costache, B.J. van Wees and S.O. Valenzuela, *One-Dimensional Nanostructures: Principles and Applications*, John Wiley & Sons, Inc., Hoboken, New Jersey, USA, (2012)



Awards & Honours:

In 2012 Prof Valenzuela won an ERC Starting Grant.

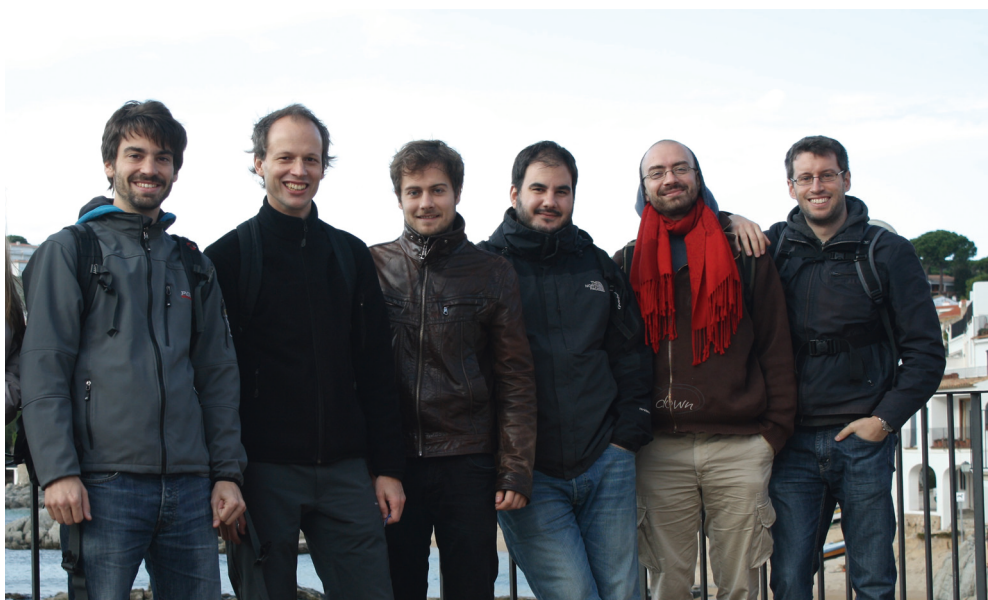
Prof Valenzuela and ICN Group Leader Prof Stephan Roche were the featured speakers at the 49th ICREA Colloquium, "Materials for Revolutionary Applications in Everything".

3

RESEARCH

3.8 Quantum Nanoelectronics Group

Led by Prof Adrian Bachtold, the Quantum Nanoelectronics Group specialises in the electrical and mechanical properties of carbon nanotubes and graphene. At this tiny scale, quantum effects start to play a dominant role in how these materials behave. For example, their energy levels are quantised, just like in atoms and molecules. Interestingly, and despite their minuscule 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: J. Guettinger, A. Bachtold, P. Weber, I. Tsioutsios, J. Moser and A. Eichler

Not shown: A. Afshar, S. J. Cartamil, M. del Álamo, J. Maily and María José Esplandiú*

* Associated from CIN2 - CSIC

NEW PROJECTS & MILESTONES IN 2012

In 2012 the Quantum Nanoelectronics Group advanced in its mass-sensing experiments, setting a new record for sensitivity: 1 yoctogram - which corresponds to the mass of a single proton!

It continued progressing in several of its on-going projects, including the ERC Project “NanoElectroMechanical Systems based on Carbon Nanotube and Graphene” (carbonNEMS), the Spanish Plan Nacional project “Nanotecnología con nanotubos de carbono: desde el movimiento controlado a la manipulación electrónica”, and Suspended Graphene Nanostructures (RODIN).

Lastly, the Group organised the NEMS-Barcelona workshop.

KEY PUBLICATIONS AND INVITED TALKS IN 2012

A nanomechanical mass sensor with yoctogram resolution, J. Chaste, A. Eichler, J. Moser, G. Ceballos, R. Rurali and A. Bachtold, *Nature Nanotechnology*, **7**, 301-304 (2012)

Strong coupling between mechanical modes in a nanotube resonator, A. Eichler, M. del Álamo Ruiz, J. A. Plaza and A. Bachtold, *Physical Review Letters*, **109**, 025503 (1-5) (2012)

NEMS resonators made from nanotubes and graphene, A. Bachtold, ETH Zurich (Laboratory of Prof Ensslin), May, Zurich, Switzerland, Talk (2012)

NEMS resonators made from nanotubes and graphene, A. Bachtold, MANA International Symposium, February, Tsukuba, Japan, Invited Talk (2012)

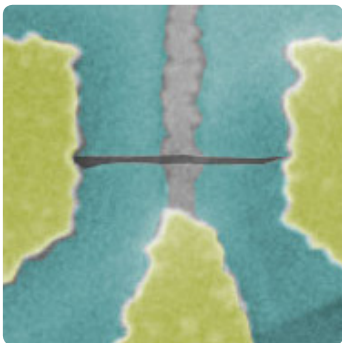
OTHER HIGHLIGHTS IN 2012

Book chapters:

Dissipative and conservative nonlinearity in carbon nanotube and graphene mechanical resonators, Moser, J., Eichler, A., Lassagne, B., Chaste, J., Tarakanov, Y., Kinaret, J., and Bachtold, A., *Fluctuating Nonlinear Oscillators: From Nanomechanics to Quantum Superconducting Circuits*, 341 (2012)

Awards & Honours:

Dr Alexander Eichler and Dr Johannes Güttinger were co-awarded the 2012 Swiss Physical Society (SPS) Award in General Physics (they each won for a different project).



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RESEARCH

3.9 Supramolecular NanoChemistry and Materials Group

Led by ICREA Research Professor Daniel Maspoch, the Supramolecular NanoChemistry and Materials Group (NANO^{UP}), founded in 2011, aims to control the supramolecular assembly of molecules, biomolecules, metal ions and nanoscale building blocks at the nanometre scale 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 Nanoencapsulation, Drug Delivery and Medical Imaging, 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: D. Maspoch, C. Carbonell, K. Stylianou, N. Mejias, M. González, J. Arriñez, A. Carné, A.M. Cano, M. Rubio, S. García, A. Kahsay, A. Ayala, A. Yazdi and I. Imaz

Not shown: I. Burneo, A. Ciardi, M.E. Evangelio and A. Ruyra

NEW PROJECTS & MILESTONES IN 2012

In 2012 the NANO^{UP} Group completed one on-going project, Design and synthesis of novel metal-organic nanomaterials, and began four new ones: BIOCIDE2LIFE, DESPRO-CIDE, Nano-BioMOFs, and Design and synthesis of sub-micron therapeutic systems through micro- and nanoencapsulation technologies. It also completed a new short-term project for the 2012 edition of Joves i Ciència: Exploration of new micro- and nanoencapsulation methodologies.

The Group continued its development of customised micro- and nanoencapsulation technologies for companies. It progressed on five existing industrial alliances, including one with Chemipol S.A. which led to a Technology Transfer Contract, and established three new service contracts.

KEY PUBLICATIONS AND INVITED TALKS IN 2012

Three-dimensional porous metal-radical frameworks based on triphenylmethyl radicals, A. Dactu, N. Roques, V. Jubera, D. Maspoch, X. Fontrodona, K. Wurst, I. Imaz, G. Mouchaham, J.P. Sutter, C. Rovira, J. Veciana, *Chemistry - A European Journal*, **18**, 152-162 (2012)

Femtoliter chemistry assisted by microfluidic-pen lithography, D. Maspoch, 40th International Conference in Coordination Chemistry, Valencia, Spain, Invited Talk (2012)

Trends in Micro- and Nanoencapsulation Research, M. Cano-Sarabia and D. Maspoch, First Workshop on Nanomedicine, UAB-CEI, Barcelona, Spain, Invited Talk (2012)

Massive production of nanoMOFs by spray-drying, I. Imaz, A. Carné, M. Cano, D. Maspoch, MOF2012, Edinburgh, UK, Talk (2012)

OTHER HIGHLIGHTS IN 2012

Book chapters:

Nanoencapsulation, M. Cano-Sarabia and D. Maspoch, *Encyclopedia of Nanotechnology*, Springer (2012)

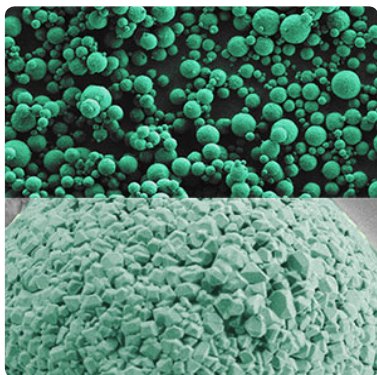
Self-assembly of coordination chains and helices, I. Imaz and D. Maspoch, *Supramolecular chemistry: from molecules to nanomaterials*, Wiley (2012)

Patents:

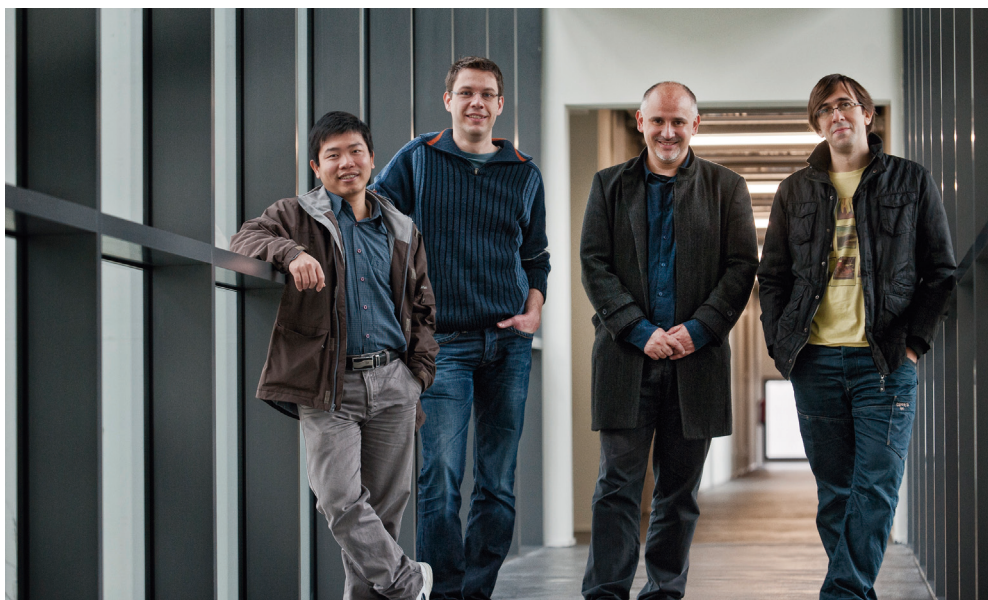
The Group applied for a PCT patent extension on 3 October, 2012, which claims priority over an earlier, European patent application (EP 11183773; **"Method for the Preparation of Metal Organic Frameworks"**)

Awards & Honours:

Researcher Marta Rubio won the Best Oral Communication prize at the 7th Trobada de Joves Investigadors dels Països Catalans.



