

ANNUAL REPORT 2015



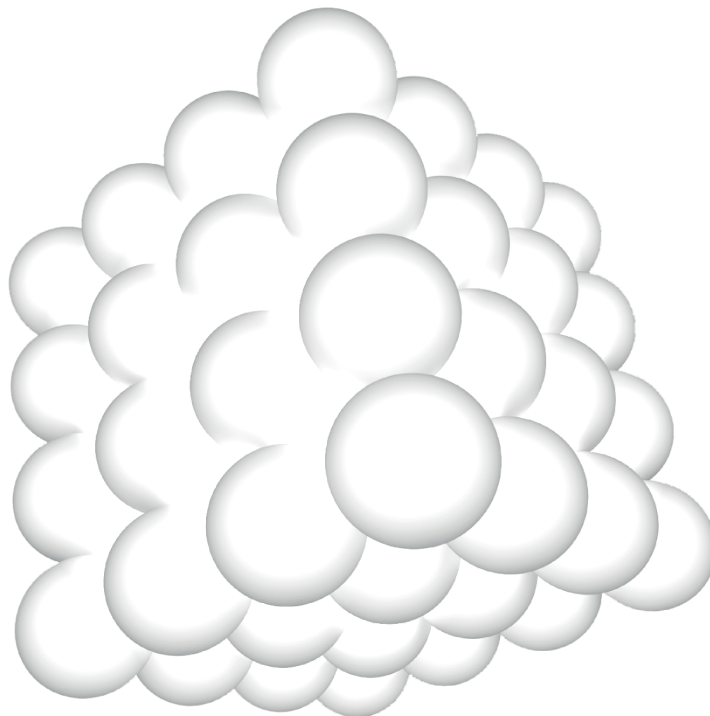
ICN2^R



EXCELENCIA
SEVERO
OCHOA

Institut Català
de Nanociència
i Nanotecnologia

ANNUAL REPORT 2015



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Letter from the Director

Prof Pablo Ordejón
Director, ICN2



2015 was, again, a year of growth and intense activity for the Catalan Institute of Nanoscience and Nanotechnology (ICN2).

The most remarkable development occurred during 2015 was the establishment of the *Barcelona Institute of Science and Technology - BIST* (www.bist.eu), an initiative of six Catalan top research centres (CRG, ICIQ, ICFO, ICN2, IFAE and IRB) to build on their individual strengths and promote cutting-edge research in science and technology within an environment of multidisciplinary scientific excellence. Its legal status is that of a Foundation, with majority of private

Patrons and funding. The aims of the BIST are: (i) to contribute towards improving conditions for carrying out high-quality research at the research centres and to increase its international visibility; (ii) to offer coordinated postgraduate programs of excellence with international impact; (iii) to build a critical mass to multiply the capacity of the research centres in different fields, such as knowledge transfer, scientific and technological platforms and talent attraction; and (iv) to cooperate with scientific institutions, companies, individuals and public or private entities to fulfil these aims. Prof. Rolf Tarrach is the President of the BIST Foundation, and Dr. Montserrat Vendrell was appointed as Director General in October 2015.

We strongly believe that the ICN2 participation in BIST will signify, in the long term, a key strategic step in the development of our Institute. It will provide many opportunities for growth, multidisciplinary collaborations, talent and funding attraction, and will strongly enhance the visibility of ICN2. It will also push us to have a stronger level of self-commitment, and higher standards for ICN2 research and management, which will help us to maintain and enhance the levels of excellence we have achieved.

A second key event of 2015 was the constitution of a new Scientific Advisory Board (SAB), with a renewed composition appointed by the Board of Patrons: with Miquel Salmeron (UC Berkeley, LBNL) as President, and Jeff Bokor (UC Berkeley), Luisa de Cola (U. Strassburg), Sylvia Daunert (U. Miami), Albert Fert (CNRS), Klaus Kern (MPI-Stuttgart), Steven Louie (UC Berkeley), Tapani Ryhanen (Nokia), Clement Sanchez (CNRS) and Nicholas D. Spencer (ETH) as members. The new SAB held its first meeting at ICN2 in June 2015, and will meet annually to review the activities of the Institute, and provide advice to the Director and the Board of Trustees, and will be a key component to define the strategy, scientific development and evaluation procedures of ICN2.

The scientific production of ICN2 shows an marked upward trend, both in the number of publications (155) and in the average impact factor (6.58), which represent a growth of 18% and 17% respectively. ICN2 is strongly involved in the development of one of the European Commission's two FET Flagship Programmes: the *Graphene Flagship*, and also participates in two new EU networks providing scientific support and infrastructure services to the international scientific community: *NFFA-Europe* (www.nffa.eu) and the *MaX Center of Excellence in HPC for Materials Design at the Exascale* (www.max-centre.eu). In this Annual Report you will also find impressive figures on our success at attracting national and international competitive funding. Additionally, we continued the strategy launched in 2012 to promote technological transfer as a key activity of ICN2. The role and resources of the Technology Transfer Office have been strengthened, which is having a brilliant impact on the transfer results.

The Administration of ICN2 has gone through a profound process of improvement. Efforts have been focused on "sharpening the tools", and the results of the new procedures and organization of the Administration departments will be apparent soon. We are sure that they will show up in an increase in efficiency, simplification of the processes and reduction of the bureaucratic burdens, in a context where these tend to increase to dangerous levels by external factors, regulations and constraints. The efforts and enthusiasm of our Administration are truly remarkable, and key for the success of our Institute.

In summary, 2015 has continued the consolidation of ICN2 as one of the top research centres in our country. I invite you to dive into the information presented in this Annual Report, and to join us our journey.

Sincerely,

Prof **Pablo Ordejón**

Director, ICN2

Prof Ordejón earned his BSc in Physics (1987) and PhD in Science (1992) at the Universidad Autónoma de Madrid (Spain). He worked as a postdoctoral researcher at the University of Illinois at Urbana-Champaign (USA) from 1992 to 1995, and as Assistant Professor at the Universidad de Oviedo from 1995 to 1999. In 1999, he obtained a research staff position at the Institut de Ciència de Materials de Barcelona of the Consejo Superior de Investigaciones Científicas (CSIC). In 2007 he moved, as leader of the Theory and Simulation research Group, to CIN2 (now ICN2), where he is currently CSIC Research Profesor. Since July 2012, he has served as Director of ICN2.

He has published more than 190 scientific articles, which have received over 20,000 citations ($h = 51$). Since 2009 he has served as Co-Editor of EPL (formerly Euro Physics Letters) and since 2004, as Regional Editor of *physica status solidi*. He was in charge of the Condensed Matter Physics area of the Physics Panel of the Spanish National Scientific Evaluation Agency (ANEP), from 2003 to 2006, and the Head of the Physics and Engineering Panel of the Access Committee to the Spanish Supercomputing Network, from 2005 to 2011. He became a Fellow of the American Physical Society in 2005.

His research is focused on the development of efficient methods for electronic structure calculations in large and complex systems, with contributions to the development of techniques for large-scale atomistic simulations based on first principles methods such as SIESTA. He has also been involved in the study of the fundamental properties of materials at the atomistic level. His current interests include, among many others, electronic transport in nanoscale devices and electronic processes at surfaces and 2D materials. He maintains frequent collaborations with industrial laboratories on the simulation of materials processes at the atomic level. He is co-founder of the spin-off company SIMUNE.

Organisation and People

● OUR MISSION

To become an international centre of reference in Nanoscience and Nanotechnology.

● A LITTLE BIT OF HISTORY

The *Institut Català de Nanociència i Nanotecnologia* (ICN2 - Catalan Institute of Nanoscience and Nanotechnology) is a non-profit international research institute located in Barcelona, Spain. It was created in 2013, when CSIC joined the Board of Trustees of the former *Institut Català de Nanotecnologia* (ICN), created in 2003 by the Ministry of Universities, Research and Information Society (DIUE) of the Catalan Government (Generalitat de Catalunya) and the *Universitat Autònoma de Barcelona* (UAB). The CSIC groups from the former *Centro de Investigación en Nanociencia y Nanotecnología* (CIN2), created in 2006 as a collaboration between CSIC and ICN, joined this effort aimed to consolidate a leading position through research and technology transference activities.

The ICN2 building was officially inaugurated on January 20, 2014. Shortly after, ICN2 received the **Severo Ochoa Excellence Award**, confirming that our efforts were headed in the right direction.

ICN2 is one of the founding members and Patrons of the **Barcelona Institute of Science and Technology - BIST**.

● ORGANISATION

ICN2 is led by its Director, Prof **Pablo Ordejón**, who reports to the Board of Patrons and is advised by the Scientific Advisory Board, made up of numerous distinguished international scientists.

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

ICN2 comprises 17 Research Groups and 6 Technical Development and Support Divisions and Facilities, covering different areas of nanoscience and nanotechnology. The 8 Administration Departments, overviewed by the ICN2 General Manager, Mr. Lluís Bellafont, support the research activity with their services and actions.

Research Groups

- Advanced Electron Nanoscopy Group
- Advanced Electronic Materials and Devices Group
- Atomic Manipulation and Spectroscopy Group
- Force Probe Microscopy and Surface Nanoengineering Group
- Inorganic Nanoparticles Group
- Magnetic Nanostructures Group
- NanoBioelectronics and Biosensors Group
- NanoBiosensors and Bioanalytical Applications Group
- Nanostructured Functional Materials Group
- Nanostructured Materials for Photovoltaic Energy Group
- Novel Energy-Oriented Materials Group
- Oxide Nanoelectronics Group
- Phononic and Photonic Nanostructures Group
- Physics and Engineering of Nanodevices Group
- Supramolecular NanoChemistry and Materials Group (NANO^{UP})
- Theoretical and Computational Nanoscience Group
- Theory and Simulation Group

Scientific-Technical Research Support

Research Support Divisions

- Nanoscience Instrument Development Division
- Electron Microscopy Division
- Nanomaterials Growth Division

Research Support Facilities

- Nanofabrication Facility
- Instrumental Core Research Facilities
- Technical Facilities - Mechanical Workshop

● BOARD OF PATRONS

PRESIDENT

Andreu Mas-Colell

Minister of Economy and Knowledge, Government of Catalonia.

VICE-PRESIDENT

Emilio Lora Tamayo

President of CSIC (*Consejo Superior de Investigaciones Científicas*).

SECRETARY

Josep Maria Martorell i Rodon

Director of Research, Ministry of Economy and Knowledge, Government of Catalonia.

MEMBERS

Lluís Calvo

Institutional CSIC Coordinator in Catalonia.

Antoni Castellà Clavé

Secretary for Universities and Research of the Ministry of Economy and Knowledge, Government of Catalonia.

Ferran Sancho Pifarré

Rector of the *Universitat Autònoma de Barcelona* (UAB).

José Ramón Urquijo Goitia

Vice-President for Organisation and Institutional Relations, CSIC.

● SCIENTIFIC ADVISORY BOARD

PRESIDENT

Prof Miquel Salmerón

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

MEMBERS

Prof Jeff Bokor

UC Berkeley and Lawrence Berkeley National Laboratory, USA

Prof Luisa de Cola

Université de Strasbourg, France.

Prof Sylvia Daunert

University of Miami, USA.

Prof Albert Fert

CNRS/Thales, France.

Prof Klaus Kern

Max-Planck-Institut für Festkörperforschung, Germany.

Prof Steven Louie

UC Berkeley and Lawrence Berkeley National Laboratory, USA.

Dr Tapani Ryhänen

Nokia Technologies, Finland.

Prof Clément Sánchez

CNRS/Université Pierre et Marie Curie/ Collège de France, France.

Prof Nicholas D. Spencer

ETH-Zürich, Switzerland.

● THE ICN2 TEAM

ICN2 is defined by its people. From senior researchers to administration staff, ICN2 personnel work as a team, contributing their creativity, energy, dedication and hard work to further the Institute.

ICN2 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. Many researchers who have completed a doctoral thesis or post-doctoral stay at ICN2 have moved on to highly prestigious institutes such as Harvard, Yale, the Max Planck institutes, CNRS and CEA. Thus, ICN2 is continuously offering new positions for junior scientists.

Over the year 2015, ICN2 engaged an annual average workforce of 253 people. Recruitment reached an historic peak, as the Institute fully consolidated its management and administrative teams and met its human resources objectives.