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 graphene, topological insulators, carbon nanotubes, DNA and organic crystals. It aims to investigate 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: V.T. Dinh, F. Ortmann, S. Roche and D. Soriano
Not shown: P. Lenarczyk and T. Louvet

NEW PROJECTS & MILESTONES IN 2012

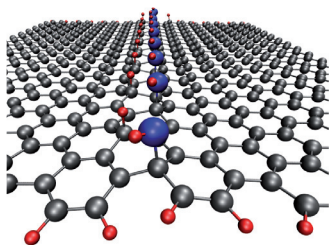
In 2012, the Theoretical and Computational Nanosciences Group completed many of its ongoing projects (MULT.EU.SIM, TRANSSIM, etc.) and created a new research line, on Topological Insulators. It also established strategic scientific collaborations and organised an international workshop, with financial support from the European Science Foundation (ESF) and the United States Air Force Office of Scientific Research (AFOSR).

Additionally, Prof Roche was very active in preparing the GRAPHENE CP-CSA for the European Community's FET Flagship Programme. The Consortium encompasses some 80 partners,

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RESEARCH

3.10 Theoretical and Computational Nanoscience Group



including companies such as Airbus, Nokia and Texas Instruments, together with leading European research groups in graphene, including those of the four Nobel Laureates members of the GRAPHENE Scientific Advisory Board.

Finally, the Group won financial support from Samsung, through its Open Innovation Programme, for a research project on graphene device simulation, entitled “Multiscale simulation of charge transport properties in polycrystalline graphene”. The project, to be done in collaboration with Prof David Jimenez of the Universitat Autònoma de Barcelona, will include two fully dedicated postdoctoral researchers funded by Samsung.

KEY PUBLICATIONS AND INVITED TALKS IN 2012

Atomistic Boron-Doped Graphene Field-Effect Transistors: A Route toward Unipolar Characteristics, Paolo Marconcini, Alessandro Cresti, Francois Triozon, Gianluca Fiori, Blanca Biel, Yann-Michel Niquet, Massimo Macucci, and Stephan Roche, *ACS Nano*, **6**, 7942 (2012)

Laser-induced effects on the electronic features of graphene nanoribbons, Hernan L. Calvo, Pablo M. Perez-Piskunow, Stephan Roche, and Luis E.F. Foa Torres, *Applied Physics Letters*, **101**, 253506 (2012)

Quenching of the Quantum Hall Effect in Graphene with Scrolled Edges, Alessandro Cresti, Michael M. Fogler, Francisco Guinea, A.H. Castro Neto, and Stephan Roche, *Physical Review Letters*, **108**, 166602 (2012)

Three-dimensional Models of Topological Insulator Films: Engineering of Dirac Cones and Robustness of Spin Texture, David Soriano, Frank Ortmann and Stephan Roche, *Physical Review Letters*, **109**, 266805 (2012)

Theoretical perspective of quantum transport in disordered graphene, Stephan Roche, GRAPHENE event, KAVLI Institute for Theoretical Physics, Santa Barbara, United States, Invited Lecture (2012)

Exploring spin-orbit coupling effects in models of topological insulators, Stephan Roche, Topological Insulators and Non-Perturbative Spin-Orbit Coupling, CECAM-HQ-EPFL, Lausanne, Switzerland, Invited Talk (2012)

OTHER HIGHLIGHTS IN 2012

An article co-authored by Prof Roche appeared in the 50th Anniversary Editor's Picks issue of *Applied Physics Letters*.

Prof Roche and ICN Group Leader Prof Sergio O. Valenzuela were the featured speakers at the 49th ICREA Colloquium, “Materials for Revolutionary Applications in Everything”.

4

TECHNICAL DEVELOPMENT AND SUPPORT

4.1 Electron Microscopy Division



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.

RESEARCH ACTIVITIES & MILESTONES IN 2012

In 2012 the Electron Microscopy Division installed and began operating its four new FEI electron microscopes, all partially funded by the European Regional Development Fund (ERDF): a Tecnai F20 S/TEM; a Magellan 400L SEM; a Quanta 650F SEM; and an Inspect F50 SEM.

It also welcomed two new members: Technician Marcos Rosado, who is funded by the Technical Support Personnel Programme (PTA) 2011-6387-I of the former Spanish ministry MICINN (now MINECO); and doctoral student Elzbieta Pach.

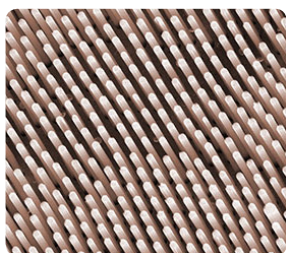
The Division continued with its on-going project "Adquisición de equipamiento para preparación de muestras para su observación por microscopía electrónica" (2010 INFRAS BB), in which the former Spanish ministry MICINN (now MINECO) and the ERDF provided funds for the purchase of sample-preparation equipment, including a plasma cleaner, an ion mill, a sputter coater, a diamond wire saw and polishing systems. The Project has been extended to June 2013.

Lastly, it began the new project "Nanocapsules for targeted delivery of radioactivity" (2011 RADEL BB), which involves eleven partners across Europe and in which Mrs Pach will be working. The network focuses on the Design, Synthesis, Characterisation and Pharmacological Studies of radioactive nanocapsules for medical diagnosis and therapy. The Division's role is to characterise (by Electron Microscopy) the functional nanomaterials generated in the project.

SERVICES

ICN's Electron Microscopy Division offers a broad array of characterisation services to internal and external users for diverse types of sample:

Electron Microscopy techniques: Transmission (TEM), Scanning (SEM), Scanning Transmission (STEM)



Characterisation: surface analysis, chemical analysis (EELS, EDX)

Temperature range: 0 °C to 1,000 °C*

Pressure range: ambient, lo-vacuum or high-vacuum*

Resolution: down to 0.25 nm*

Sample types: organic and inorganic (including metallic) materials, and biological samples

Sample sizes: 5 x 5 x 5 mm (L x W x D); the Inspect F50 SEM has a large chamber compatible with 8-inch wafers

Nanofabrication capabilities: E-beam Lithography (EBL)*, **

* Depending on technique and instrument

** In conjunction with ICN's Nanofabrication Division

KEY PUBLICATIONS AND INVITED TALKS IN 2012

Epitaxial films of the proton-conducting Ca-doped LaNbO₄ material and a study of their charge transport properties, A. Cavallaro, C. Solís, P. R. Garcia, B. Ballesteros, J. M. Serra, J. Santiso, *Solid State Ionics*, **216**, 25–30 (2012)

Magnetic properties of planar nanowire arrays of Co fabricated on oxidized step-bunched silicon templates, S.K. Arora, B.J. O'Dowd, B. Ballesteros, P. Gambardella, and I.V. Shvets, *Nanotechnology*, **23**, 235702 (2012)

Structural and magnetic properties of planar nanowire arrays of Co grown on oxidized vicinal silicon (111) templates, S.K. Arora, B.J. O'Dowd, C. Nistor, T. Balashov, B. Ballesteros, A. Lodi Rizzini, J.J. Kavich, S.S. Dhesi, P. Gambardella, and I.V. Shvets, *Journal of Applied Physics*, **111**, 07E342 (2012)

Deposition of Functionalised Single Wall Carbon Nanotubes through Matrix Assisted Pulsed Laser Evaporation, Á. Pérez del Pino, E. György, L. Cabana, B. Ballesteros, G. Tobias, *Carbon* **50**, 4450-4458 (2012)

OTHER HIGHLIGHTS IN 2012

Book chapter:

Functionalisation of carbon nanotubes, G. Tobias, E. Mendoza, B. Ballesteros, *Encyclopedia of Nanotechnology*, Springer (2012)

4

TECHNICAL DEVELOPMENT AND SUPPORT

4.2 Nanofabrication Division



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 Technology Transfer 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.

RESEARCH ACTIVITIES & MILESTONES IN 2012

In 2012 ICN's Nanofabrication Division Leader Dr Kehagias, together with colleagues at the company PTMTEC Oy (Finland), developed a desk-top Roll-to-Roll Ultraviolet Light-Assisted Nanoimprint Lithography Machine. This one-of-a-kind machine enables meter-per-meter production of nanoscale devices and components.

The Division completed a research collaboration with the technology centre CETEMMSA, aimed at replacing indium tin oxide (ITO), the dominant transparent conductor currently on the market. They developed alternative transparent electrodes based on nano-imprinted metallic grids to support inkjet-printed organic solar cells.

It also began the new project "Moulding Production Technology for multifunctional structured plastic components enabled by nanoimprint lithography" (Plast4Future), part of the European Commission's Seventh Framework Programme (FP7).

Lastly, ICN's Nanofabrication Division began negotiations with a multinational company on a possible new research accord on roll-to-roll (R2R) nanofabrication.

SERVICES

ICN's Nanofabrication Division offers diverse services to internal and external users for applications in Nanoelectronics, Nanophononics, Nanophotonics, Spintronics, Nanobioelectronics and Biosensors:

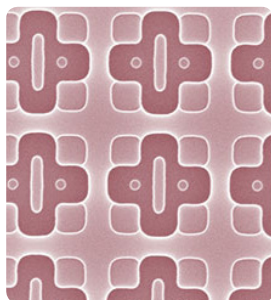
Lithography:

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, Al₂O₃) - AJA International
ITO-Molecular beam epitaxy
Sputter (Au) coater - Edmunds
Spin coater - Laurel
Reverse Gravure Coating

Characterisation:

Atomic force microscope - Veeco Instruments
Optical microscope - Nikon Eclipse LV100
Gold-ball bonder - Delvotek

General:

Plasma cleaner - PVA Tepla PS210
Oven - Memmert
Hot plates

KEY PUBLICATIONS AND INVITED TALKS 2012

Polymer photonic band-gaps fabricated by nanoimprint lithography, V. Reboud, T. Kehoe, J. Romero Vivas, N. Kehagias, M. Zelsmann, F. Alsina, C.M. Sotomayor Torres, *Photonics and Nanostructures – Fundamentals and Applications*, **10** (4), 632–635, 2012

Alternative Nanofabrication techniques, Nikolaos Kehagias, Material Science Department, University of Patras, Greece, 17 December 2012 (Invited lecture)

Roll-to-roll nanomanufacturing of three-dimensional sub 100 nm structures, Kehagias, Nikolaos; Francone, Achille; Atasoy, Hakan; Volger, Marko; Gruetzner, Gabi; Sotomayor Torres, Clivia, 38th International Conference on Micro and Nano Engineering, 16-20 September 2012, Toulouse, France (Talk)

4

TECHNICAL DEVELOPMENT AND SUPPORT

4.3 Nanoscience Instrument Development Division



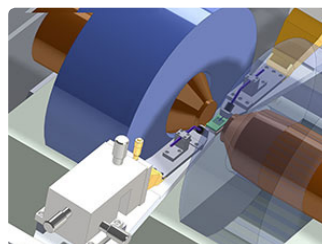
The Nanoscience Instrument Development Division, formed in 2010 and led by Dr Gustavo Ceballos, focuses on the design, development, improvement and deployment of advanced, state-of-the-art instruments for Nanoscience and Nanotechnology. It aims to create an integrated scientific and technical platform 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.

RESEARCH ACTIVITIES & MILESTONES IN 2012

In 2012 Dr Ceballos led Working Group 2 (Infrastructures) of the Transpyrenees Action on Advanced Infrastructures for Nanosciences and Nanotechnologies (TRAIN²) project, part of the European Union's SUDOE programme.

He was one of the organisers of the TRAIN² Workshop on Nanometrology, held on 3 and 4 May 2012, in Barcelona, Spain.



Lastly, ICN's Nanoscience Instrument Development Division also participated in the youth science programme Joves i Ciència.

SERVICES

The Division 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.

KEY PUBLICATIONS AND INVITED TALKS IN 2012

A nanomechanical mass sensor with yoctogram resolution, J. Chaste, A. Eichler, J. Moser, G. Ceballos, R. Rurali and A. Bachtold, *Nature Nanotechnology*, **7**, 301-304 (2012)

Yield and Shape Selection of Graphene Nanoislands Grown on Ni(111), M. Olle, G. Ceballos, D. Serrate, and P. Gambardella, *Nano Letters*, **12** (9), 4431-4436 (2012)



5.1 Aitor Mugarza

In 2012 Dr Mugarza focused on the electronic and magnetic properties of metal-organic molecules and graphene at the interface with metals, and on the scattering behaviour of electrons with strong spin-orbit interaction.

In particular, his studies on the manipulation of electronic and magnetic properties of single and double metal phthalocyanines (MPc and MPc2) led to several publications. Following systematic research from previous years, he investigated different methods to manipulate these properties at the single-molecule level. A combined STM and XMCD study on Li-doped metal phthalocyanines showed how their magnetism could be switched on and off, depending on the metal ion. By controlling the position of the dopant in the molecule, Dr Mugarza and his colleagues were able to selectively modify the charge and spin of the ligand and metal components. In a parallel study, they formed metal-organic exchange-biased heterostructures by using single molecule magnets and anti-ferromagnetic pinning layers.

In a parallel project, Dr Mugarza focused on engineering electronic and magnetic properties at the graphene/metal interface, showing how ferromagnetic substrates can induce spin polarisation and open a band gap in the graphene Dirac bands. The particular interaction at the interface results in a strong spin-filtering effect both in the transport perpendicular and parallel to the interface.

Dr Mugarza also investigated the effects of the entanglement between spin and kinetic momentum induced by spin-orbit coupling on the scattering properties of surface electrons at defects such as atomic steps. The initial results suggest a complex scenario in which disorder and surface localisation of the electron play an important role.

KEY PUBLICATIONS AND CONFERENCE APPEARANCES IN 2012

Exchange biasing single molecule magnets: coupling of TbPc2 to antiferromagnetic layers, A. Lodi Rizzini, C. Krull, T. Balashov, A. Mugarza, C. Nistor, F. Yakhou, V. Sessi, S. Klyatskaya, M. Ruben, S. Stepanow, and P. Gambardella, *Nano Lett.* **12**, 5703 (2012)

Electronic and magnetic properties of molecule-metal interfaces: transition metal phthalocyanines adsorbed on Ag(100), A. Mugarza, R. Robles, C. Krull, R. Korytar, N. Lorente, P. Gambardella, *Physical Review B*, **85**, 155437 (2012)

Effect of surface reconstruction on the photoemission cross-section of the Au(111) surface state, P. Borghetti, J. Lobo-Checa, E. Goiri, A. Mugarza, F. Schiller, J. E. Ortega, E. Krasovskii, *Journal of Physics: Condensed Matter*, **24**, 395006 (2012)

Spin and charge at the molecule-metal interface, A. Mugarza, University of Tokyo, Tokyo, Japan, Invited Lecture, Invited Talk (2012)

Magnetic and vibrational excitations in single molecules studied with scanning tunneling spectroscopy, A. Mugarza, International workshop on the advance of probe microscopies in Aragón, 10 April, Zaragoza, Spain, Invited Talk (2012)

5

RAMÓN Y CAJAL RESEARCHERS

5.2 Carlos F. Sanz-Navarro



In 2012 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. Dr Sanz-Navarro left ICN in August 2012 and ultimately joined the company Abengoa Solar NT.

KEY PUBLICATIONS AND CONFERENCE APPEARANCES IN 2012

Carbon nanotubes as substrates for molecular spiro-pyran-based switches, E. Malic, A. Setaro, P. Bluemmel, Carlos F. Sanz-Navarro, Pablo Ordejón, S. Reich and A. Knorr, *J. Phys.: Condens. Matter* **24**, 394006 (2012)



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.

In 2012, in parallel to his basic research, he was involved in setting up the laboratory and developing new research lines in the Physics and Engineering of Nanodevices Group. His main scientific results during 2012 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 co-workers demonstrated a conceptually new device that enables gathering of information by magnon-electron scattering and magnon-drag effects. This information is crucial to the physics of electron-magnon interactions, magnon dynamics and thermal spin transport (see *Nature Materials*, 2012, below).

- **Electrical detection of spin precession in freely suspended graphene spin valves**

Dr Costache and colleagues achieved spin injection and detection in freely suspended graphene using cobalt electrodes and a nonlocal spin-valve geometry. The devices are fabricated with a single electron-beam-resist poly(methyl methacrylate) process that minimises both the fabrication steps and the use of (aggressive) chemicals, greatly reduc-

ing contamination and increasing the yield of high-quality, mechanically stable devices. Devices grown in this way can exhibit mobilities exceeding $104 \text{ cm}^2 \text{ V}^{-1} \text{ s}^{-1}$ at room temperature. Moreover, as the contacts deposited on graphene are only exposed to acetone and isopropanol, the method is compatible with almost any contacting material (see *Small*, 2012, below).

Dr Costache is involved in various research projects, including “Beyond CMOS Nanodevices for Adding Functionalities to CMOS”, of the European Commission’s Seventh Framework Programme (FP7), and “Transporte de espines y dinamica de la magnetización en nanoestructuras”, funded by the former Spanish Ministry of Science and Innovation (MICINN; now MINECO).

KEY PUBLICATIONS AND CONFERENCE APPEARANCES IN 2012

Magnon-drag Thermopile, M.V. Costache, G. Bridoux, I. Neumann and S.O. Valenzuela, *Nature Materials*, **11**, 199–202 (2012)

Electrical Detection of Spin Precession in Freely Suspended Graphene Spin Valves on Cross-Linked Poly(methyl methacrylate), I. Neumann, J. Van de Vondel, G. Bridoux, M.V. Costache, F. Alzina, C.M. Sotomayor Torres, and S.O. Valenzuela, *Small*, **9**, 156–160 (2012)

Lateral metallic devices made by a multiangle shadow evaporation technique, M.V. Costache, G. Bridoux, I. Neumann and S.O. Valenzuela, *J. Vac. Sci. Technol. B*, **30**, 04E105 (2012)

Magnon-drag thermopile, M.V. Costache, G. Bridoux, I. Neumann, and S.O. Valenzuela, *Proc. SPIE*, **8461**, 84611A (2012)

Magnon-drag thermopile, M.V. Costache, SPIE: NanoScience + Engineering, Spintronics V, San Diego, USA, 12–16 August, Invited Talk, (2012)

Spintronic nanodevices for energy-harvesting, M.V. Costache, Grupo Especializado de Física de Estado Sólido de la Real Sociedad Española de Física (GEFES’12), Seville, Spain, 25–27 January, Invited Talk, (2012)



5.4 Inhar Imaz

During 2012 Dr Inhar Imaz focused on the discovery and development of new methodologies for the synthesis of new supramolecular nanomaterials for future applications in Biomedicine.

• Metal-organic frameworks (MOFs)

MOFs are a new class of materials in which metal ions are associated to organic ligands. Their exceptional porous architectures offer extremely high surface areas (up to 10,000 m²/g), enabling various functions such as catalysis, and gas storage or separation. There has been increasing interest in the synthesis of nanoscale MOFs for new applications. The use of nanoMOFs for Biomedicine is still in its embryonic stage. Many challenges remain, such as the development of a general, reliable, fast, economic and scalable synthetic methodology; and identification of new nanoMOFs with desirable biomedical properties.

• Spray-drying: a new route to MOFs

Discrete nanoMOFs with controlled chemical composition are readily synthesised using nanoemulsions as confined reaction media. However, the synthesis of a broad-spectrum of nanoMOFs with adjustable composition and homogeneous size distribution remains non-trivial, as does large-scale production of nanoMOFs and their assembly into advanced superstructures for practical use. In 2012, Dr Imhaz and his colleagues in ICN's Supramolecular Chemistry and Nanomaterials Group devised a spray-drying technique that avoids most of these problems, offering low-cost, rapid and scalable synthesis and self-assembly of diverse nanoMOFs. It drastically reduces pro-

duction times and costs, enables continuous and scalable synthesis, as well as solvent recovery, and enables new superstructures.

• Contrast Agent MOFs

Advances have been made in the development of MOFs that act as contrast agents for Magnetic Resonance Imaging (MRI). Dr Imaz is exploring a new synthetic strategy based on the use of metallo-macrocyclic contrast agents as bridging organic building blocks to connect metal ions, having obtained an initial nanoscopic metal-organic system showing high stability, high dispersion and low toxicity. Early studies on MRI properties have confirmed the potential of these nanoMOFs in this area.

KEY PUBLICATIONS AND CONFERENCE APPEARANCES IN 2012

Three-dimensional porous metal-radical frameworks based on triphenylmethyl radicals, A. Dactu, N. Roques, V. Jubera, D. Maspoch, X. Fontrodona, K. Wurst, I. Imaz, G. Mouchaham, J.P. Sutter, C. Rovira, J. Veciana, *Chemistry-A European Journal*, **18**, 152-162 (2012)

Massive production of nanoMOFs by spray-drying, I. Imaz, A. Carné, M. Cano and D. Maspoch, MOF2012, Talk (2012)

Metal-biomolecule nanomaterials, M. Rubio-Martínez, Josep Puigmartí-Luis, I. Imaz, D. Maspoch, VII Trobada de Joves Investigadors dels Països Catalans, Talk (2012)

Metal-organic framework nanoarrays fabricated by tip-based nanolithography, C. Carbonell, I. Imaz, D. Maspoch, VII Trobada de Joves Investigadors dels Països Catalans, Talk (2012)

Synthesis of new nanoscale metal-organic frameworks for biomedical applications, A. Carné, I. Imaz, D. Maspoch, VII Trobada de Joves Investigadors dels Països Catalans, Talk (2012)

Book chapters:

Self-assembly of coordination chains and helices (chapter), I. Imaz and D. Maspoch, *Supramolecular chemistry: from molecules to nanomaterials*, Wiley (2012)

COLLABORATIVE RESEARCH

5.5 ICN Researchers in Collaborative Groups

5

Through the CIN2 collaboration with CSIC, ICN has placed several 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 2012, 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).

5 COLLABORATIVE RESEARCH

5.6 CNBSS

The Centre for NanoBioSafety and Sustainability (CNBSS) was established in 2009 as a joint initiative of Leitat Technological Centre and ICN. The Centre was created in response to the emerging needs to rationalise and assess the risks of new Nanotechnologies.

The CNBSS has three primary objectives:

- To develop new tools and methods to determine the safe and rational use of nanomaterials in products throughout their complete life-cycle;
- To develop new, safe and sustainable applications of Nanoscience and Nanotechnology in a broad spectrum of fields;
- 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.