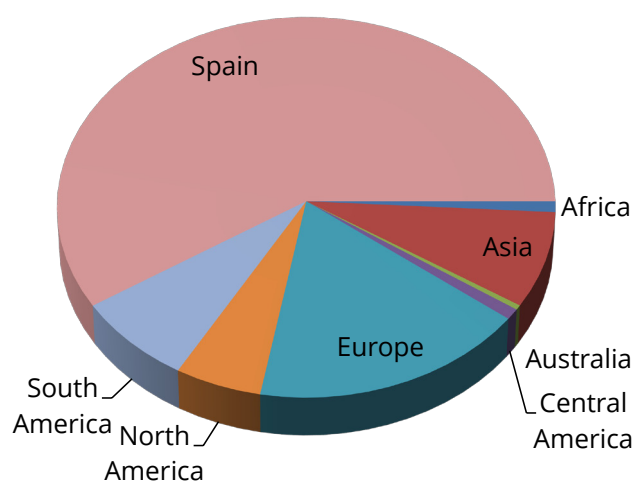
ICN2 is an equal opportunity employer committed to diversity and inclusion of people with disabilities, and seeks a workforce diverse in age, culture nationality and gender.

2015 annual average workforce

Job by Role	Female	Male	Total
Direction		1,0	1,0
Division Leader	1,0	2,1	3,1
Doctoral Student	20,0	37,3	57,3
Group Leader	3,0	12,1	15,1
Internship student	15,5	32,7	48,2
Laboratory Engineer	1,0	2,4	3,4
Postdoctoral Researcher	11,7	33,7	45,4
Ramón y Cajal Researcher	1,9	2,1	4,0
Senior Researcher	1,1	6,0	7,1
Visiting Postdoctoral Researcher	4,0	6,3	10,3
Management & Services	24,3	15,0	39,3
Technicians	3,4	15,3	18,7
Total			253,0

Nationality

Africa	0,92 %
Asia	8,14 %
Australia	0,39 %
Cantral America	0,92 %
Europe	17,50 %
North America	5,47 %
South America	7,58 %
Spain	59,08 %



Research and Technical Development



Severo Ochoa Award - Nanodevices for Social Challenges

The research developed at ICN2 has a big impact on fields such as life sciences (medicine, health, and environment), energy and information and communication technologies. This is one of the main reasons why the Spanish Ministry of Economy and Competitiveness acknowledged the Institute in 2014 as a **Severo Ochoa Center of Excellence**. This Programme recognizes the excellence of the scientific contributions of centres, their potential industrial and social impact and their potential for talent attraction. At the time ICN2 received the award, only 18 research centres had been awarded. In 2015 the list grew to 21 awarded centres.



The funding provided by the Severo Ochoa award is focused on the Programme on “Nanodevices for Social Challenges”. It is largely devoted to the recruitment of staff and the procurement of equipment to support the development of research projects.

● CROSS-DISCIPLINARY APPROACHES

The Programme is based on four cross-disciplinary methodological approaches:

• Growth and synthesis of nanomaterials

Expertise in growth of thin films, PLD, CVD, ALD, etc. with a broad range of materials, including graphene, metal and multiple component oxides.

• Nanofabrication

Expertise in both bottom-up and top-down fabrication, including self-assembly, nanoparticle synthesis, corrosive etching, supramolecular chemistry, screenprinting, nanoimprint lithography, roll-to-roll lithography on flexible substrates, inkjet printing, and rapid prototyping.

• Characterisation and metrology

World-class expertise in a very broad range of characterisation techniques, some of them developed by ICN2 researchers. Experience in nanometrology includes two patent applications, and the plan to establish a dedicated industrial Nanometrology centre with private partners.

• Theory and simulation

Expertise includes pioneering developments of tools for atomistic simulations of matter, including electronic and thermal processes in nanodevices, and the structure and properties of nanomaterials.

● RESEARCH AREAS

The research will produce specific applications and devices which are able to reach the market, providing new solutions to major social challenges in the following areas:

• Biosystems

Expertise in optical and electrochemical biosensing, biofunctionalised inorganic nanoparticles, supramolecular chemistry, water-surface interactions and characterisation. Related activities include EU projects in point-of-care devices and biosensors, ERC in nanomaterials for diagnostics & therapy, commercialisation with numerous licensed patents and two spin-off companies (biosensing and drug delivery).

• Energy

Expertise in materials, capacitors and energy transfer, phononics and photonics, photovoltaics, piezoelectrics, nanofabrication of flexible substrates and thin-film materials, spectroscopy and characterisation, leadership positions in EU projects and platforms (Graphene Flagship, Photonics platform, ERC in piezoelectrics), collaborative prototyping with industry in next-generation photovoltaics, roll-to-roll lithography, and inks for active layers.

• Information and communication technologies

Expertise in materials, spintronics, magnetism, graphene, topological isolators, photonics, phononics and heat transfer, nanodevice fabrication and characterisation.

In 2009, the EU identified KETs for their potential impact in strengthening Europe's industrial and innovation capacity. Six KETs were highlighted as key for European sustainable growth: Nanotechnology; Micro- and Nano-electronics; Advanced Materials; Photonics; Industrial Biotechnology and, Advanced Manufacturing. In this context, the relevance of the ICN2 Programme on "Nanodevices for Social Challenges" is evident, as it involves virtually all the six KETs.

● BEYOND RESEARCH

In addition to the scientific cross-disciplinary goals, ICN2 will carry out a comprehensive **recruiting and training programme** aimed at attracting and developing the professional careers of talented senior and junior researchers associated with the Severo Ochoa Programme (PhD programme; Postdoctoral programme; Visitors programme; ICN2- User Programme Training; Academia Intern Programme; and workshops and seminars). It also includes other ambitious actions such as the creation of a specific Gender action plan and international knowledge dissemination and outreach activities.

An external **Scientific and Industrial Advisory Committee** (SIAC), appointed by the Director with the advice of the ICN2 Scientific Advisory Board, advises on strategic directions and the progress of the project. The work plan is divided into **seven Work Packages**, one per Application Area and Cross-Disciplinary Activity. Overall management is carried out by the **Project Management Committee**, which is formed by one representative of each WP, plus two additional members to follow up dissemination and technology transfer activities.

Research Groups

The research workforce of ICN2 is distributed across 17 highly specialized research groups. Synergies among groups with complementary research lines are stimulated.



- > Advanced Electron Nanoscopy Group
- > Advanced Electronic Materials And Devices Group
- > Atomic Manipulation and Spectroscopy Group
- > Force Probe Microscopy and Surface Nanoengineering Group
- > Inorganic Nanoparticles Group
- > Magnetic Nanostructures Group
- > NanoBioelectronics and Biosensors Group
- > NanoBiosensors and Bioanalytical Applications Group
- > Nanostructured Functional Materials Group
- > Nanostructured Materials for Photovoltaic Energy Group
- > Novel Energy-Oriented Materials Group
- > Oxide Nanoelectronics Group
- > Phononic and Photonic Nanostructures Group
- > Physics and Engineering of Nanodevices Group
- > Supramolecular NanoChemistry and Materials Group
- > Theoretical and Computational Nanoscience Group
- > Theory and Simulation Group

Advanced Electron Nanoscopy Group

Main Research Lines

- **Transmission Electron Microscopy advanced techniques and related spectroscopies (EELS, EDX and CL) for Nanotechnology and Materials Science**
- **Exploring the limits of physical resolution in advanced electron microscopy**
- **Understanding the ultimate behaviour of materials at the nanoscale**



GROUP MEMBERS

Arbiol Cobos, Jordi, ICREA Research Professor and Group Leader

Asensi, Roger, Visiting Student

Bologna, Nicolás, Visiting Doctoral Student

de la Mata, Maria, Postdoctoral Researcher

Genç, Aziz, Visiting Student

Martí Sánchez, Sara, Doctoral Student

Schlafer, Johannes Martin, Postdoctoral Researcher

Tang, Pengyi, Visiting Doctoral Student



GROUP LEADER



Prof Jordi Arbiol

Prof. Jordi Arbiol was born in Molins de Rei (Catalonia), 1975. Graduated in Physics at Universitat de Barcelona (UB) in 1997, where he also obtained his PhD (European Doctorate and PhD Extraordinary Award) in 2001 in the field of transmission electron microscopy (TEM) applied to nanostructured materials.

He was Assistant Professor at UB. From 2009 to 2015 he was Group Leader at Institut de Ciència de Materials de Barcelona, ICMAB-CSIC and Scientific Supervisor of its electron microscopy facilities. Since 2013 he is Vice-President of the Spanish Microscopy Society (SME), and since 2009 he was Member of its Executive Board. Since 2015 he is the leader of the Group of Advanced Electron Nanoscopy at Institut Català de Nanociència i Nanotecnologia (ICN2). He has been awarded with the 2014 EMS Outstanding Paper Award, EU40 Materials Prize 2014 (E-MRS) and listed in the Top 40 under 40 Power List (2014) by The Analytical Scientist.



NEW PROJECTS & MILESTONES

Led by ICREA Research Prof Jordi Arbiol, the aim of this Group is developing and applying Electron Nanometrology tools such as Transmission Electron Microscopy advanced techniques and related spectroscopies (EELS, EDX and CL) for Nanotechnology and Materials Science needs. The increasing interest in Materials Science, Nanoscience and Nanotechnology has created a serious global need for the development of Nanoscopy tools in order to be able to observe and chemically analyse the synthesized nanostructures at atomic scale.

Exploring the limits of physical resolution in advanced electron microscopy and understanding the ultimate behaviour of materials at the nanoscale and their related properties are the central aims of our research. The newest research lines we are working in are based on single atom recognition and localization in embedded quantum structures. In parallel we are interested in finding methodologies to perform a direct correlation between the structural and chemical properties at the atomic scale and the physical properties at sub-nanometer scale (photonics, plasmonics and phononics).





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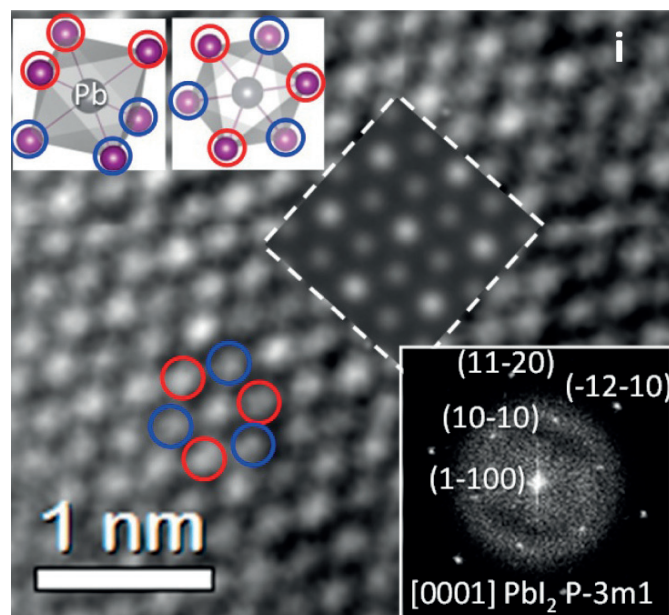
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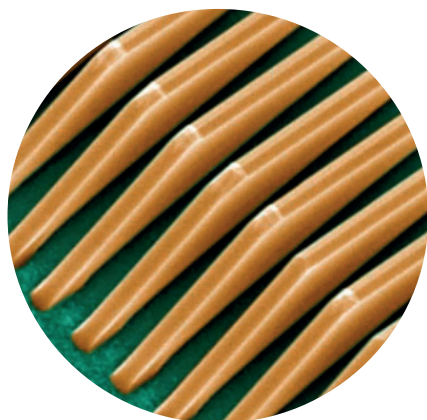
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PROJECTS (Active during 2015)

Single ATOM detection through Advanced Electron Nanoscopies, Funded by **Ministry of Economy, Spain** (Europa Excelencia Call), 01/10/2014 to 31/03/2016, Jordi Arbiol

e-Nanoscopy and core-shell multilayers for Tandem devices and systems based on Nanostructures for solar energy Transformation in sun FUELS, Funded by **Ministry of Economy, Spain** (RETOS Call), 01/01/2015 to 31/12/2017, Jordi Arbiol



CONTRIBUTIONS

Photonic 1D nanomaterials: Correlation between Optical Properties at sub-nanometer scale with its structure at atomic scale, **Trends in NanoTechnology 2015 (TNT2015)**, Toulouse (France), 07/09/2015, Jordi Arbiol, María de la Mata, Aziz Genç (Keynote)