NEW PROJECTS & MILESTONES IN 2012

2012 was a year of great interest for the CNBSS. Through its initial funding, the CNBSS built newly equipped laboratories for chemical synthesis characterisation. It continued its work on several research projects, including:

- Inclusion and extraction of nanomaterials (MWCNT, SiO₂) in polymer matrices and evaluation of their physical and chemical properties and their toxicity;
- Study on the migration of nanomaterials in nanocomposites;
- Development of filtration system with nanofibres;
- Development of inertisation methods for nanoparticles and of personal protective equipment;
- Development of Electrical Double-Layer Supercapacitors (EDLCs).

Furthermore, the reputation of the CNBSS as a centre of reference grew thanks to various milestones that it achieved in the same year:

- Participated in the development of the exhibit TecnoRevolució at the science museum CosmoCaixa, in Barcelona;
- Provided support to ICN's Technology Transfer Office:
 - Writing up process documents and designing protocols for a project on cisplatin;
 - Billing aprox. €40,000 for technical services (together with ICN's Inorganic Nanoparticles Group);

- Creation of an online tool to calculate nanoparticle concentration
- Authored various editorials on its website (www.cnbss.cat)
 - “Safety and regulation of Nanotechnology and nanomaterials in 2012: what’s next?”
 - “Uncertain regulation... uncertain future”
 - “Nanotoxicology, contribution to Beijing’s dialogue”
 - “Environmental remediation with nanoparticles”

KEY PUBLICATIONS IN 2012

- **Nanotecnología: una antigua tecnología con nuevas aplicaciones en sociedad** (book chapter), Vincent Jamier, Eudald Casals and Víctor Puentes, *Cuadernos de la Fundación MAPFRE*
- **Overview of Nanomedicines Regulation in the European Union** (book chapter), Ignasi Gispert, in NanoBiotechnology: Inorganic Nanoparticles vs. Organic Nanoparticles, *Frontiers of Nanoscience* Vol. 4, Elsevier

KEY EVENTS IN 2012

In 2012 the CNBSS organised two events: the workshop “Rethinking Nano” (November 2012), which drew 55 attendees; and the official premiere of Gold Light jewellery (December 2012), which drew 60 attendees.

It also participated in various events, including:

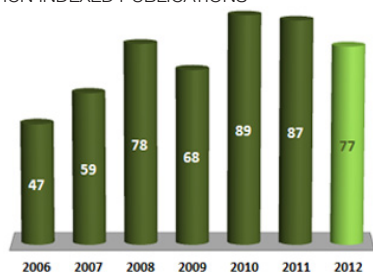
- The conference “**Nanociencia, Nanotecnología e implicación en riesgos laborales**”, organised by the Catalan government’s Workplace Inspection authority (Invited Talk);
- Nanotoxicology Conference 2012: “**Tracking the NanoSafety Evolution of Nanoparticles**” (Talk + Co-chair of the session);
- NanoSAFE Conference 2012:
 - “**The social context of nanotechnology and regulating its uncertainty: a nanotechnologist approach**”, Dr Vincent Jamier, ICN (talk);
 - “**Colloidally stable, biocompatible nanoparticles for biological applications**”, Dr Isaac Ojea, ICN (talk)
 - “**Monitoring migration and transformation of nanomaterials in polymeric composites during climatic aging**”, Gemma Vilar, LEITAT (talk).

6 SCIENTIFIC OUTPUT

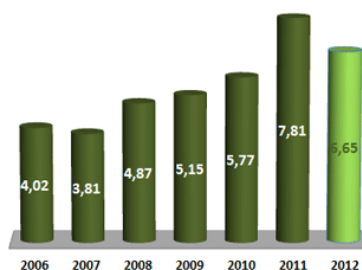
6.1 Publications

The number, quality and relevance of publications authored by ICN researchers remain strong year by year, as illustrated in the following graphs:

ICN INDEXED PUBLICATIONS



AVERAGE ICN IMPACT FACTOR



IMPACT FACTOR

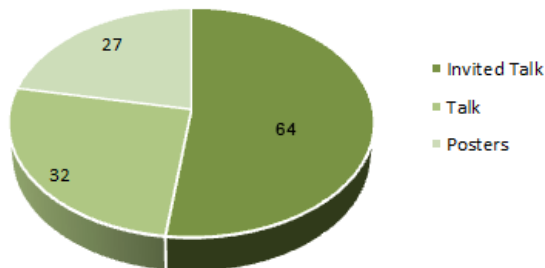
Ranking	Journal	Publications	Impact Factor
1	<i>Chemical Reviews</i>	1	40.20
2	<i>Chemical Society Reviews</i>	1	28.76
3	<i>Nature Nanotechnology</i>	1	27.27
4	<i>Advanced Materials</i>	2	13.88
5	<i>Nano Letters</i>	6	13.20
6	<i>ACS Nano</i>	5	11.42
7	<i>Advanced Functional Materials</i>	1	10.18
8	<i>Small</i>	3	8.35
9	<i>Physical Review Letters</i>	3	7.37
10	<i>Chemistry of Materials</i>	1	7.29
11	<i>Lab on a Chip</i>	3	6.26
12	<i>Chemical Communications</i>	1	6.17
13	<i>Journal of Materials Chemistry</i>	3	5.97
14	<i>Chemistry - A European Journal</i>	1	5.92
15	<i>Nanoscale</i>	2	5.92
16	<i>Analytical Chemistry</i>	1	5.05
17	<i>Nanomedicine</i>	1	4.80
18	<i>Journal of Physical Chemistry C</i>	2	4.80
19	<i>Carbon</i>	2	4.50
20	<i>Langmuir</i>	3	4.19
21	<i>Journal of Hazardous Materials</i>	1	4.17
22	<i>Nanotechnology</i>	2	3.98
23	<i>Applied Physics Letters (APL)</i>	2	3.84
24	<i>Electrochimica Acta</i>	1	3.83
25	<i>Physical Review B</i>	6	3.69
26	<i>Microchimica Acta (MCA)</i>	1	3.03
27	<i>Electronanalysis</i>	1	2.87
28	<i>Solid State Ionics</i>	1	2.65
29	<i>Journal of Physics: Condensed Matter</i>	2	2.55
30	<i>Journal of Physics D: Applied Physics</i>	1	2.54
31	<i>Ultramicroscopy</i>	1	2.47
32	<i>Journal of the Optical Society of America B: Optical</i>	1	2.18
33	<i>Journal of Applied Physics</i>	2	2.17
34	<i>Biomedical Materials</i>	1	2.16
35	<i>Photonics and Nanostructures - Fundamentals and</i>	1	1.68
36	<i>Solid State Communications</i>	1	1.65
37	<i>Physica E: Low-dimensional Systems and...</i>	1	1.53
38	<i>Micron</i>	1	1.53
39	<i>Physica Status Solidi A - Applications and Materials</i>	1	1.46
40	<i>Journal of Vacuum Science & Technology B</i>	1	1.34
41	<i>Water Science & Technology</i>	1	1.12
42	<i>Journal of Photopolymer Science and Technology</i>	1	0.90
43	<i>Desalination and Water Treatment</i>	1	0.61
44	<i>Molecular Crystals and Liquid Crystals</i>	1	0.58
45	<i>Acta Physica Polonica A</i>	1	0.44

NUMBER OF INDEXED PUBLICATIONS: 77
AVERAGE IMPACT FACTOR: 6.648

6.2 Events in which ICN researchers participated

In 2012 ICN researchers participated in 123 events related to Nanoscience and Nanotechnology. A breakdown of their contributions is shown below.

ICN Contributions: 2012



6.3 Events organised by ICN

Commercializing nano

Casa de Convalescència, Barcelona - 20 March , 2012

GRAPHENE 2012

Brussels, Belgium - 10-13 April, 2012

TRAIN2 Workshop on Nanometrology

Hotel Campus - Campus UAB, Bellaterra, Barcelona - 3 to 4 May, 2012

PHONONS AND FLUCTUATIONS 3 WORKSHOP

Hotel Eden Roc, Sant Feliu de Guíxols, Girona - 21 to 24 May, 2012

NANO-TEC Workshop 3

Beau-Rivage Palace, Lausanne - 30 to 31 May 2012

NEMS/BARCELONA, Training Workshop on Noise and Nonlinearities in Mechanical Resonators

Casa de Convalescència, Barcelona - 28 May to 1 June , 2012

VI JORNADA AIN

Aplicaciones Industriales de la Nanotecnologia

Casa Llotja de Mar, Barcelona - 7 June, 2012

WAM-NANO 2012

III International Workshop on Analytical Miniaturization and NANOTEchnologies

Casa de Convalescència, Barcelona - 11 to 12 June, 2012

Final NANO -TEC Workshop

Hotel Front Marítim, Barcelona - 6 to 7 November, 2012

6 SCIENTIFIC OUTPUT

Rethinking Nano Workshop; From discovery to Design
CERC, Centre d'Estudis I Recursos Culturals, Barcelona - 8 November, 2012

BNC-b Nanocluster Workshop
Campus UAB, EDIF. ICN2, Bellaterra, Barcelona - 20 November, 2012

TRAIN2 Industry Conference
World Trade Center, Barcelona - 21 November, 2012

TRAIN2 International Conference
World Trade Center, Barcelona - 21 to 22 November, 2012

ICN STANDS AT TRADE SHOWS & FAIRS

NANOSPAIN 2012
Santander, Spain - 27 February to 1 March, 2012

BIO 2012*
Boston, USA - 19 to 21 June 2012
* As a member of the Biocat delegation

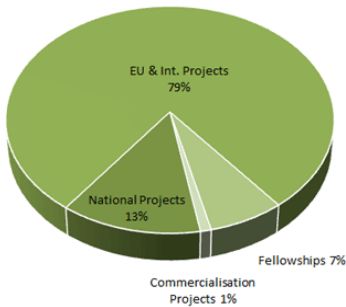
NANOTECH
Santa Clara, USA - 19 to 21 June 2012

7 PROJECTS & FELLOWSHIPS

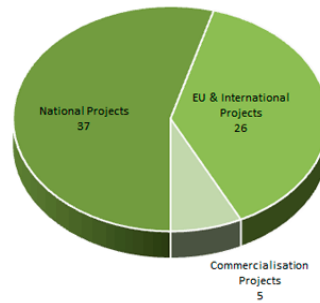
Competitive research funding is vital for ICN's financial viability and serves as an indicator of the quality and international competitiveness of the Institute's research. In 2012 total competitive funding continued to grow, with most new funding stemming from various new EU & International research projects.

ICN measures project funding for fellowships and projects (classified as *National*, *EU & International*, or *Commercialisation*). The breakdown of competitive funding at ICN for 2012 is illustrated in the pie chart below.

Breakdown of Competitive Funding in 2012

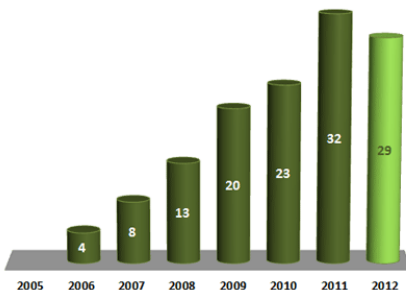


Number of active ICN projects in 2012

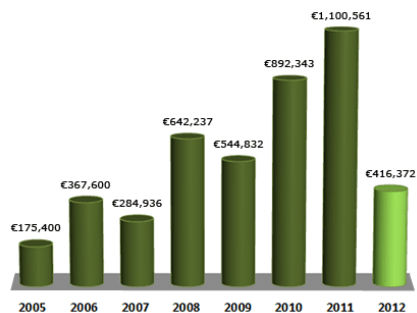


Fellowships are another important part of ICN's research funding strategy. The charts below indicate the number of fellowships and total amount awarded, respectively, for each year since research activity began at ICN (2005 to 2012).

Number of fellowships at ICN: 2005 to 2012



Funding from fellowships at ICN: 2005 to 2012





From L to R: C. López, A. Francesch, L. Bellafont, S. Domene, C. Granadero, M. Balza, B. Kogon, M. Corominas, M. Martí, A. de la Osa, J. Vela, C. Domínguez, A. Rodríguez, L. Camarero, X. Ros, E. Nieto, G. Picazo, M. Pueyo, R. Juan, J. Reverter, F.J. Valenzuela, M. Hoflich, M. Garrés, X. Ilzarbe, A. Maciá and D. Lizcano

Not shown: S. Bekk, G. Beltran, I. Caño, O. Fernández, P. Gros, J. Hernando, G. Liviero, M. Lorente, G. Qushair and D. Torres

ICN's Management and Services team performs a wide range of functions and provides numerous support services to the Institute's Research Groups. Its 29 members are distributed in six departments: Finance, Information Technologies, Human Resources & Education, General Services, Technology Transfer, and Marketing and Communication.

This team enabled ICN to grow its volume of activity by an annual rate of 29% over the past 5 years. Each department has been designed and scaled to provide services to ICN's nine Research Groups and three Technical Divisions as well as to gradually integrate five CSIC Research Groups and one CSIC Technical Services Division from CIN2.

In late 2012 ICN began moving to its new headquarters, the ICN2 building, where its Research Groups will join CSIC Research Groups from CIN2.

Human Resources & Education

ICN's HR policies have become a competitive advantage. During 2012 the Institute grew from 150 to 186 people (including full-time personnel, visiting researchers, interns and students), with a corresponding increase in activity across all administrative areas. Among the principal accomplishments of the HR & Education Department in 2012 was to devise and implement an Internal Communication policy.

Finances

All ICN financial management is supported by SAP, and the Finances team has been expanded to serve the oncoming R&D personnel from CIN2 (five Research Groups and one Technical Development & Support Division).

IT Systems

In 2012 the IT department began developing the infrastructure for ICN's new headquarters (network, IP communications, firewalls, etc.). The Department provides support to all ICN and CIN2-CSIC users.

General Services

In late 2012 the General Services department began moving ICN to its new headquarters, the ICN2 building, establishing the maintenance infrastructure, activating the Risk Prevention plan, and preparing all 45 laboratories for installation of scientific equipment.

Technology Transfer

ICN's Technology Transfer Office had three major highlights in 2012: Lucta has developed commercial products based on knowledge transfer from ICN; Samsung and ICN have signed an accord for graphene research; and ICN signed an agreement with a multinational company on two projects.

Marketing and Communication

The Marketing and Communication department designed and launched a museum exhibition on Nanotechnology, Dimensió Nano, partly financed by FECYT and in collaboration with the museum mNACTEC, in Terrassa, Spain. In addition to the exhibition, which will run until late 2013 and then itinerate to other points around Catalonia, the Department also developed a series of classroom activities and training sessions for school teachers. These materials were made available to the Catalan Ministry of Education. The Department also launched internal services in Scientific Editing, Translation and Illustration, and in Graphic Design, to improve the standard of all major publications and public materials produced by ICN scientists.

Lastly, in 2012 ICN's Management and Services team also collaborated with the CIN2 administrative team to give support to CSIC Group Leaders in administrative and communication tasks, in order to ensure smooth integration of ICN and CIN2-CSIC in 2013.

9

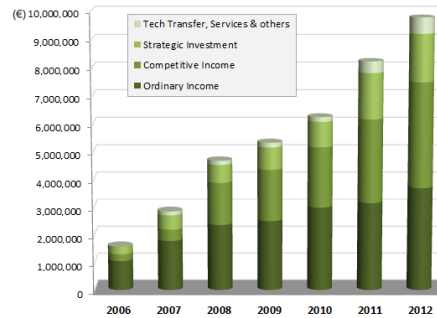
FINANCE

9.1 Financial accounts 2012

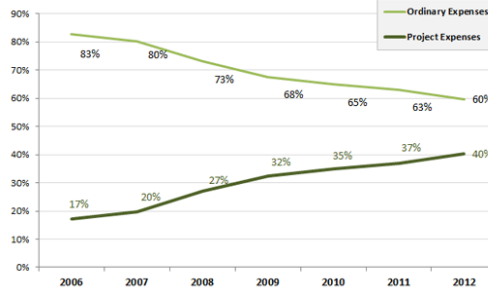
ICN's financial statements for 2012 are written in accordance with the Spanish General Accounting Plan 2007.

The Institute's operating budget comprises revenues from contributions by public administrations and agencies, from competitive grants, and from companies (via Technology Transfer). These revenues fund the operational activities of the institute. The main items are Personnel Costs, General Operating Expenses and Depreciation.

Evolution of ICN Income: 2006 to 2012



Ratio between ordinary and project expenses



9.2 International competitiveness

Among ICN's principal objectives is to be highly competitive at the international level, both in the quality of the science it produces and the levels of competitive funding that it secures through national and international grants and fellowships and through Commercialisation Accords with companies.

In 2012 total funding from all of these sources reached €4.6 million.

Evolution of ICN Competitive Funding Approvals 2005-2012



9.23 Income 2012

The total revenue for 2012: 9.743.484 euros, from 4 main sources:

Ordinary Income: Funds that finance management structure and services of the institute.

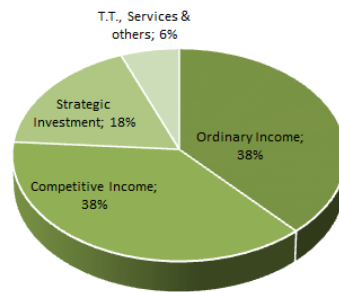
Competitive Income: Funds that finance research projects, which have been obtained in competitive funding from the European Union, ministries and regional governments.

Strategic Investment: Funds from the UE, MEC, CSIC, or Generalitat, which finance the institute's technological infrastructure.

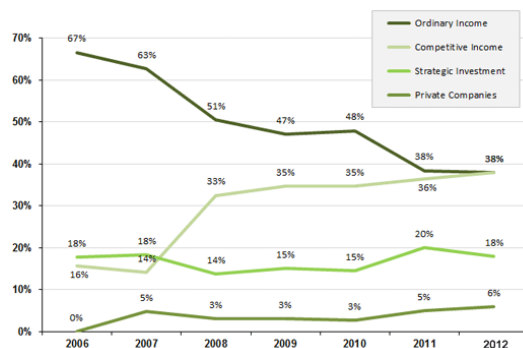
Private Companies: Funds from technology transfer, events, and other activities funded by private companies, also includes bank interest and extraordinary incomes.

2012	
TOTAL INCOME:	€9,743,484
Ordinary Income: €3,702,969	
Generalitat de Catalunya	€2,500,900
CSIC	€1,202,069
Competitive Income: €3,748,841	
Generalitat de Catalunya	€243,628
Ministerio de Economía y Competitividad	€1,414,426
European Commission	€2,090,787
Strategic Investment: €1,711,981	
Generalitat de Catalunya	€933,711
Ministerio de Economía y Competitividad	€203,523
European Commission	€209,042
ERDF	€342,754
CSIC	€22,952
Tech Transfers & Services:	€579,693

Income 2012



Evolution of Income Sources



9

FINANCE

9.4 Expenses

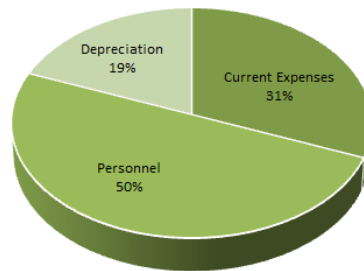
In 2012 total expenditure at ICN was €9,760,647. Expenses are classified as follows:

Project Expenses: These fund Research, and Technology Transfer. They comprise Current Expenses, Personnel Costs and Depreciation of Equipment and Facilities.

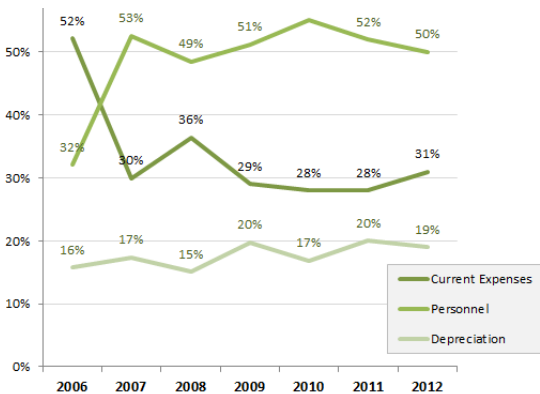
Ordinary Expenses: These fund Research, and Technology Transfer. They comprise Current Expenses, Personnel Costs and Depreciation of Equipment and Facilities.

	2012
EXPENSES:	€9,760,647
Project Expenses:	€ 3,930,539
Current Expenses	€1,487,055
Personnel	€1,995,212
Depreciation	€448,272
Ordinary Expenses:	€5,830,108
Current Expenses	€1,545,312
Personnel	€2,928,283
Depreciation	€1,356,513

Expenses 2012



Evolution of expenses at ICN: 2006 to 2012



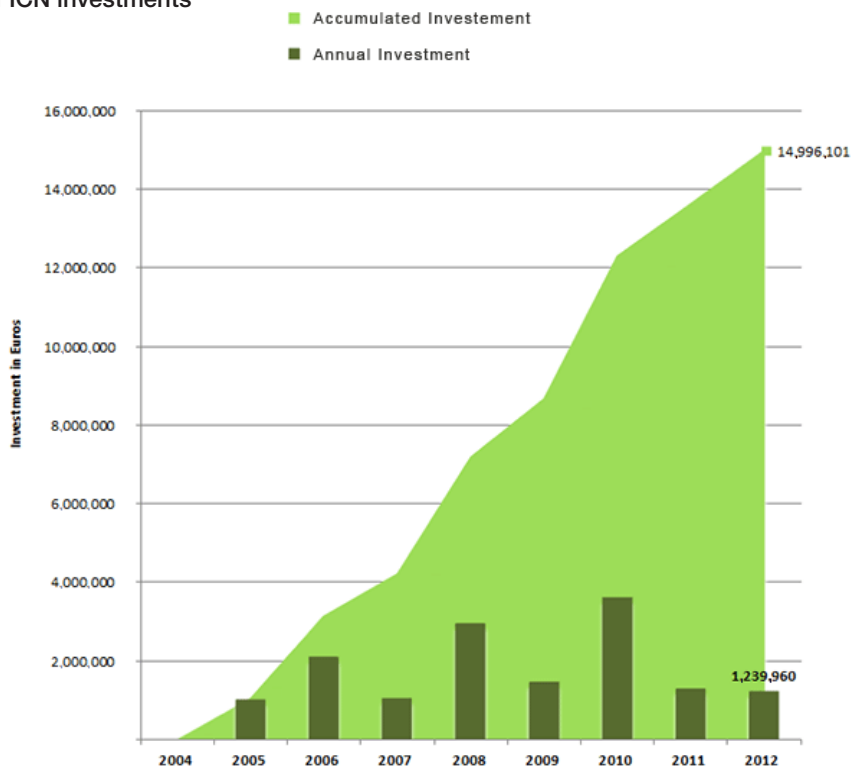
FACILITIES AND EQUIPMENT 10

In 2012 ICN's accumulated investment in scientific equipment, common services and general infrastructure was €14,996,101.