Plasmonic nanoengineering in metal nanostructures: from solid nanocubes to complex hollow multiwalled nanoboxes, **SPIE PHOTONICS WEST and SPIE BIOS 2015**, San Francisco (USA), 9/2/2015, Jordi Arbiol (Invited)

Exploring the optical properties of 1D nanomaterials at sub-nanometer scale with a direct correlation to its structure at atomic scale, **DPG Spring Meeting 2015** (Berlin 2015), Deutsche Physikalische Gesellschaft e.V., Berlin (GER), 16/3/2015, Jordi Arbiol (Invited)

Direct correlation between optical properties at sub-nanometer scale and structure at atomic scale, in-situ performance in a STEM, **3rd Croatian Microscopy Congress (HMK2015)**, Zadar (Croatia), 27/4/2015, Jordi Arbiol (Invited)

*Energy Nanomaterials: a close look to their atomic scale structure and the influence on their properties at the nanoscale, **European Materials Research Society Spring Meeting 2015 (E-MRS Spring 2015)**, Lille (France), 12/05/2015, Jordi Arbiol (Invited)*

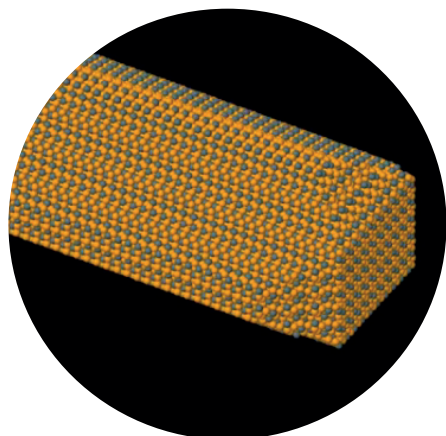
*Exploring the optical properties of nanomaterials at sub-nanometer scale with a direct correlation to its structure at atomic scale, **European Materials Research Society Spring Meeting 2015 (E-MRS Spring 2015)**, Lille (France), 14/05/2015, Jordi Arbiol (Invited)*

*Non-planar Nanostructures at Atomic Scale, **PHONSI - Nanophotonics by Nanocrystals, from integration to single photon operation Workshop**, ETH, Zurich (Switzerland), 30/09/2015, Jordi Arbiol (Invited)*

*Insight on the fine structure of Nanowires down to single atom detection: correlation to their physical properties, **Materials Research Society Fall Meeting 2015 (MRS Fall 2015)**, Boston (USA), 01/12/2015, María de la Mata, Jordi Arbiol (Invited)*

*Veure els àtoms de prop: UN VIATGE AL NANOMON, **Fundació OMS**, Manresa (Catalonia), Manresa, 21/03/2015, Jordi Arbiol (Invited Conference)*

*Direct correlation between optical properties at sub-nanometer scale and structure at atomic scale, in-situ performance in a STEM, **University of Texas at Austin**, Austin (USA), 05/05/2015, Jordi Arbiol (Invited Conference)*



*Non-planar Nanostructures at Atomic Scale, **Technische Universiteit Eindhoven, TU/e**, Eindhoven (Netherlands), 01/09/2015, Jordi Arbiol (Invited Conference)*

*Excitonic Structure of Shell-Quantum Dots in GaAs-AlGaAs Core-Shell Nanowires, **Materials Research Society Spring Meeting 2015 (MRS Spring 2015)**, San Francisco (USA), 08/04/2015, Yannik Fontana, Pierre Corfdir, Barbara van Hattem, Luca Francaviglia, Eleonora Russo-Averchi, Martin Heiss, Cesar Magen, Jordi Arbiol, Richard T. Phillips, Anna Fontcuberta i Morral (Oral)*

*Solution Phase van der Waals Epitaxy of ZnO Wire Arrays, **Materials Research Society Spring Meeting 2015 (MRS Spring 2015)**, San Francisco (USA), 08/04/2015, Yue Zhu, Yong Zhou, M. Iqbal B. Utama, Maria de la Mata, Yanyuan Zhao, Qing Zhang,, Bo Peng, Cesar Magen, Jordi Arbiol, Qihua Xiong (Oral)*

*Synthesis of Metal, Metal Oxide, Metal Fluoride Nanoparticles: Tuning Shape and Composition, **Materials Research Society Spring Meeting 2015 (MRS Spring 2015)**, San Francisco (USA), 10/04/2015, Susana Ricart, Alba Garzon, Jordi Martinez-Esain, Changyong Lu, Maria de la Mata, Jordi Arbiol, Jordi Garcia-Anton, Teresa Puig, Xavier Obradors, Ramon Yanez, Josep Ros, Eduardo Solano (Oral)*

*TiO₂ Anatase Nanocrystals Modification by WO₃ for Enhanced Gas Sensors: From Surface Deposition to Heterojunctions, **Materials Research Society Spring Meeting 2015 (MRS Spring 2015)**, San Francisco (USA), 09/04/2015, Mauro Epifani, Elisabetta Comini, Raul Diaz, Teresa Andreu, Aziz Genc, Jordi Arbiol, Pietro Siciliano, Guido Faglia, Juan R. Morante (Oral)*

*Plasmonic Nanoengineering in Hollow Metal Nanostructures, **Materials Research Society Spring Meeting 2015 (MRS Spring 2015)**, San Francisco (USA), 09/04/2015, Aziz Genc, Javier Patarroyo, Raul Arenal, Luc Henrard, Edgar Gonzalez, Neus G. Bastus, Victor Puentes, Jordi Arbiol (Oral)*

Strain Release Mechanisms in III-As/III-Sb Heterostructured Nanowires, **Materials Research Society Spring Meeting 2015 (MRS Spring 2015)**, San Francisco (USA), 07/04/2015, María de la Mata, Cesar Magen, Hadas Shtrikman, Philippe Caroff, Jordi Arbiol (Oral)

Atomic Study of the Strain Relaxation in Arsenide and Antimonide Nanowire Heterostructures, **European Materials Research Society Spring Meeting 2015 (E-MRS Spring 2015)**, Lille (France), 14/05/2015, María de la Mata, Cesar Magen, Hadas Shtrikman, Philippe Caroff, Jordi Arbiol (Oral)

Relaxation Mechanisms in Highly Mismatched Antimonide and Arsenide Heterostructured Nanowires, **Microscopy at the Frontiers of Science 2015 (MFS2015)**, Oporto (Portugal), 09/09/2015, María de la Mata, Cesar Magen, Hadas Shtrikman, Philippe Caroff, Jordi Arbiol (Oral)

Strain Relaxation at Atomic Scale of III-V Heterostructured Nanowires, **Materials Research Society Fall Meeting 2015 (MRS Fall 2015)**, Boston (USA), 30/11/2015, María de la Mata, Cesar Magen, Philippe Caroff, Jordi Arbiol (Oral)

BOOKS

Semiconductor Nanowires. Materials, Synthesis, Characterization and Applications, Jordi Arbiol, Qihua Xiong (Editors), Woodhead Publishing (Elsevier), 2015, ISBN: 9781782422532

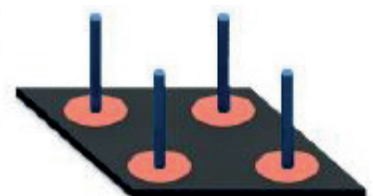
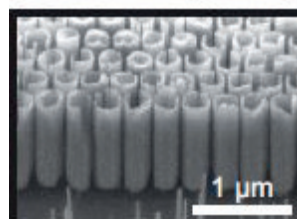
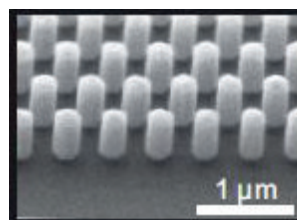
THESES

Doctorand: **Aziz Genç**
Title: Plasmonic Nanoengineering in Hollow Metal Nanostructures: An Electron Energy-Loss Spectroscopy Study
Defense date: 21/07/2015
Director: Prof Jordi Arbiol

Doctorand: **María de la Mata**
Title: Atomic Scale Characterization of Semiconductor Non-Planar Nanostructures
Defense date: 26/10/2015
Director: Prof Jordi Arbiol

AWARDS

2014 EMS Outstanding Paper Award, by the European Microscopy Society (EMS), Prof Jordi Arbiol, may 2015.



Advanced Electronic Materials and Devices Group

Main Research Lines

- **Fundamental electronic and electrochemical phenomena of novel materials, such as graphene and other 2D's**
- **Preparation (CVD) of high quality films of 2D materials. Technology and nanofabrication for advanced electronic devices and systems based on these materials**
- **Bioelectronics & Biomedical Technologies: cell bioelectronics, flexible implant, neuroprosthetics**
- **Electronic & electrochemical biosensors based on 2D materials**
- **Novel 2D materials for energy storage and conversion**



GROUP MEMBERS

Bonaccini Calia, Andrea Prieto, Doctoral Student

García Cortadella, Ramón, Master Student

Garrido Ariza, Jose Antonio, ICREA Research Professor and Group Leader

Hebert, Clement, Postdoctoral Researcher

Viana Casals, Damiá, Doctoral Student



GROUP LEADER



ICREA Prof Jose Antonio Garrido

Jose Antonio Garrido is an ICREA Research Professor working at Catalan Institute of Nanoscience and Nanotechnology (ICN2) in Barcelona, and head of the Advanced Electronic Materials and Devices Group, which explores novel electronic materials, such as graphene and other 2D materials, and their potential in electronic and bioelectronic applications.



NEW PROJECTS & MILESTONES

Led by ICREA Research Professor Jose A. Garrido, the Advanced Electronic Materials and Devices Group joined the ICN2 on September 2015. The Group focuses on material science and technology of novel

electronic materials, with a strong emphasis on carbon materials such as graphene, as well as other 2D materials (MoS₂). In addition, the Group works towards the development of technological applications of these materials in electronics, bioelectronics and biosensing, energy storage and conversion, etc.

He received a master and PhD degree in Telecommunication Engineering from the Technical University of Madrid, in 1996 and 2000, respectively. From 2001 to 2004, he worked as a postdoc at the Walter Schottky Institute, Technische Universität München, and afterwards became Group Leader of the Functional Carbon Materials group. He obtained his habilitation in experimental physics at the TU Munich in 2010. From 2011 to 2015, Jose A. Garrido held a lecturer (privatdozent) position at the department of physics of the Technische Universität München. Jose A. Garrido is Editor of the journal Diamond and Related Materials and co-coordinator of the workpackage Biomedical technologies of the European Graphene Flagship initiative.

The activities cut across different scientific aspects, from fundamentals (physics of devices and semiconductors) to materials (growth of graphene and 2D materials by CVD, surface functionalization, advanced characterization), through devices (fabrication technology, nanofabrication), and to applications (biosensors, neural implants and biomedical technologies, energy storage and conversion).



PROJECTS

Graphene-Based Revolutions in ICT And Beyond, funded by **EC**, 01/10/2013 – 31/03/2016, Jose A. Garrido

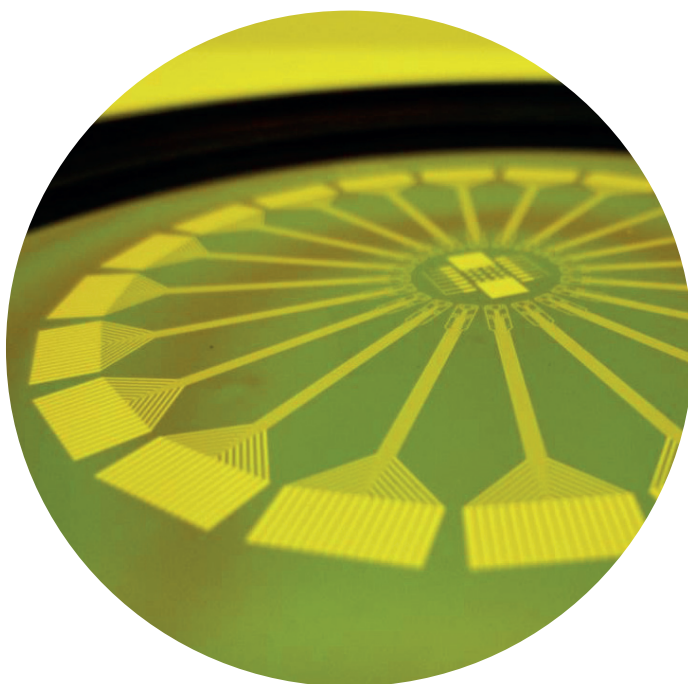


CONTRIBUTIONS

Graphene electronics for biomedical technologies, **GraphIn International Workshop** (Graphene Industry - Challenges & Opportunities), Zaragoza, Spain. 03/12/2015, Jose A. Garrido (Invited)

Graphene electronics for biomedical technologies, **1st Japan - EU workshop on grapheme and 2D materials**, Tokyo, Japan, 02/11/2015, Jose A. Garrido (Invited)

Graphene technology and biomedical applications, **NANOBIOAPP2015, Latest Advances on Nanomaterials for Biomedical Applications**, Barcelona, 21-23/09/2015, Jose A. Garrido (Invited)



Atomic Manipulation and Spectroscopy Group

Main Research Lines

- Metal-organic hybrid interfaces
- Graphene-based nanostructures
- Electron scattering and quantum confinement



GROUP MEMBERS

De Oliveira, Sofia, Visiting Doctoral Student
Gastaldo, Michele, Doctoral Student
González Cuxart, Marc, Doctoral Student
Hieulle, Jeremy, Postdoctoral Researcher
Moreno Sierra, César, Postdoctoral Researcher

Mugarza Ezpeleta, Aitor, ICREA Research Professor and Group Leader
Panighel, Mirco, Postdoctoral Researcher
Paradinas Aranjuelo, Marcos, Laboratory Engineer
Schirone, Stefano, Doctoral Student
Valbuena Martínez, Miguel Angel, Postdoctoral Researcher



GROUP LEADER



Prof Aitor Mugarza

Prof Mugarza earned his BS degree in Physics in 1997 and his PhD in Physics in 2002, both at the University of the Basque Country. After his doctoral studies, he was awarded a Marie Curie fellowship to work as a postdoctoral scientist at the Lawrence Berkeley National Laboratory, USA, and at the Materials Science Institute of Barcelona (ICMAB). He later joined ICN in 2007 with a Ramon y Cajal Fellowship. In 2013, he was appointed Group Leader of the Atomic Manipulation and Spectroscopy Group at ICN2 and ICREA Research Professor since 2015.



NEW PROJECTS & MILESTONES

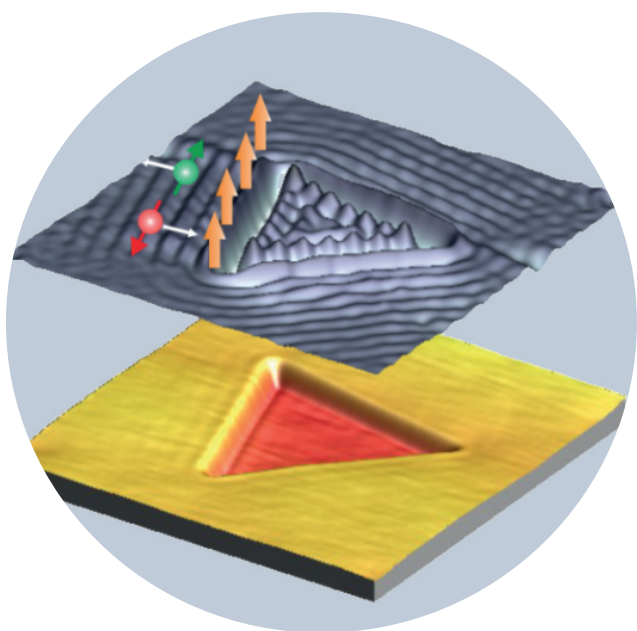
The main activity of the Atomic Manipulation and Spectroscopy Group in 2015 has been focused on the synthesis and characterization of carbon-based nanostructures and hybrid metalorganic networks. One of the ongoing research lines has been the study of electronic and magnetic properties of hybrid metal-organic heterostructures. In particular, we have demonstrated how the moment of the smallest magnetic objects, single-molecule magnets, can be coupled to Fe-based

ferromagnetic and antiferromagnetic substrates. Regarding carbon-based nanostructures, we have continued our studies on the synthesis of graphene nanoislands, providing understanding on the relation between the atomic stacking with the metallic surface and the shape and edge structure of the nanoislands, and how these can be controlled by thermally activated transitions. The new common direction of the group's research on these two systems heads towards the on-surface synthesis of covalent networks, in particular 2D metal-organic networks and functionalized graphene nanoribbons.



His research activity is based on the investigation of the electronic and magnetic properties of matter on the nanoscale, and developing strategies to manipulate them with atomic precision. By combining Scanning Tunnelling Microscopy techniques with Synchrotron Radiation Spectroscopy, he correlates microscopic phenomena to macroscopic observables that are relevant for the understanding and design of new materials and devices. He is currently focusing on novel materials that include molecular nanostructures, graphene, topological insulators and other 2D Dirac materials.

Another active field in the group has been the study of electron scattering phenomena in materials with strong spin-orbit coupling. Here, the electron spin and momentum appear intertwined, giving rise to non-conventional spin-dependent scattering phenomena. By using scanning tunnelling microscopy to build quantum resonators and map electron interferences, we have discovered a novel spin-flip scattering mechanism that leads to strong electron confinement, which is in stark contrast to the absence of backscattering predicted for ideal systems.



PUBLICATIONS

Atomic species identification at the (101) anatase surface by simultaneous scanning tunnelling and atomic force microscopy,

Stetsovych O., Todorovi A.M., Shimizu T.K., Moreno C., Ryan J.W., León C.P., Sagisaka K., Palomares E., Matolín V., Fujita D., Perez R., Custance O., *Nature Communications*; **6**: 7265, 2015. 10.1038/ncomms8265. IF: 11.470

Exchange bias of TbPc₂ molecular magnets on antiferromagnetic FeMn and ferromagnetic Fe films, Nistor C., Krull C., Mugarza A., Stepanow S., Stamm C., Soares M., Klyatskaya S., Ruben M., Gambardella P., *Physical Review B - Condensed Matter and Materials Physics* (21); **92 (18)**: 184402, 2015. 10.1103/PhysRevB.92.184402. IF: 3.736

Spin-flip and element-sensitive electron scattering in the BiAg₂ surface alloy, Schirone S., Krasovskii E.E., Bihlmayer G., Piquerel R., Gambardella P., Mugarza A., *Physical Review Letters*; **114 (16)**: 166801, 2015. 10.1103/PhysRevLett.114.166801. IF: 7.512

Substrate-induced stabilization and reconstruction of zigzag edges in graphene nanoislands on Ni(111), Garcia-Lekue A., Olle M., Sanchez-Portal D., Palacios J.J., Mugarza A., Ceballos G., Gambardella P., *Journal of Physical Chemistry C*; **119 (8)**: 4072 - 4078, 2015. 10.1021/jp511069y. IF: 4.772



PROJECTS (Active during 2015)

Híbridos covalentes en superficies, Funded by **MINECO**, 1/1/2014 - 31/12/2016, Aitor Mugarza

SGR, Funded by **AGAUR**, 1/1/2014 - 31/12/2016, Aitor Mugarza

Atomic-scale engineering of unconventional organic superconductors - BP-DGR 2013 (Modalitat B), Funded by **AGAUR**, 30/9/2014 - 29/9/2016, César Moreno

Electron Scattering in materials with strong spin-orbit coupling - FI, Funded by **AGAUR**, 1/3/2014 - 28/2/2017, Stephano Schirone



CONTRIBUTIONS

Electronic and magnetic properties at the metal-organic interface, Instituto de Nanociencia de Aragón, Zaragoza, Spain, 25/03/2015, Aitor Mugarza (Invited)

Electronic and magnetic properties at the metal-organic interface, University of Würzburg, Würzburg, Germany, 15/01/2015, Aitor Mugarza (Invited)

Manipulating molecular charge and spin: interface effects and extrinsic doping, International Conference on Single-Molecule Electronics, Regensburg, Germany, 15-17/09/2015, Aitor Mugarza (Invited)

Intramolecular structure of individual organic molecules by Atomic Force Microscopy, ICMAB-CSIC, Barcelona, Spain, 09/02/2015, César Moreno (Invited)

Spin-dependent electron scattering in graphene nanostructures on Ni(111), International Conference on Magnetism, Barcelona, Spain, 05-10/06/2015, Aitor Mugarza (Oral)

Spin-dependent electron scattering at the graphene-Ni interface, International Workshop on Organic and Graphene Electronics and Spintronics, Barcelona, Spain, 12-13/03/2015, Aitor Mugarza (Oral)

Imaging of Single Organic Molecules on Oxide Semiconductors with Submolecular Resolution by Atomic Force Microscopy, ELECSPIN2015 International Workshop on Organic and Graphene Electronics and Spintronics, Barcelona, Spain, 12-13/03/2015, César Moreno (Oral)

Magnetic properties of tetra-phenyl-porphyrins adsorbed on metal surfaces, 31st European Conference on Surface Science, Barcelona, Spain, 31/08 - 04/09/2015, Mirco Panighel (Oral)

BiAg₂ Rashba surface alloy: Spin-flip electron scattering, 31st European Conference on Surface Science, Barcelona, Spain, 31/08 - 04/09/2015, S. Schirone (Oral)

Engineering edge structure and electronic properties of graphene nanoislands by Au intercalation, 31st European Conference on Surface Science, Barcelona, Spain, 31/08 - 04/09/2015, Michele Gastaldo (Oral)

Domains Boundaries in Merged Graphene Islands on Ni (111), 31st European Conference on surface Science, Barcelona, Spain, 31/08 - 04/09/2015, Sofia Oliveira Parreiras (Poster)

Submolecular resolution in 3D, 31st European Conference on Surface Science, Barcelona, Spain, 31/08 - 04/09/2015, César Moreno (Poster)

Magnetic properties of tetra-phenyl-porphyrins adsorbed on metal surfaces, 20th International Conference on Magnetism, Barcelona, Spain, 05-10/07/2015, Mirco Panighel (Poster)

Spin-flip Electron scattering in the BiAg₂ Rashba surface alloy, 20th International Conference on Magnetism, Barcelona, Spain, 05-10/07/2015, S. Schirone (Poster)

Decoupling of shape-selected graphene nanoislands grown on Ni (111) by Au intercalation, ELECSPIN2015 International Workshop on Organic and Graphene Electronics and Spintronics, Barcelona, Spain, 12-13/03/2015, Michele Gastaldo (Poster)

More information:
<http://ams.icn.cat>

Force Probe Microscopy and Surface Nanoengineering Group

Main Research Lines

- Force Probe Spectroscopy and Metrology
- Self-sustained motion and catalytic micropumps
- Interfacial water
- Polymer-based interfaces
- Nanoparticles of organic superconductors



GROUP MEMBERS

Calò, Annalisa, Visiting Postdoctoral Researcher

Esplandiu Egido, María José, CSIC Tenured Scientist

Evangelio Araujo, Laura, Visiting Student

Fontanet, Andrea Del Carme, CSIC Visiting Student

Fraxedas Calduch, Jordi, CSIC Scientific Researcher and Group Leader

Gramazio, Federico, Doctoral Student

Mingorance Ferrer, Alba, SO Doctoral Student

Ribas, Esteve, CSIC Visiting Student

Ruso, Daniel, CSIC Technician

Salavert Otal, Rita, Visiting Student

Verdaguer Prats, Albert, CSIC Tenured Scientist

Wilhelms, Edvard, Student

Zhang, Kuan, SO Doctoral Student



GROUP LEADER



CSIC Scientific Researcher
Dr Jordi Fraxedas

Jordi Fraxedas (Tarragona, 1962) graduated in Physics from the University of Zaragoza (Spain) in 1985 and obtained his PhD (Dr rer. nat.) in 1990 from the University of Stuttgart (Germany). His thesis work was performed at the Max Planck Institut für Festkörperforschung and at the Berliner Speicherring für Synchrotronstrahlung (BESSY), under the supervision of Prof M. Cardona.

After a post-doctoral position at the European Synchrotron Radiation Facility (ESRF) in Grenoble (France) and an



NEW PROJECTS & MILESTONES

The Group participates in several projects at the European and Spanish level. Within the EU FP7 the Group is involved in **advanced AFM instrumentation and in directed self-assembly of block copolymers** in collaboration with leading European universities and companies. In the first case, a prototype of an AFM head is being designed which should be able to be operated in industrial environments with a robot arm at high speed (3 MHz) and providing real-time information on the mechanical properties of surfaces of industrial interest (plastic injection, solar

cells, etc.). In the second case the interfacial mechanisms of self-assembly are being investigated at the fundamental level in order to better address the future use of new smaller polymers.