Expenditure for the year was €1,239,960. The main scientific, technical and IT equipment acquired comprised:

- an Inductively Coupled Plasma Mass-Spectrometry (ICP-MS) system
- a High-Performance Liquid Chromatography-Mass Spectrometry (HPLC-MS) system
- Laser with tunable filter (Continuum)
- Thermogravimetric analyser (Pyris 1)
- Gas Sorption Measurement unit (Autosorb iQ-AG)
- DSC8 Differential Scanning Calorimetry unit
- Laboratory furniture for the CNBSS
- Firewalls

Evolution of ICN investments



11 TECHNOLOGY TRANSFER

In 2012 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.

INTELLECTUAL PROPERTY AND SPIN-OFFS

- Seven new in-house technologies evaluated for patenting
- One European priority patent application filed
- Three patents expanded internationally, via the Patent Cooperation Treaty (PCT)
- Third ICN licensing agreement signed: ICN, ICREA and the company Chemipol S.A. signed a know-how licensing agreement on joint development of new fungicidal paints incorporating micro- and nanoencapsulation technologies to prevent the growth of fungi on surfaces.

COMMERCIAL CONTRACTS

- Seven new R&D contracts with Spanish companies and one with a foreign company.
- 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 (previously known as MICINN), to be completed by ICN and a corporate partner
- Ten valorisation projects in progress, through VALTEC (three), the CELLEX Foundation (two), INNPACTO, PROVAT, RecerCaixa, VALOR and the Bill & Melinda Gates Foundation (one each)

OTHER HIGHLIGHTS

- ICN and a multinational company signed a global collaboration agreement that will begin with two R&D projects in 2013.
- ICN, UAB and Samsung signed an accord for a 3-year R&D project.



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 in ensuring 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.

HIGHLIGHTS IN 2012

Barcelona Graduate School of Economics MESI programme: Students from the Masters in the Economics of Science and Innovation programme were given a presentation on ICN and a tour of the Institute and its labs.

Dimensió Nano: ICN, Recrea, La Mandarina de Newton and the museum mNACTEC created this multimedia exhibit dedicated to introducing Nanoscience and Nanotechnology to the public. Dimensió Nano was inaugurated at the Museum in June 2012 and is slated to run until late 2013.

ESCOLAB 2012: Groups of secondary school children visited ICN labs to learn about Nanoscience and Nanotechnology and to ask researchers questions.

Joves i Ciència 2012: High school students performed short research stays in the laboratories of four ICN research groups during summer 2012.



12 PUBLIC OUTREACH



Presentation of Gold Light, the world's first quantum jewellery

(Hotel Mercer, Barcelona, 13 December 2012)

This event was organised by the Centre for NanoBioSafety and Sustainability (CNBSS). Gold Light is the fruit of a collaboration that combines Barcelona's long artisanal tradition with Nanotechnology developed by ICN's Inorganic Nanoparticles Group. Gold Light is an extraordinary jewellery product, unique for both its innovation and its aesthetics.

Professors i Ciència 2012: A group of nearly 20 secondary school teachers visited ICN to learn about Nanoscience and Nanotechnology, visit the Institute's labs and learn science experiments for use in the classroom.

Saló d'Ensenyament 2012: ICN and the museum mNACTEC shared a stand dedicated to the exhibit Dimensió Nano, which was inaugurated at the museum in June 2012.

TERMCAT: ICN helped TERMCAT, the Catalan government's centre for Catalan terminology, create a trilingual (Catalan, English and Spanish) glossary of Nanoscience and Nanotechnology terms, which was officially launched on 16 April 2012.

Secondary school teacher visit through the Catalan Department of Education: A group of 12 secondary school Chemistry and Physics teachers visited ICN for a presentation on Nanoscience & Nanotechnology and to tour various labs. The visit was organised by the Centre for Science Experiments (CDEC), which also made teaching materials developed by ICN and collaborators available online.

Department	Position
Jordi Pascual	Director*
Pablo Ordejón	Director*
Cristina Granadero	Director's Assistant

*Dr Pascual left ICN in April 2012 and Dr Ordejón joined ICN as Director in July 2012.

ATOMIC MANIPULATION AND SPECTROSCOPY GROUP

<i>Pietro Gambardella</i>	<i>ICREA Research Professor and Group Leader</i>
Aitor Mugarza	Ramon y Cajal Researcher
Can Onur Avci	Doctoral Student
Corneliu Nistor	Postdoctoral Researcher
Cornelius Krull	Doctoral Student
Kevin Garelo	Postdoctoral Researcher
Marc Ollé	Doctoral Student
Mihai Miron	Postdoctoral Researcher
Raoul François Marie Piquere	Postdoctoral Researcher
Santos Alvarado	Visiting Scientist
Stefano Schirone	Doctoral Student/ Visiting Student
Sylvie Godey	Technician

INORGANIC NANOPARTICLES GROUP

<i>Víctor F. Puntes</i>	<i>ICREA Research Professor and Group Leader</i>
Cecilia López	Group Project Manager
Edgar Emir González	Postdoctoral Researcher
Emilia Izak	Doctoral Student
Eudald Casals	Doctoral Student
Isaac Ojea	Technician
Javier Patarroyo	Visiting Student
Joan Comenge	Doctoral Student
Jordi Piella	Doctoral Student
Lorena García	Doctoral Student
Martí Busquets	Doctoral Student
Miriam Varón	Doctoral Student
Neus Gomez	Postdoctoral Researcher
Ngoc Tran Thi	Doctoral Student
Sofia Rubio	Doctoral Student
Sonia Goy	Visiting Doctoral Student

MAGNETIC NANOSTRUCTURES GROUP

<i>Josep Nogués</i>	<i>ICREA Research Professor and Group Leader</i>
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APPENDIX 13.1 Personnel (by department)

Department	Position
Alberto López	Doctoral Student
Enric Menéndez	Visiting Postdoctoral Researcher
José Francisco López-Barberá	Postdoctoral Student

NANOBIOELECTRONICS AND BIOSENSORS GROUP

<i>Arben Merkoçi</i>	<i>ICREA Research Professor and Group Leader</i>
Abdelmoneim Mars	Visiting Doctoral Student
Abdel-Rahim Hussein	Visiting Postdoctoral Researcher
Adaris Maria López	Doctoral Student
Alejandro Chamorro	Visiting Doctoral Student
Alejandro Zamora	Visiting Student
Alfredo de la Escosura	Postdoctoral Researcher
Anna Fomitcheva	Student
Anna Puig	Group Project Manager
Briza Pérez	Postdoctoral Researcher
Carmen Clotilde Mayorga	Postdoctoral Researcher
Claudio Parolo	Doctoral Student
Daniel Quesada	Visiting Student
Deniz Bas	Visiting Postdoctoral Researcher
Dina Kats	Visiting Student
Edén Morales	Doctoral Student
Erica Rodríguez	Visiting Doctoral Student
Flavio Pino	Doctoral Student
Gemma Aragay	Postdoctoral Researcher
Helena Montón	Doctoral Student
Lenka Hlavata	Visiting Doctoral Student
Lourdes Josefina Rivas	Doctoral Student
Luis Miguel Baptista	Doctoral Student
Maria Guix	Doctoral Student
Mariana Medina	Doctoral Student
Marisa Maria V. Maltez	Doctoral Student
Marisol Espinoza	Doctoral Student
Miquel Cadevall	Doctoral Student
Ruslán Raulievich Alvarez	Visiting Doctoral Student
Sandrine Miserere	Postdoctoral Researcher

OXIDE NANO-ELECTRONICS GROUP

<i>Gustavo Catalán</i>	<i>ICREA Research Professor and Group Leader</i>
Sahar Sareminaeini	Visiting Student

Department

Position

PHONONIC AND PHOTONIC NANOSTRUCTURES (P2N) GROUP

<i>M. Clivia Sotomayor Torres</i>	<i>ICREA Research Professor and Group Leader</i>
Achille Leo Francone	Postdoctoral Researcher
Claudia Delgado	Postdoctoral Researcher
Colombe Ribéreau-Gayon	Student
Daniel Navarro	Postdoctoral Researcher
Eileen Armstrong	Visiting Doctoral Student
Emigdio Chávez	Doctoral Student
Erwan Guillotel	Project Manager
Francesc Alzina	Senior Researcher
John Cuffe	Doctoral Student
Jordi Gomis	Postdoctoral Researcher
Juan Sebastián Reparaz	Postdoctoral Researcher
Lars Schneider	Laboratory Engineer
Marianna Sledzinska	Laboratory Engineer
Markus Wagner	Postdoctoral Researcher
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 (PEND) GROUP

<i>Sergio O. Valenzuela</i>	<i>ICREA Research Professor and Group Leader</i>
German Bridoux	Postdoctoral Researcher
Ingmar Neumann	Doctoral Student
Juan Francisco Sierra	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
Joachim Mailly	Visiting Student
Joel Moser	Postdoctoral Researcher
Johannes Guettinger	Postdoctoral Researcher
Miguel Del Álamo	Visiting Student
Peter Weber	Doctoral Student
Santiago José Cartamil	Visiting Student

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APPENDIX 13.1 Personnel (by department)

Department	Position
SUPRAMOLECULAR NANO CHEMISTRY & MATERIALS GROUP (NANO^{UP})	
<i>Daniel Maspoch</i>	<i>ICREA Research Professor and Group Leader</i>
Abraham Ayala	Visiting Student
Adane Kahsay	Visiting Student
Agnese Ciardi	Visiting Student
Àngels Ruyra	Doctoral Student
Antonia Maria Cano	Postdoctoral Researcher
Arnau Carné	Doctoral Student
Amirali Yazdi	Visiting Student
Carlos Carbonell	Doctoral Student
Emi Evangelio	Postdoctoral Researcher
Inhar Imaz	Ramón y Cajal Researcher
Iván Patricio Burneo	Visiting Doctoral Student
Javier Ariñez	Doctoral Student
Kyriakos Stylianou	Marie Curie Postdoctoral Researcher
Marta González	Group Project Manager
Marta Rubio	Doctoral Student
Nereida Mejías	Doctoral Student
Sonia García	Postdoctoral Researcher
THEORETICAL AND COMPUTATIONAL NANOSCIENCE GROUP	
<i>Stephan Roche</i>	<i>ICREA Research Professor and Group Leader</i>
David Soriano	Postdoctoral Researcher
Frank Ortmann	Senior Researcher
Pawel Lenarczyk	Visiting Student
Thibault Louvet	Visiting Student
Van Tuan Dinh	Doctoral Student
ELECTRON MICROSCOPY DIVISION	
<i>Belén Ballesteros</i>	<i>Division Leader</i>
Elzbieta Pach	Doctoral Student
Marcos Rosado	Technician
NANOFABRICATION DIVISION	
<i>Nikolaos Kehagias</i>	<i>Division Leader</i>
Miltiadis Vasileiadis	Visiting Student
NANOSCIENCE INSTRUMENT DEVELOPMENT DIVISION	
<i>Gustavo Ceballos</i>	<i>Division Leader</i>
Marc Maymó	Laboratory Engineer