At the Spanish level the Group participates in two projects focused on the **tailoring of the affinity of water to surfaces and to micro/nanofluidics using carbon-based materials** (nanotubes and graphene), respectively. The main objective is to be able to control the dynamics of water at different interfaces, i.e., structuring water as ice at temperatures above 0 degrees C and inducing mass transport via electrokinetic processes.



established Researcher position at the European Laboratory for Particle Physics (CERN) in Geneva (Switzerland), he joined the Solid State Research Institute of Barcelona (ICMAB) of the Spanish Research Council (CSIC) in 1995 and worked as a Chercheur associé at the Centre National de la Recherche Scientifique (CNRS) in 2002.

His research activity is focused on interfacial phenomena and surface science. He has co-authored more than 120 peer-reviewed scientific articles and published the books entitled *Molecular Organic Materials: From Molecules to Crystalline Solids* (Cambridge University Press, 2006) and *Water at Interfaces: A Molecular Approach* (Taylor and Francis CRC (2014)).



PUBLICATIONS

Capillary and van der Waals interactions on CaF₂ crystals from amplitude modulation AFM force reconstruction profiles under ambient conditions, Calo A., Robles O.V., Santos S., Verdaguer A., *Beilstein Journal of Nanotechnology*; **6 (1)**: 809 - 819, 2015. 10.3762/bjnano.6.84. IF: 2.670

Creation of guiding patterns for directed self-assembly of block copolymers by resistless direct e-beam exposure, Evangelio L., Fernandez-Regulez M., Borrise X., Lorenzoni M., Fraxedas J., Perez-Murano F., *Proceedings of SPIE - The International Society for Optical Engineering*; **9423**: 942326, 2015. 10.1117/12.2085830.

Elucidation of the wettability of graphene through a multi-length-scale investigation approach, Amadei C.A., Lai C.-Y., Esplandiu M.J., Alzina F., Vecitis C.D., Verdaguer A., Chiesa M., *RSC Advances*; **5 (49)**: 39532 - 39538, 2015. 10.1039/c5ra04397b. IF: 3.840

Revealing water films structure from force reconstruction in dynamic AFM, Calò A., Domingo N., Santos S., Verdaguer A., *Journal of Physical Chemistry C*; **119 (15)**: 8258 - 8265, 2015. 10.1021/acs.jpcc.5b02411. IF: 4.772

Silicon-Based Chemical Motors: An Efficient Pump for Triggering and Guiding Fluid Motion Using Visible Light, Esplandiu M.J., Afshar Farniya A., Bachtold A., *ACS Nano*; **9 (11)**: 11234 - 11240, 2015. 10.1021/acsnano.5b04830. IF: 12.881

Spin density wave and superconducting properties of nanoparticle organic conductor assemblies, Winter L.E., Steven E., Brooks J.S., Benjamin S., Park J.-H., De Caro D., Faulmann C., Valade L., Jacob K., Chtioui I., Ballesteros B., Fraxedas J., *Physical Review B - Condensed Matter and Materials Physics*; **91 (3)**: 035437, 2015. 10.1103/PhysRevB.91.035437. IF: 3.736

Continuous monitoring of tip radius during atomic force microscopy imaging, Fraxedas, J., Pérez-Murano, F., Gramazio, F., Lorenzoni, M., Rull Trinidad, E., Staufer, U.; *Proceedings of SPIE - The International Society for Optical Engineering*; **9636**, 2015. Article number 963600



PROJECTS

Automated In-line Metrology for Nanoscale Production (AIM4NP) - Collaborative Project, targeted to SME, funded by **EC**, 01/03/2013 - 31/06/2016, Jordi Fraxedas

Afinidad y estructura del agua interfacial sobre superficies nanoestructuradas en condiciones ambientales, funded by **MINECO**, 01/01/2013-31/12/2015, A. Verdaguer

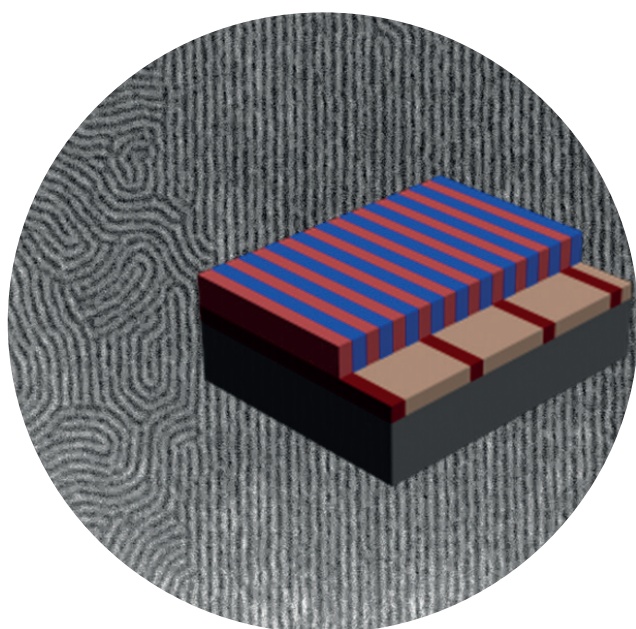
Nanoscòpia i Nanoenginyeria de Superfícies, funded by **AGAUR**, 17/07/2014 - 31/12/2016, Jordi Fraxedas



CONTRIBUTIONS

Continuous monitoring of tip radius during atomic force microscopy imaging, **SPIE Scanning Microscopies**, Monterey, CA, USA, September 2015, Jordi Fraxedas, Francesc Pérez-Murano, Federico Gramazio, Matteo Lorenzoni, Enrique Rull Trinidad, Urs Staufer (Invited)

Development and performance analysis of catalytic micropumps, **I Workshop on Non-Equilibrium Statistical Physics and Multidisciplinary Applications**, Barcelona, 2015, M. José Esplandiú (Invited)



Confocal Fluorescence Microscopy: molecular sensors for ions. Application Case: Study of micro/nanoactuators self-propelled by catalytic reactions, **XXII Leica Course for the new specialist in Spectral Confocal Microscopy**, Universidad Autónoma de Barcelona and LEICA MICROSISTEMAS, S.A., Barcelona, May 2015, M. José Esplandiú (Invited)

Open Knowledge Program: Lecture on Fundamentals of photolithography and charged particle beam lithography, **Instituto Catalán de Nanociencia y Nanotecnología, ICN2**, Barcelona, March 2015, M. José Esplandiú (Invited)

Formation of chemical guiding patterns for DSA of block co-polymers by high resolution resistless nanolithography methods, **E-MRS Spring Meeting**, Symposium R: Block-copolymer self assembly for nanotechnology applications, Lille, France, May 2015, Laura Evangelio, Matteo Lorenzoni, Marta Fernández-Regúlez, Xavier Borrísé, Jordi Fraxedas, Francesc Pérez-Murano (Oral)

Enabling density multiplication in directed self-assembly of block co-polymers by chemical surface modification using wide guiding stripes, **E-MRS Spring Meeting**, Symposium R: Block-copolymer self assembly for nanotechnology applications, Lille, France, May 2015, Laura Evangelio, Matteo Lorenzoni, Jordi Fraxedas, Francesc Pérez-Murano, Weihua Li, Marcus Müller (Oral)

Determination of the interfacial energies in chemical guiding patterns for directed self-assembly of block co-polymers, **41st Micro and NanoEngineering (MNE)**, The Hague (NL), September 2015, Laura Evangelio, Matteo Lorenzoni, Jordi Fraxedas, Francesc Pérez-Murano (Oral)

Catalytic pumps for colloid manipulation and patterning, **2015 MRS Spring Meeting**, San Francisco, USA, April 2015, M. José Esplandiú (Oral)

Water Effects on Surface Screening of Ferroelectric Materials and PFM, **ISAF-ISIF-PFM 2015**, Singapur, 24/05/2015, Albert Verdagué, Kumara Cordero, Annalisa Calò, Neus Domingo (Oral)

Water adsorption on ferroelectric oxide surfaces: A synchrotron Near Ambient Pressure X-ray Photoelectron Spectroscopy (XPS) study, **31st European Conference on Surface Science ECOSS-31**, Barcelona, 30/08 - 04/09/2015, Albert Verdaguer, Laura Rodriguez, Maria Jose Esplandiu, Kumara Cordero, Carlos Escudero, Virginia Pérez, Annalisa Calo, Neus Domingo. (Oral)

Force reconstruction from dynamic AFM on differently terminated thiol SAMs, **31st European Conference on Surface Science ECOSS-31**, Barcelona, 30/08 - 04/09/2015, Annalisa Calo, Maria Jose Esplandiu, Sergio Santos, Albert Verdaguer. (Oral)

Density multiplication in directed self-assembly of block co-polymers by chemical surface modification using wide guiding stripes, **SPIE Advanced Lithography**, San Jose, CA, USA, February 2015, L. Evangelio, M. Fernández-Regúlez, W. Li, M. Lorenzoni, C. Nicolet, C. Navarro, J. Fraxedas, M. Müller, F. Pérez-Murano (Póster)

Creation of guiding patterns for directed self-assembly of block co-polymers by resistless direct e-beam exposure, **SPIE Advanced Lithography**, San Jose, CA, USA, February 2015, L. Evangelio, M. Fernández-Regúlez, X. Borrisé, M. Lorenzoni, J. Fraxedas, F. Pérez-Murano (Póster)

Nanostructured pattern replication on transparent polycarbonate by plastic injection, **EuroNanoForum2015**, Riga (Latvia), June 2015, Jordi Fraxedas, Daniel Ruso, Francesc Perez-Murano, Carles Colominas and Andrés García-Granada (Póster)

Characterization of buried interfaces of polymer films using high kinetic energy photoemission, **VII AUSE Congress and II ALBA User's Meeting**, Bellaterra, June 2015, Jordi Fraxedas, Laura Evangelio, M. Lorenzoni, F. Gramazio, Ricardo García and F. Pérez-Murano (Poster)

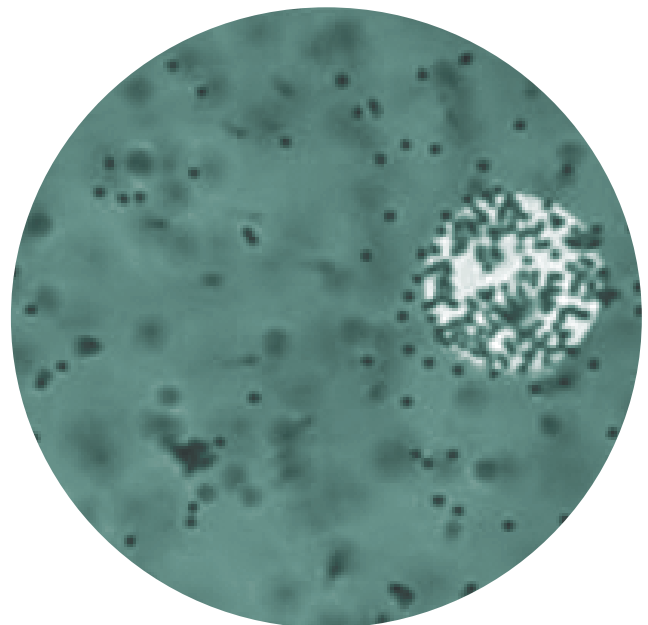
Water adsorption and freezing on ferroelectric oxide thin films, **31st European Conference on Surface Science ECOSS-31**, Barcelona, 30/08 - 04/09/2015, Laura Rodriguez, Kumara Cordero, Maria Jose Esplandiu, Carlos Escudero, Victoria Perez, Annalisa Calo, Neus Domingo, Albert Verdaguer. (Poster)

Study of surface screening by adsorbates on LiNbO₃ single crystals in different environments by Near Ambient Pressure XPS, **31st European Conference on Surface Science ECOSS-31**, Barcelona, 30/08 - 04/09/2015, Rohini Kumara Cordero Edwards, Laura Rodriguez, Carlos Escudero, Virginia Perez, Gustau Catalan, Neus Domingo, Albert Verdaguer. (Poster)



European patent application CIN2PAT

02/15 *Method for monitoring radius and shape variations of atomic force microscope cantilever tips and device thereof, with Ref. EP15163207.2 and priority date 10/04/2015 by CSIC with Univ. Delft.*



Inorganic Nanoparticles Group

Main Research Lines

- Design and development of synthetic strategies for the production of complex nanoparticles
- Functionalisation with specific relevant (bio) molecules
- The study of their physicochemical and fundamental properties



GROUP MEMBERS

Blanco, Ángel, Visiting Student
Busquets, Martí, Doctoral Student
F. Puentes, Víctor, ICREA Research Professor and Group Leader
Girona, Marta, Visiting Student
Gómez Bastus, Neus, Senior Researcher
Iguaz, Joaquim, Visiting Student
Malec, Jędrzej Rafal, Visiting Student

Merkoçi Xhelo, Florind, Technician
Patarroyo Rengifo, Javier, Doctoral Student
Peral, Ariadna, Group Project Manager
Piella Bagaria, Jordi, Doctoral Student
Russo, Lorenzo, SO Doctoral Student
Solé, Helena, Visiting Student
Yazdi, Amirali, SO Doctoral Student
Yudina, Tetyana, Doctoral Student



GROUP LEADER



ICREA Prof
Víctor F. Puentes

ICREA Research Prof Víctor F. Puentes' work spans the full breadth of nanoparticle research: synthesis, conjugation and characterisation of inorganic nanoparticles; nanotoxicology and nanosafety; and myriad applications for sectors including medicine and the environment.

Prof Puentes completed his undergraduate studies in Chemical Engineering and Materials Science at the Université Louis Pasteur Strasbourg (France) and at the Universitat Autònoma de Barcelona (UAB). In 1998, he earned his PhD in Physics from the Universitat de Barcelona



NEW PROJECTS & MILESTONES

In 2015 the Inorganic Nanoparticles Group worked on several of its ongoing projects on the design and synthesis of inorganic NPs for their interactions with biological systems and energy harvesting (see projects list). Two projects were completed in 2015: TUNANOCRYSTAL (Desarrollo de estrategias para síntesis de nanocristales

inorgánicos multi-componente complejos con propiedades físico-químicas ajustables from Spanish Government - Ministerio de Economía y Competitividad) and QNANO (A pan-European infrastructure for quality in nanomaterials safety testing from European Commission - FP7-INFRASTRUCTURES)

Nanoparticles are engineered and designed in view of their applicability in materials science, catalysis, energy harvesting, environmental remediation



(UB), working with Prof Xavier Batlle and Prof Amilcar Labarta on Giant Magnetoresistance in granular alloys. He then spent more than 3 years at the University of California, Berkeley, and the Lawrence Berkeley National Laboratory (LBNL), in the groups of Prof Paul Alivisatos and Prof Kannan Krishnan, working on the synthesis and control of nanostructures. In 2003 he returned to Catalonia with a Ramón y Cajal research position at the University of Barcelona, and in 2005 obtained an ICREA Professorship at ICN to create the Inorganic Nanoparticles Group, which he presently heads.

By the end of 2015, Prof Puntès held 131 peer-reviewed publications and over 9,000 total citations. He is also well-known for his work in science communication for the general public, his industrial and commercial efforts, and for his endeavours linking science and art.

and nanobiomedicine and nanotoxicology, among others. This is achieved by controlling the size, shape and structure of their inorganic core, and selectively linking active molecules to the nanoparticle surface, which allows them to selectively interact with specific systems (materials, biological, environmental etc.).

In this regard, the main scientific objectives of the group include:

I. Design and development of synthetic strategies for the production of complex nanoparticles (focusing on complex multicomponent and hollow nanoparticles comprising different families of metal, metal oxides, semiconductor oxides and semiconductors).

II. Functionalisation with specific relevant (bio)molecules and materials (core-shell NPs, heterodimers...) in order to interface the NP in the desired system and increase NP functionalities.

III. The study of their physicochemical and fundamental properties. As a result, we design new drug-delivery platforms, advanced catalysts to improve energy-chemical processes, optimize NP's features to enhance the production of hydrogen or boost the Biogas production. We also focus on the precise characterisation of the obtained nanoparticles in terms of their reactivity (aggregation, corrosion and dissolution) and physicochemical properties, as prepared, during and after use.



PUBLICATIONS

Use of cerium oxide (CeO₂) nanoparticles for the adsorption of dissolved cadmium (II), lead (II) and chromium (VI) at two different pHs in single and multi-component systems, Contreras, Ar., Casals, E., Puentes, V. F., Komilis, D., Sánchez, A., Font, X., *Global Nest Journal*; **17 (3)**: 536-543, 2015.

Design and pharmacokinetical aspects for the use of inorganic nanoparticles in radiomedicine, Puentes, V. F., *The British journal of radiology*; **89 (1057)**: 20150210, 2015.

SERS efficiencies of micrometric polystyrene beads coated with gold and silver nanoparticles: the effect of nanoparticle size, Mir, B., Morla, J., Gisbert, P., Pazos, N., Xie, Hy., Bastús, NG, Puentes, V. F., Alvarez, R., Guerrini, L., *Journal of Optics*; **17 (11)**: 114012, 2015.

High Aspect Ratio Gold Nanorods Grown with Platinum Seeds, Varon, M., Arbiol, J. & Puentes, V. F., *Journal Of Physical Chemistry C*; **119 (21)**: 11818-11825, 2015.

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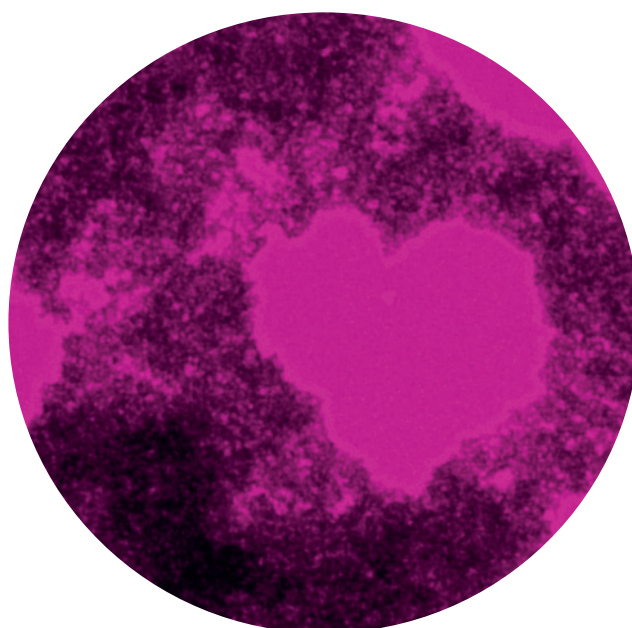
Chitosan functionalisation of gold nanoparticles encourages particle uptake and induces cytotoxicity and pro-inflammatory conditions in phagocytic cells, as well as enhancing particle interactions with serum components, Boyles, M., Kristl, T., Andosch, A., Zimmermann, M., Tran, N., Casals, E., Himly, M., Puentes, V. F, Huber, C., Lütz-Meindl, U., Duschl, A., *Journal of nanobiotechnology*; **13 (1)**: 84, 2015.

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PROJECTS

*Suport a les activitats dels grups de recerca de Catalunya (SGR), funded by **AGAUR**, 01/01/2014 - 31/12/2016, Victor.F.Puntes*

*FutureNanoNeeds: Framework to respond to regulatory needs of future nanomaterials and markets, funded by **EC - FP7-NMP-2013-LARGE-7**, 01/01/2014 - 30/06/2015, Victor F.Puntes*

*GUIDEnano: Assessment and mitigation of nano-enabled product risks on human and environmental health: Development of new strategies and creation of a digital guidance tool for nanotech industries, funded by **EC - FP7-NMP-2013-LARGE-7**, 01/11/2013 - 30/04/2017, Victor.F.Puntes*

*TUNANOCRYSTAL: Desarrollo de estrategias para síntesis de nanocristales inorgánicos multi- componente complejos con propiedades físico-químicas ajustables, funded by **MINECO**, 01/01/2013 - 31/12/2015, Victor F. Puntes*

*Cerium oxide nanoparticles as a new therapeutic tool for tissue regeneration in liver diseases, funded by **Fundació La Marató (La Marató de TV3)**, 14/01/2013 - 13/01/2016, Victor F. Puntes*

*QNANO: A pan-European infrastructure for quality in nanomaterials safety testing, funded by **EC - FP7-INFRASTRUCTURES**, 01/02/2011 - 31/01/2015, Victor F. Puntes*

*Developing new strategies for the production of viable hybrid nanocrystals with applicability in energy conversion and (photo)catalysis, funded by **EC**, 01/12/2012 - 30/11/2015, Gómez Bastus, N.*

*NanoTOES-Nanotechnology: Training of experts in safety, funded by **EC**, 01/11/2010 - 28/02/2015, Victor F. Puntes*



CONTRIBUTIONS

*De la biomassa al combustible sintetic, **Institut de Recerca en Energía de Catalunya (IREC)**, Barcelona, Spain (Dec. 2015), Victor Puntes (Invited)*

*Characterization of the physicochemical transformations of nanocarriers occurring during biological exposure, **Workshop JRC Ispra: Characterisation of Nanomaterials and Nanomedicine**, Ispra, Italy (Nov. 2015), Victor Puntes (Invited)*

*Pharmaprocess, **Fira de Barcelona**, Barcelona, Spain (Oct. 2015), Victor Puntes (Invited)*

*Jornadas sobre nanotecnología y alimentación, **Universidad de San Carlos de Guatemala**, Barcelona, Spain (Oct. 2015), Victor Puntes (Invited)*

*Nanoparticle interaction with biomolecules: how it shapes the nano-effects on immunity, **ESF-EMBO Symposium - Interaction Between the Immune System and Nanomaterials: Safety and Medical Exploitation**, Pultusk, Poland (Oct. 2015), Victor Puntes (Invited)*

*Nanobiointeractions, **Casa de la Convalescència**, Barcelona, Spain (Sep. 2015), Victor Puntes (Invited)*

*África y Biogás, **Colibantan**, Barcelona, Spain (Sep. 2015), Victor Puntes (Invited)*

*Nanoeduca, **CCCB: Centre de Cultura Contemporània de Barcelona**, Barcelona, Spain (Jul. 2015), Victor Puntes (Invited)*

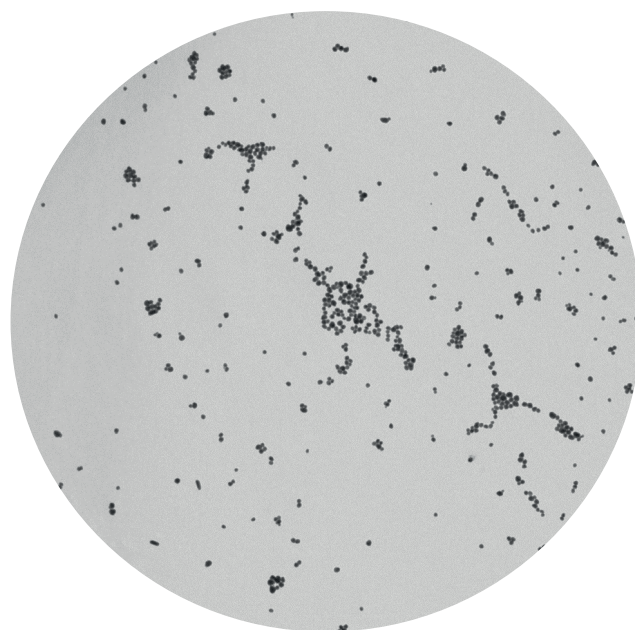
*Nanopartículas naturales y no intencionadas presentes en la alimentación, **Jornada "Nanotecnología y Alimentación", Agencia Española de Consumo, Seguridad Alimentaria y Nutrición (AECOSAN)**, Madrid, Spain (June 2015), Victor Puntes (Invited)*

Nanoremediation, **Institut Català de Recerca de l'aigua (ICRA)**, Girona, Spain (Mar. 2015), Victor Puentes (Invited)

Nanodialogue, **Universitat de Barcelona**, Barcelona, Spain (Feb. 2015), Victor Puentes (Invited)

Oxidative stress reduction by nanoparticles of cerium oxide (CeO₂ NPS) partially reverts the activation of portal endothelial cells from cirrhotic rats, **50th International Liver Congress of the European Association for the Study of the Liver**, Journal of Hepatology 62, S331 (2015), Vienna, Austria, 22-26/04/2015, Rodríguez, J., Ribera, J., Casals, G., Oró, D., Marfà, S., Morales, B., Yudina, T., Puentes, V. F., Jiménez, W., Ruiz, M. (Meeting abstract)

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More information:
<http://www.inorganicnanoparticles.net/>

Magnetic Nanostructures Group

Main Research Lines

- Exchange coupling in bi-magnetic core/shell nanoparticles and nanostructures
- Magnetic nanostructures for biomedical applications
- Magnetoplasmonic effects
- Novel magnetic and structural characterisation tools for nanoparticles
- Innovative fabrication approaches



GROUP MEMBERS

Fantechi, Elvira, Postdoctoral Researcher

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GROUP LEADER



ICREA Prof
Josep Nogués

ICREA Research Prof Nogués earned his BSc from the Universitat Autònoma de Barcelona (UAB), in Spain, in 1986. After obtaining his PhD at the Royal Institute of Technology in Stockholm, Sweden, in 1993, he moved to the University of California San Diego for post-doctoral studies.