Department	Position
CSIC	
<i>Carlos Sanz</i>	<i>Ramon y Cajal Researcher</i>
<i>Mar Cardellach</i>	<i>Doctoral Student</i>
MANAGEMENT & SERVICES	
<i>Matias Pueyo</i>	<i>Managing Director</i>
MANAGEMENT & SERVICES - CIN2 Unit	
<i>Ramon Cosialls</i>	<i>CIN2 Manager</i>
<i>Dulce Tienda</i>	<i>CIN2 Director's Assistant</i>
<i>Miguel Lechado</i>	<i>Assistant</i>
MANAGEMENT & SERVICES - Common Equipment	
<i>Javier Saiz</i>	<i>Technician (CIN2)</i>
<i>Guillaume Sauthier</i>	<i>Technician (CIN2)</i>
<i>Pablo García</i>	<i>Technician</i>
<i>Pablo González</i>	<i>Laboratory Engineer</i>
<i>Xavier Borrisé</i>	<i>Technician</i>
MANAGEMENT & SERVICES - Marketing and Communication	
<i>Boaz Kogon</i>	<i>Communication and Strategy Manager</i>
<i>Ana de la Osa</i>	<i>Events Officer</i>
<i>Dámaso Torres</i>	<i>Webmaster and Graphic Designer</i>
<i>Gemma Beltrán</i>	<i>Visiting Student</i>
<i>Gemma Picazo</i>	<i>Visiting Student</i>
<i>Gregory Qushair</i>	<i>Scientific Communication Officer</i>
<i>Miriam Lorente</i>	<i>Visiting Student</i>
<i>Pau Gros</i>	<i>Visiting Student</i>
MANAGEMENT & SERVICES - Finance & Projects	
<i>Lluís Bellafont</i>	<i>Finance and Projects Manager</i>
<i>Elma Antón</i>	<i>Accounts Payable</i>
<i>Emma Nieto</i>	<i>Finance and Accounting</i>
<i>Inmaculada Caño</i>	<i>Travel and Expenses Services</i>
<i>Judit Vela</i>	<i>Finance and Accounting</i>
<i>Laura Camarero</i>	<i>Assistant</i>
<i>Marc Corominas</i>	<i>Visiting Student</i>
<i>Marta Balza</i>	<i>Funding and Projects Coordinator</i>
<i>Mireia Martí</i>	<i>Funding and Projects Controller</i>
<i>Sandra Domene</i>	<i>Purchasing Services</i>

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APPENDIX 13.1 Personnel (by department)

Department	Position
Silvia Degli Abbati	Assistant
Stewe Bekk	Funding and Projects Controller
MANAGEMENT & SERVICES - General Services	
<i>Xavier Ros</i>	<i>General Services Manager</i>
Astrid Francesch	Assistant
Carlos Germán Domínguez	Maintenance Technician
Francisco Javier Valenzuela	Maintenance Technician
MANAGEMENT & SERVICES - Human Resources & Education	
<i>Rosa Juan</i>	<i>Human Resources & Education Manager</i>
Anabel Rodríguez	Assistant
Maria Montserrat Garrés	Internal Communication Officer
MANAGEMENT & SERVICES - IT	
<i>David Lizcano</i>	<i>IT Manager</i>
Antonio Macià	IT Network and Security Engineer
Francesc Xavier Ilzarbe	Visiting Student
Gabriela Liviero	Visiting Student
Jordi Hernando	IT Assistant
Manfred Hoflich	IT Client Services
Oliver Fernández	IT Client Services Manager
Oscar Cardenal	Systems Engineer
MANAGEMENT & SERVICES - Technology Transfer	
<i>Jordi Reverter</i>	<i>Technology Transfer Manager</i>
Jamier Vincent	Project Manager
Estefania Molina	Student
Cristina López	Technological Transfer Officer

Top 20 publications in 2012 (by impact factor)

Nanomaterials for Sensing and Destroying Pesticides, Gemma Aragay, Flavio Pino, Arben Merkoçi, *Chemical Reviews*, **112**, 5317-5338 (2012)

Cancer detection using nanoparticle-based sensors, A. Turner, A. Merkoçi and M. Perfezou, *Chemical Society Reviews*, **41**, 2606–2622 (2012)

A nanomechanical mass sensor with yoctogram resolution, J. Chaste, A. Eichler, J. Moser, G. Ceballos, R. Rurali and A. Bachtold, *Nature Nanotechnology*, **7**, 301-304 (2012)

Graphene Oxide as an Optical Biosensing Platform, Eden Morales-Narváez, Arben Merkoçi, *Advanced Materials*, **24**, 3298–3308 (2012)

Mesoscopic model for the simulation of large arrays of bi-magnetic core/shell nanoparticles, G. Margaris, K. N. Trohidou, J. Nogués, *Advanced Materials*, **24**, 4331–4336 (2012)

Bacterial Isolation by Lectin-Modified Microengines, S. Campuzano, J. Orozco, D. Kagan, M. Guix, W. Gao, S. Sattayasamitsathit, J. C. Claussen, A. Merkoçi and J. Wang, *Nano Letters*, **12**, 396-401 (2012)

Exchange biasing single molecule magnets: coupling of TbPc2 to antiferromagnetic layers, A. Lodi Rizzini, C. Krull, T. Balashov, A. Mugarza, C. Nistor, F. Yakhov, V. Sessi, S. Klyatskaya, M. Ruben, S. Stepanow, and P. Gambardella, *Nano Letters*, **12**, 5703 (2012)

Phonons in Slow Motion: Dispersion Relations in Ultra-Thin Si Membranes, J. Cuffe, E. Chavez, A. Shchepetov, P.-O. Chapuis, E. H. El Boudouti, F. Alsina, D. Dudek, J. Gomis-Bresco, Y. Pennec, B. Djafari-Rouhani, M. Prunnila, J. Ahopelto, C. M. Sotomayer Torres, *Nano Letters*, **12**, 3569–3573 (2012)

Simple Monitoring of Cancer Cells Using Nanoparticles, Marisa Maltez-da Costa, Alfredo de la Escosura-Muñiz, Carme Nogués, Leonard Barrios, Elena Ibáñez, Arben Merkoçi, *Nano Letters*, **12** (8), 4164–4171 (2012)

Fast Relaxation Dynamics via Acoustic Phonons in Carbon Nanotubes, O. A. Dyatlova, C. Köhler, E. Malic, J. Gomis-Bresco, J. Maultzsch, A. Tsagan-Mandzhiev, T. Watermann, A. Knorr, and U. Woggon, *Nano Letters*, **12**, 2249–225 (2012)

Yield and Shape Selection of Graphene Nanoislands Grown on Ni(111), M. Olle, G. Ceballos, D. Serrate, and P. Gambardella, *Nano Letters*, **12** (9), 4431-4436 (2012)

Atomistic Boron-Doped Graphene Field-Effect Transistors: A Route toward Unipolar Characteristics, Paolo Marconcini, Alessandro Cresti, Francois Triozon, Gianluca Fiori, Blanca Biel, Yann-Michel Niquet, Massimo Macucci, and Stephan Roche, *ACS Nano*, **6**, 7942 (2012)

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13.2 Selected Publications

Citrate-Coated Gold Nanoparticles As Smart Scavengers for Mercury(II) Removal from Polluted Waters, Ojea-Jiménez, I., López, X., Arbiol, J., & Puentes, V., *ACS Nano*, **6**, 2253–2260 (2012)

Facile Preparation of Cationic Gold Nanoparticle-Bioconjugates for Cell Penetration and Nuclear Targeting, Ojea-Jiménez, I., García-Fernández, L., Lorenzo, J., & Puentes, V. F., *ACS Nano*, **6** (9), 7692–7702 (2012)

Nanochannels Preparation and Application in Biosensing, Alfredo de la Escosura-Muñiz, Arben Merkoçi, *ACS Nano*, **6** (9), 7556–7583 (2012)

Superhydrophobic Alkanethiol-Coated Microsubmarines for Effective Removal of Oil, Maria Guix, Jahir Orozco, Miguel García, Wei Gao, Sirilak Sattayasamitsathit, Arben Merkoçi, Alberto Escarpa, Joseph Wang, *ACS Nano*, **6** (5), 4445–4451 (2012)

Noise-Assisted Crystallization of Opal Films, W. Khunsin, A. Amann, G. Kocher-Oberlehner, S. G. Romanov, S. Pullteap, H. Cheng Seat, E. P. O'Reilly, R. Zentel, and C. M. Sotomayor Torres, *Advanced Functional Materials*, **22**, 1812–1821 (2012)

Detection of Circulating Cancer Cells Using Electrocatalytic Gold Nanoparticles, Marisa Maltez-da Costa, Alfredo de la Escosura-Muñiz, Carme Nogués, Leonard Barrios, Elena Ibáñez, Arben Merkoçi, *Small*, **8** (23), 3605-3612

Electrical Detection of Spin Precession in Freely Suspended Graphene Spin Valves on Cross-Linked Poly(methyl methacrylate), Neumann, J. Van de Vondel, G. Bridoux, M. V. Costache, F. Alzina, C. M. Sotomayor Torres, and S. O. Valenzuela, *Small*, **9**, 156-160 (2012)

Structuration and Integration of Magnetic Nanoparticles on Surfaces and Devices, Bellido, E., Domingo, N., Ojea-Jimenez, I., and Ruiz-Molina, D., *Small*, **8** (10), 1465-1491 (2012)

EU & INTERNATIONAL PROJECTS

Project Title: SPOT - SPin Orbit Torque memory for cache & multicore processor applications

Principal Researcher at ICN: ICREA Prof Dr Pietro Gambardella

Funding: EU 7th Research Framework Programme - European Research Council

Project Title: NOMAD - Nanoscale Magnetization Dynamic

Principal Researcher at ICN: ICREA Prof Pietro Gambardella

Funding: European Commission

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

Principal Researcher at ICN: ICREA Prof Víctor Puntès

Funding: European Commission

Project Title: A pan European infrastructure for quality in nanomaterials safety testing (QNANO)

Principal Researcher at ICN: ICREA Prof Víctor Puntès

Funding: European Commission

Project Title: NanoTOES—Nanotechnology: Training Of Experts in Safety

ICN Groups Participating in the Project: Inorganic Nanoparticles Group

Principal Researcher at ICN: ICREA Prof Víctor Puntès

Funding: European Commission

Project Title: Developing New Strategies for

the Production of Viable Hybrid Nanocrystals with Applicability in Energy Conversion and (Photo)catalysis

Principal Researcher at ICN: Dr Neus Gómez

Funding: European Commission

Project Title: ONDA - Ordered hetero- and Nano-structures with epitaxial Dielectrics for magnetic and electronics Applications

Principal Researcher at ICN: ICREA Prof Josep Nogués Sanmiquel

Funding: European Commission

Project Title: POC4PETS - Point of care diagnostics for rapid and cheap pathogen detection of companion animals

Principal Researcher at ICN: ICREA Prof Arben Merkoçi Hyka

Funding: European Commission

Project Title: Development of Electrochemical Peptide Nanosensors for protein and antibody detection (Peptide Nanosensors)

Principal Researcher at ICN: ICREA Prof Arben Merkoçi Hyka

Funding: European Commission

Project Title: Nanosystems for the early Diagnosis of Neurodegenerative diseases (NADINE)

Principal Researcher at ICN: ICREA Prof Arben Merkoçi Hyka

Funding: European Commission

Project Title: Nanoparticle-based Sensors for Detection of Chemical and Biological Threats