In 1997 he returned to UAB. He is currently an ICREA Research Professor and Group Leader of ICN2's Magnetic Nanostructures Group. Dr Nogués has published 219 articles (including 8 reviews), and has more than 13,000 citations and an H-index of 49. He has authored one patent and his work has given rise to over 185 invited talks.



NEW PROJECTS & MILESTONES

In 2015, the Group has been working on novel nanoparticles and nanostructures for biomedical application in the framework of THERANANO (Multifunctional magnetic and magnetoplasmonic theranostic nanostructures). The aim of the project is designing bottom-up and top-down hybrid magnetic nanostructures for diverse biomedical applications (hyperthermia or multimode imaging).

Moreover, it has continued its research in exchange coupling in core/shell nanoparticles and magnetic nanostructures in the context of the COEFNANO project. In addition, the Group has advanced in the study of magnetic nanowires to be used for molecule manipulation within the MANAQA project.

In the Explora project MORE, the Group has worked on the optimization of the nanofabrication processes to develop magneto-opto-mechanical nanosystems combining metal assisted chemical etching of silicon and nanoimprint lithography.



PUBLICATIONS

A new reversal mode in exchange coupled antiaromagnetic/ferromagnetic disks: Distorted viscous vortex, Gilbert D.A., Ye L., Varea A., Agramunt-Puig S., Del Valle N., Navau C., Lopez-Barbera J.F., Buchanan K.S., Hoffmann A., Sanchez A., Sort J., Liu K., Nogues J., *Nanoscale*; **7 (21)**: 9878 - 9885. 2015. 10.1039/c5nr01856k. IF: 7.394



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Enhanced magnetic properties in antiferromagnetic-core/ferrimagnetic-shell nanoparticles, Vasilakaki M., Trohidou K.N., Nogués J., *Scientific Reports*; **5**: 9609, 2015. 10.1038/srep09609. IF: 5.578

High temperature magnetic stabilization of cobalt nanoparticles by an antiferromagnetic proximity effect, De Toro J.A., Marques D.P., Muñiz P., Skumryev V., Sort J., Givord D., Nogués J., *Physical Review Letters*; **115 (5)**: 057201, 2015. 10.1103/PhysRevLett.115.057201. IF: 7.512

Origin of the large dispersion of magnetic properties in nanostructured oxides: Fe_xO/Fe₃O₄ nanoparticles as a case study, Estrader M., Lopez-Ortega A., Golosovsky I.V., Estrade S., Roca A.G., Salazar-Alvarez G., Lopez-Conesa L., Tobia D., Winkler E., Ardisson J.D., Macedo W.A.A., Morphis A., Vasilakaki M., Trohidou K.N., Gukasov A., Mirebeau I., Makarova O.L., Zysler R.D., Peiro F., Baro M.D., Bergstrom L., Nogués J., *Nanoscale*; **7 (7)**: 3002 - 3015, 2015. 10.1039/c4nr06351a. IF: 7.394

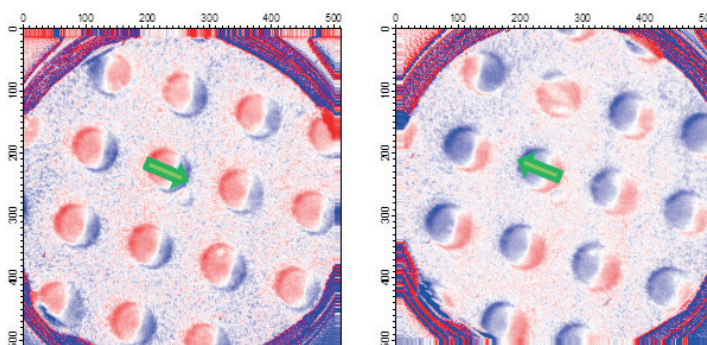


PROJECTS

Magneto-optical-mechanical nanoresonators (MORE), funded by **MINECO**, 15/10/2014 - 15/10/2015, Borja Sepúlveda

Multifunctional magnetic and magnetoplasmonic theranostic nanostructures (THERANANO), funded by **MINECO**, 01/01/2014 - 31/12/2016, Josep Nogués, Borja Sepúlveda

Coupling effects in magnetic patterned nanostructures (COEFNANO), funded by **EC, (IRSES)**, 01/01/2013 - 31/12/2016, Josep Nogués





CONTRIBUTIONS

Antiferromagnetic coupling in ferromagnetic hard-soft core/shell nanoparticles and possible biomedical applications, International Conference on Composites/ NanoEngineering Applications, Chengdu, China, 12-18/07/2015, M. Estrader, S. Estradé, F. Peiró, A. López-Ortega, I. Golosovsky, G. Salazar-Alvarez, M. Vasilakaki, K.N. Trohidou, M.A. Roldan, M. Varela, D.C. Stanley, M. Sinko, M.J. Pechan, D. J. Keavney, M Laver, K.L. Krycka, J.A. Borchers S. Suriñach, M.D. Baró, J. Nogués (Keynote)

Size dependent magnetism in FeO/Fe₃O₄ core/shell nanoparticles and its possible biomedical applications, International Union of Materials Research Societies - International Conference on Advanced Materials (IUMRS-ICAM 2015), Jeju Island, Korea, 25-29/10/2015, M. Estrader, A. López-Ortega, A.G. Roca, G. Salazar-Alvarez, S. Estradé, E. Winkler, I.V. Golosovsky, M. Vasilakaki, K.N. Trohidou, J.D. Ardisson, W.A.A. Macedo, F. Peiró, S. Suriñach, R.D. Zysler, M.D. Baró, J. Nogués (Keynote)

Antiferromagnetic coupling in ferromagnetic hard-soft core/shell nanoparticles, American physical Society Meeting, San Antonio, USA, 02-06/03/2015, J. Nogués (Invited)

Size dependent magnetism in FeO/Fe₃O₄ core/shell nanoparticles and its possible biomedical applications, International Workshop on Complex Magnetic Nanostructures, Aegina, Greece, 02-05/06/2015, M. Estrader, A. Lopez-Ortega, A.G. Roca, G. Salazar-Alvarez, S. Estrade, E. Winkler, I.V. Golosovsky, M. Vasilakaki, K.N. Trohidou, J.S. Ardisson, W. Macedo, F. Peiro, S. Suriñach, R.D. Zysler, M.D. Baro, J. Nogués (Invited)

Exchange bias effects in arrays of Co/CoO nanoparticles, International Workshop on Complex magnetic Nanostructures, Aegina, Greece, 02-05/06/2015, G. Margaritis, K. Trohidou, J. Nogués (Invited)

Evidence of an interfacial antiferromagnetic coupling in ferrimagnetic hard-soft core/shell nanoparticles, International Conference on Frontiers on Materials Processing, Applications Research and Technology, Hyderabad, India, 12-15/06/2015, M. Estrader, S. Estradé, F. Peiró, A. López-Ortega, I. Golosovsky, G. Salazar-Alvarez, M. Vasilakaki, K.N. Trohidou, M.A. Roldan, M. Varela, D.C. Stanley, M. Sinko, M.J. Pechan, D. J. Keavney, S. Suriñach, M.D. Baró, J. Nogués (invited)

Nanomechanical behaviour of amorphous and crystalline CoNiReP electrodeposited nanowires: a comparison with thick films with analogous compositions, International Conference on Frontiers on Materials Processing, Applications Research and Technology, Hyderabad, India, 12-15/06/2015, D. Esqué-de los Ojos, M.A. Zeeshan, P. Castro-Hartmann, M. Guerrero, J. Nogués, S. Suriñach, M.D. Baro, B.J. Nelson, S. Pane, E. Pellicer, J. Sort (Invited)

Comparative study of the nanomechanical properties of amorphous and crystalline nanowires with respect to thick films with analogous microstructure, Collaborative Conference on 3D & Materials Research, Busan, Korea, 15-19/06/2015, M.A. Zeeshan, D. Esque-de los Ojos, P. Castro-Hartmann, M. Guerrero, J. Nogués, S. Suriñach, M.D. Baro, B.J. Nelson, S. Pane, E. Pellicer, J. Sort (Invited)

Colloidal lithography nanopatterning for bioanalytical applications, Workshop on Analytical Nanoscience and Nanotechnology, Salamanca, Spain, 06-08/07/2015, P. Güell, M. Seco, A. Aranda-Ramos, C. Nogués, J. Nogués, B. Sepulveda (Invited)

Template assisted electrodeposition and magnetic properties of multi-segmented hard ferromagnetic (FM)/spacer/soft FM PtCo/Cu/Ni nanowires, **Collaborative Conference on 3D & Materials Research**, Busan, Korea, 15-19/06/2015, J. Zhang, S. Agramunt, S. Pane, S. Estarde, F. Peiro, N. Del valle, M.D. Baro, C. Navau, A. Sanchez, J. Nogués, E. Pellicer, J. Sort (Invited)

Antiferromagnetic coupling in ferrimagnetic hard-soft core/shell nanoparticles, **International Conference on Magnetism**, Barcelona, Spain, 05-10/07/2015, M. Estrader, A. López-Ortega, A. Juhin, S. Estradé, I. Golosovsky, M. Sikora, C. Carvallo, G. Salazar-Alvarez, M. Vasilakaki, K.N. Trohidou, M. Varela, D.C. Stanley, M.J. Pechan, P. Santcavit, P. Galtzel, D. J. Keavney, F. Peiro, S. Suriñach, M.D. Baró, J. Nogués (Invited)

STEM-EELS study of structural phase transitions in core/shell bi-magnetic oxide nanoparticles, **International Conference on Composites/NanoEngineering**, Chengdu, China, 12-18/07/2015, M.A. Roldan, J. Salaranca, R. Ishikawa, R. Mishra, A. López-Ortega, M. Estrader, G. Salazar-Alvarez, J. Nogués, S.J. Pennycook, M. Varela (Invited)

Structure, mechanical and magnetic performance of amorphous and crystalline electrodeposited CoNiReP thin films and nanowires, **International Symposium on Metastable, Amorphous and Nanostructured Materials**, Paris, France, 13-17/07/2015, J. Sort, S. APne, D. Esqué-de los Ojos, A.M. Zeesham, M. Guerrero, S. Suriñach, J. Nogués, M.D. Baro, B.J. Nelson, E. Pellicer (Invited)

Self-organized spatio-temporal electric, mechanical and magnetic micropatterning in electrodeposited cobalt-indium films and microdisks, **International Symposium on Metastable, Amorphous and Nanostructured Materials**, Paris, France, 13-17/07/2015, I. Golvano-Escobal, N. Domingo, J.C. Gonzalez-Rosillo, T. Puig, S. Pane, X. Illa, S. Suriñach, M.D. Baro, J.F. Lopez-Barbera, J. Nogués, E. Pellicer, J. Sort (Invited)

Magnetic patterning strategies based on order-disorder transitions and nanocrystallization of metallic glasses, **Energy Materials Nanotechnology Spain Meeting**, San Sebastian, Spain, 01-04/09/2015, J. Sort, E. Menendez, H. Zhang, D. Nieto, S. Suriñach, M.D. Baro, E. Pellicer, J. Nogués (Invited)

Hard X-ray RIXS-MCD, a magnetic spectroscopy for in-situ characterization of nanoparticles and their internal structure, **Energy Materials Nanotechnology Spain Meeting**, San Sebastian, Spain, 01-04/09/2015, A. Juhin, N. Daffe, A. Lopez-Ortega, M. Sikora, P. Sainctavit, N. Mas, V. Dupuis, S. Neveu, F. Choueikani, M. Estrader, C. Carvallo, S. Estardé, F. Peiro, M.D. Baro, J. Nogués, M. Rovezzi, P. Glatzel, (Invited)