Principal Researcher at ICN: ICREA Prof Arben Merkoçi Hyka

Funding: NATO

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13.3 Active competitive projects in 2012

Project Title: Innovative Nano and Micro Technologies for Advanced Thermo and Mechanical Interfaces (NANOTHERM)

Principal Researcher at ICN: ICREA Prof Dr Clivia M. Sotomayor Torres

Funding: European Commission

Project Title: Carbon based smart systems for wireless applications (NANO-RF)

Principal Researcher at ICN: ICREA Prof Dr Clivia M. Sotomayor Torres

Funding: European Commission

Project Title: RODIN - Suspended graphene nanostructures

Principal Researcher at ICN: Prof Adrian Bachtold

Funding: European Commission

Project Title: carbonNEMS - NanoElectro-Mechanical Systems Based on Carbon Nanotubes and Graphene

Principal Researcher at ICN: Prof Adrian Bachtold

Funding: European Commission

Project Title: MULT-EU-SIM - European multi-scale simulation for the computational era

Principal Researcher at ICN: ICREA Prof Stephan Roche

Funding: European Commission

Project Title: TRAIN2 - Transpyrenees Action on Advanced Infrastructures for Nanosciences and Nanotechnologies

Principal Researcher at ICN: ICREA Prof Stephan Roche

Funding: SUDOE Territorial Cooperation Programme

Project Title: GRAPHENE-CA - Graphene-

Driven Revolutions in ICT and Beyond

Principal Researcher at ICN: ICREA Prof Stephan Roche

Funding: FET Flagship Initiatives Preparatory Action

Project Title: Multiscale simulation of charge transport properties in polycrystalline graphene

Principal Researcher at ICN: ICREA Prof Stephan Roche

Funding: Samsung

NATIONAL PROJECTS

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

Principal Researcher at ICN: ICREA Prof Pietro Gambardella

Funding: Former Spanish Ministry of Science and Innovation (now MINECO)

Project Title: Large Area Molecularly Assembled Nanopatterns for Devices (LAMAND)

Principal Researcher at ICN: ICREA Prof Dr Clivia M. Sotomayor Torres

Funding: European Commission

Project Title: NANO-TEC - Ecosystems technology and design for nanoelectronics

Principal Researcher at ICN: ICREA Prof Dr Clivia M. Sotomayor Torres

Funding: European Commission

Project Title: NANOFUNCTION - Beyond CMOS Nanodevices for Adding Functionalities to CMOS

Principal Researcher at ICN: ICREA Prof Dr Clivia M. Sotomayor Torres

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Funding: European Commission

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

Principal Researcher at ICN: Dr Olivier Chapius (until early 2012) and Dr Francesc Alzina (onwards)

Funding: European Commission

Project Title: NaPANIL - Nanopatterning, Production and Applications based on Nanolithography

Principal Researcher at ICN: ICREA Prof Dr Clivia M. Sotomayor Torres

Funding: European Commission

Project Title: SEAL - Semiconductor Equipment Assessment Leveraging Innovation

Principal Researcher at ICN: ICREA Prof Dr Clivia M. Sotomayor Torres

Funding: European Commission

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

Principal Researcher at ICN: ICREA Prof Dr Clivia M. Sotomayor Torres

Funding: European Commission

Project Title: SGR

Principal Researcher at ICN: ICREA Prof Pietro Gambardella

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

Project Title: Materiales con efecto espin-orbital amplificados para espintrónica

Principal Researcher at ICN: ICREA Prof Pietro Gambardella

Funding: Former Spanish Ministry of Science and Innovation (now MINECO)

Project Title: SGR

Principal Researcher at ICN: ICREA Prof Víctor Puentes

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

Project Title: CISPLATINO

Principal Researcher at ICN: ICREA Prof Víctor Puentes

Funding: ACCIÓ

Project Title: VACUNES

Principal Researcher at ICN: ICREA Prof Víctor Puentes

Funding: ACCIÓ

Project Title: Diseño de Nanopartículas Inorgánicas conjugadas: Nuevas herramientas para el tratamiento del cáncer

Principal Researcher at ICN: ICREA Prof Víctor Puentes

Funding: Former Spanish Ministry of Science and Innovation (now MINECO)

Project Title: Tuning the magnetic properties of nanoparticles and lithographed structures by intrinsic and extrinsic parameters (MAGTUNE)

Principal Researcher at ICN: ICREA Prof Josep Nogués

Funding: Former Spanish Ministry of Science and Innovation (now MINECO)

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

Principal Researcher at ICN: ICREA Prof Arben Merkoçi Hyka

Funding: Fundació Privada per a la Recerca i Docència Sant Joan de Déu

Project Title: NANOMaterials for Highly on-

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13.3 Active competitive projects in 2012

off Electroswitchable Recognitions capabilities with Outstanding ElectroBioSensing applications (NANOHEROES)

Principal Researcher at ICN: ICREA Prof Arben Merkoçi Hyka

Funding: Former Spanish Ministry of Science and Innovation (now MINECO)

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

Principal Researcher at ICN: ICREA Prof Arben Merkoçi Hyka

Funding: Former Spanish Ministry of Science and Innovation (now MINECO)

Project Title: Nanobiosensors for tumor markers

Principal Researcher at ICN: ICREA Prof Arben Merkoçi Hyka

Funding: Former Spanish Ministry of Science and Innovation (now MINECO)

Project Title: Multifunctional water processing system based on nanoplatfoms for ultrasensitive detection and purification of environmental pollutants

Principal Researcher at ICN: ICREA Prof Arben Merkoçi Hyka

Funding: Former Spanish Ministry of Science and Innovation (now MINECO)

Project Title: SGR

Principal Researcher at ICN: ICREA Prof Pietro Gambardella

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

Project Title: Grup de treball Nanobiocat

Principal Researcher at ICN: ICREA Prof Arben Merkoçi Hyka

Funding: ACC1Ó

Project Title: WAM-NANO 2012 Workshop: NANOTEchnology based Lab-on-a-chip

Principal Researcher at ICN: ICREA Prof Arben Merkoçi Hyka

Funding: MIENCO

Project Title: NanoTEG - Nanostructured thermoelectric systems for green transport and energy efficient applications

Principal Researcher at ICN: ICREA Prof Dr Clivia M. Sotomayor Torres

Funding: European Commission

Project Title: nanoTHERM - Tailoring electronic and phononic properties of nanomaterials: Towards ideal Thermoelectricity

Principal Researcher at ICN: ICREA Prof Dr Clivia M. Sotomayor Torres

Funding: Former Spanish Ministry of Science and Innovation (now MINECO)

Project Title: SGR

Principal Researcher at ICN: ICREA Prof Dr Clivia M. Sotomayor Torres

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

Project Title: ACHPIN – Study of Confined Acoustic Phonons in Fabricated Nanostructures

Principal Researcher at ICN:

ICREA Prof Dr Clivia M. Sotomayor Torres

Funding:

Former Spanish Ministry of Science and Innovation (now MINECO)

Project Title: Workshop: Recuperación de fluctuaciones: combinar la fonónica y los procesos no-lineales de los átomos a los sistemas

Principal Researcher at ICN: ICREA Prof Dr

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13.3 Active competitive projects in 2012

Clivia M. Sotomayor Torres

Funding: MINECO

Project Title: Spin transport and magnetisation dynamics in nanostructures

Principal Researcher at ICN: ICREA Prof Sergio Valenzuela

Funding: Former Spanish Ministry of Science and Innovation (now MINECO)

Project Title: Nanotechnology with carbon nanotubes: from controlled motion to electron manipulation

Principal Researcher at ICN: Prof Adrian Bachtold

Funding: Former Spanish Ministry of Science and Innovation (now MINECO)

Project Title: SGR

Principal Researcher at ICN: Prof Adrian Bachtold

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

Project Title: DESPRO NANO - Long lasting disinfectants

Principal Researcher at ICN: ICREA Prof Daniel Maspocho

Funding: Former Spanish Ministry of Science and Innovation (now MINECO)

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

Principal Researcher at ICN: ICREA Prof Daniel Maspocho

Funding: Fundació Ramón Areces

Project Title: NANO-SCENT - Controlled release of fragrances

Principal Researcher at ICN: ICREA Prof

Daniel Maspocho

Funding: Former Spanish Ministry of Science and Innovation (now MINECO)

Project Title: Food safety - development of novel technologies based on phages for controlling salmonellosis

Principal Researcher at ICN: ICREA Prof 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 at ICN: ICREA Prof Daniel Maspocho

Funding: Former Spanish Ministry of Science and Innovation (now MINECO)

Project Title: Evaluation of an anti-salmonellosis phage cocktail by nanoencapsulation techniques

Principal Researcher at ICN: ICREA Prof Daniel Maspocho

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

Project Title: BIOCIDE2LIFE, Micro- and nanoencapsulated biocides: the next generation of disinfectants with short + long-2Life antimicrobial activity

Principal Researcher at ICN: ICREA Prof Daniel Maspocho

Funding: Fons Europeu de desenvolupament regional (FEDER), Institució dels Centres de Recerca de Catalunya (Institució CERCA), Ministry of Economy and Knowledge of the Catalan Government (Generalitat of Catalonia)

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13.3 Active competitive projects in 2012

Project Title: Desarrollo de una nueva generación de productos biocidas con efecto inmediato, remanente y capacidad para reducir la transferencia de microorganismos (DESPRO-CIDE)

Principal Researcher at ICN: ICREA Prof Daniel Maspoch

Funding: MINECO

Project Title: Adquisición de equipamiento para preparación de muestras para su observación por microscopía electrónica

Principal Researcher at ICN: Dr Belén Ballesteros

Funding: Former Spanish Ministry of Science and Innovation (now MINECO)

Project Title: Dimensió Nano
ICN Departments Participating in the Project: Communications

Partners: mNACTEC, La Mandarina de Newton and Recrea

Funding: Fundación Española para la Ciencia y la Tecnología (FECYT)

Project Title: Desarrollo de una nueva generación de productos biocidas con efecto inmediato, remanente y capacidad para reducir la transferencia de microorganismos (DESPRO-CIDE)

Principal Researcher at ICN: ICREA Prof Daniel Maspoch

Funding: MINECO

Project Title: Adquisición de equipamiento para preparación de muestras para su observación por microscopía electrónica

Principal Researcher at ICN: Dr Belén Ballesteros

Funding: Former Spanish Ministry of Science and Innovation (now MINECO)

Project Title: Dimensió Nano

ICN Departments Participating in the Project: Marketing and Communication

Partners: mNACTEC, La Mandarina de Newton and Recrea

Funding: Fundación Española para la Ciencia y la Tecnología (FECYT)

COMMERCIALISATION PROJECTS

Project Title: Development of electrochemical biosensor based on nanoparticles for fast and simple detection of DNA sequences

Principal Researcher at ICN: ICREA Prof Arben Merkoçi Hyka

Funding: Vetgenomics

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

Principal Researcher at ICN: ICREA Prof Daniel Maspoch

Funding: Private company

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

Principal Researcher at ICN: ICREA Prof Daniel Maspoch

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 at ICN: ICREA Prof Daniel Maspoch

Funding: Commercial contract

Project Title: n/a

Principal Researcher at ICN: ICREA Prof Daniel Maspoch

Funding: Lucta, S.A