Multidimensional EELS: from spectrum image to spectrum volumen and beyond, **Energy Materials Nanotechnology Spain Meeting**, San Sebastian, Spain, 01-04/09/2015, S. Estrade, P. Torruella, R. Arenal, L. Yedra, A. Eljarrat, L. Lopez-Conesa, R. Arenal, F. de la Peña, Z. Saghi, M. Estrader, A. Lopez-Ortega, G. Salazar-Alvarez, J. Nogués, P.A. Midgley, F. Peiro (Invited)

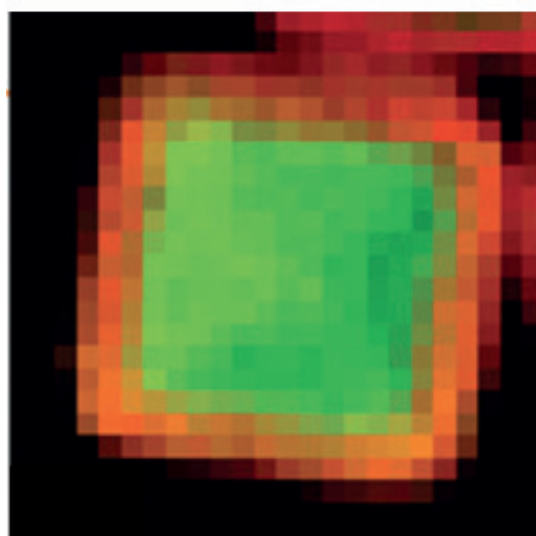
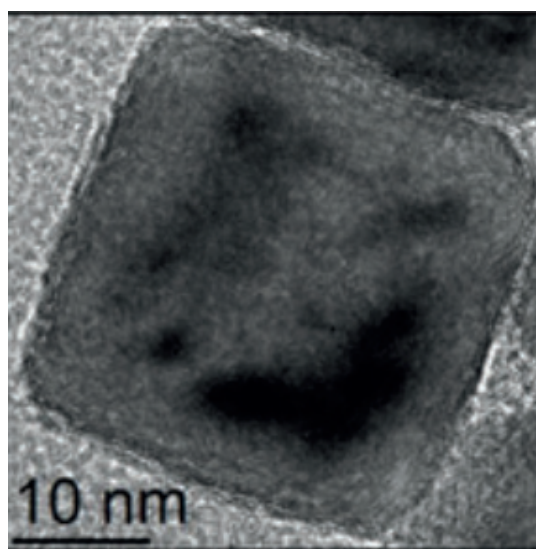
*High temperature stabilization of cobalt nanoparticles by an antiferromagnetic proximity effect, **Energy Materials Nanotechnology Spain Meeting***, San Sebastian, Spain, 01-04/09/2015, J.A. De Toro, D.P. Marques, P. Muñiz, V. Skumryev, J. Sort, D. Givord, J. Nogués (Invited)

*Antiferromagnetic coupling in ferrimagnetic hard-soft core/shell nanoparticles and possible biomedical applications, **Energy Materials Nanotechnology Spain Meeting***, San Sebastian, Spain, 01-04/09/2015, M. Estrader, A. López-Ortega, A. Juhin, S. Estradé, I. Golosovsky, M. Sikora, C. Carvallo, G. Salazar-Alvarez, M. Vasilakaki, K.N. Trohidou, M. Varela, D.C. Stanley, M.J. Pechan, P. Santcavit, P. Galtzel, D. J. Keavney, F. Peiro, S. Suriñach, M.D. Baró, J. Nogués (Invited)

*Dissimilar trends in the nanomechanical behavior of amorphous and crystalline metallic nanowires, **European Congress on Advanced materials and Processes***, Warsaw, Poland, 20-25/09/2015, M.A. Zeeshan, D. Esque-de los Ojos, P. Castro-Hartmann, M. Guerrero, J. Nogués, S. Suriñach, M.D. Baro, B.J. Nelson, S. Pane, E. Pellicer, J. Sort (Highlighted)

*High temperature magnetic stabilization of cobalt nanoparticles by an antiferromagnetic proximity effect, **Int. Workshop on Amorphous and Nanostructured Magnetic Materials***, Iasi, Romania, 21-24/09/2015, J.A. De Toro, D.P. Marques, P. Muñiz, V. Skunryev, J. Sort, D. Givord, J. Nogués (Invited)

*Accessing the chemical and optoelectronic properties of nanostructures in 3D: The EELS spectral volume, **Energy Materials Nanotechnology Open Week***, Chengdu, China, 22-25/09/2015, S. Estarde, P. Torruella, L. Yedra, A. Eljarrat, L. Lopez-Conesa, R. Arenal, F. de la Peña, Z. Saghi, M. Estarder, A. Lopez-Ortega, G. Salazar-Alvarez, J. Nogués, P.A. Midgley, F. Peiro (Invited)



Advanced multifunctional magnetic and magnetoplasmonic nanoparticles for enhanced hyperthermia, **Energy Materials Nanotechnology Open Week**, Chengdu, China, 22-25/09/2015, E. Fantechi, A.G. Roca, C. Innocenti, M. Albino, C. Sangregorio, N. Bastus, V. Puentes, J. Nogués, (Invited)

Plasmonic and magneto-plasmonic nanostructures for biomedical applications, **Energy Materials Nanotechnology Open Week**, Chengdu, China, 22-25/09/2015, P. Güell, F. Pi, J. Nogués, B. Sepulveda (Invited)

Magneto-plasmonic nanostructures for theranostic applications, **Energy Materials Nanotechnology Guangzhou Meeting**, Guangzhou, China, 03-06/12/2015, A.G. Roca, E. Fantechi, N.G. Bastús, V. Puentes, J. Nogués (Invited)

Multifunctional magnetic and magneto-plasmonic nanoparticles for enhanced hyperthermia applications, **International Conference on Nanoscience**, Nanotechnology and Nanobiotechnology, Brasilia, Brazil, 14-18/12/2015, E. Fantechi, A.G. Roca, P., Güell, N. Bastús, V. Puentes, B. Sepúlveda, J. Nogués (Invited)

Controlled electrodeposition and magnetic properties of hard ferromagnetic (FM)/spacer/soft FM multisegmented nanowires, **European Materials Research Society Meeting**, Lille, France, 11-15/05/2015, J. Zhang, S. Agramunt, S. Pane, S. Estrade, F. Peiro, N del Valle, M.D. Baro, C.Navau, A. Sanchez, J. Nogués, E. Pellicer, J. Sort (Oral)

Optimizing the magnetic properties of inverse antiferromagnet-core/ferrimagnetic shell nanoparticles, **International Conference on Magnetism**, Barcelona, Spain, 05-10/07/2015, M. Vasilakaki, K. Trohidou, J. Nogués (Oral)

Determination of the local oxidation state of transition metals in 3D: application to magnetic nanoparticles, **International Conference on Magnetism**, Barcelona, Spain, 05-10/07/2015, S. Estrade, P. Torruella, R. Arenal, L. Yedra, A. Eljarrat, L. Lopez-Conesa, M. Estrader, A. Lopez-Ortega, G. Salazar-Alvarez, J. Nogues, F. Peiro (Oral)

Segmented nanowires for multi-level high-density magnetic data storage: modeling and experimental proof of concept, **International Conference on Magnetism**, Barcelona, Spain, 05-10/07/2015, N. Del Valle, S. Agramunt-Puig, E. Pellicer, J. Zhang, J. Nogues, C. Navau, A. Sanchez, J. Sort (Oral)

Hard x-ray RIXS-MCD, a magnetic spectroscopy for in-situ characterization of nanoparticles and their internal structure, **International Conference on X-ray Absorption Fine Structure**, Karlsruhe, Germany, 23-28/08/2015, A. Juhin, N. Daffe, A. Lopez-Ortega, M. Sikora, P. Saintavit, N. Mas, V. Dupuis, S. Neveu, F. Choueikani, M. Estrader, C. Carvallo, S. Estardé, F. Peiro, M.D. Baro, J. Nogués, M. Rovezzi, P. Glatzel, (Oral)

Neutron diffraction studies of magnetic order in the core-shell nanosystem $\text{FeO}/\text{Fe}_3\text{O}_4$, **European Conference on Neutron Scattering**, Zaragoza, Spain, 30/08 - 04/09/2015, I. Golosovsky, A. Gukasov, I. Mirebeau, O. Makarova, M. Estrader, A. Lopez-Ortega, J. Nogués (Oral)

EELS-tomography. Pushing the spatial and spectral resolution, **European Congress on Advanced materials and Processes**, Warsaw, Poland, 22-25/09/2015, P. Torruella, R. Arenal, Z. Saghi, L. Yedra, A. Eljarrat, F. De la Peña, M. Estarder. G. Salazar-Alvarez, A. Lopez-Ortega, J. Nogues, P.A. Midgley, F. Peiro, S. Estarde (Oral)

Iron-oxide based magnetic nanostructures for enhanced theranostic applications, **International Conference on Magnetism**, Barcelona, Spain, 05-10/07/2015, E. Fantechi, A.G. Roca, J. Nogués, C. Innocenti, M. Albino, C. Sangregorio (Poster)

Oxide wizard as a new tool to probe magnetic properties at the nanoscale, International **Conference on Magnetism**, Barcelona, Spain, 05-10/07/2015, P. Torruella, L. Yedram E. Xuriguera, M. Estarder, A. Lopez-Ortega, M. Baro, J. Nogues, M. Roldan, M. Varela, S. Estarde, F. Peiro (Poster)

Modelling exchange bias behaviour of bi-magnetic nanoparticle assemblies, **International Conference on Magnetism**, Barcelona, Spain, 05-10/07/2015, G. Margaris, K. Trohidou, J. Nogues (Poster)

High temperature magnetism of epsilon-Fe₂O₃: the transition from hard to soft magnetism, **International Conference on Magnetism**, Barcelona, Spain, 05-10/07/2015, M. Gich, J. Padilla, J. Nogues, J. Kreisel A. Roig, J.L. Garcia-Muñoz (Poster)

High temperature magnetic properties and spin-lattice coupling of magnetoelectric epsilon-Fe₂O₃, **International Conference on Magnetism**, Barcelona, Spain, 05-10/07/2015, M. Gich, J. Padilla, J. Nogues, J. Kreisel A. Roig, J.L. Garcia-Muñoz (Poster)

Bi-magnetic core-shell nanoparticles: a polarised SANS study, **European Conference on Neutron Scattering**, Zaragoza, Spain, 30/08 - 04/09/2015, M. Laver, M. Estrader, A. Lopez-Ortega, J. Nogués (Poster)



AWARDS

Best poster award at the International Conference on Magnetism 2015, Alejandro Gómez, E. Fantechi, J. Nogués, 05-10/07/2015, Barcelona

NanoBioelectronics and Biosensors Group

Main Research Lines

- **Catalytic/carrier nanomaterials:** Nanoparticles as electrocatalysts, Nanoparticles carriers of biomolecules, and Nanowires / nanotubes for nonenzymatic / enzyme “mimics” sensors
- **Nanomicrofluidics and Lab-on-a-chip technology**
- **Paper-nanobiosensors:** Paper/nanopaper-based nanobiosensors
- **Nanochannels:** Nanoporous membranes as electrical sensing platforms
- **Graphene:** Biosensors based on graphene-related materials
- **Nanomotors:** Self-propelled micro/nanomotors for biosensing and other applications



GROUP MEMBERS

Ait Lahcen, Abdelatif, Visiting Doctoral Student

Alvarez De Lasarte Sagrera, Irene, SO Technician

Álvarez Diduk, Ruslan Raulevich, Visiting Postdoctoral Researcher

Amim, Luiza, Visiting Postdoctoral Researcher

Baptista Pires, Luis Miguel, Doctoral Student

Batet, Marta, Undergraduate Student

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Chamorro, Alejandro, Doctoral Student

Crespo, Mari Ángeles, Undergraduate Student

de la Escosura Muñiz, Alfredo, Senior Postdoctoral Researcher

Dragos-Pinzaru, Oana-Georgiana, Visiting Postdoctoral Researcher

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Florio, Livia, Visiting Doctoral Student

Forns, David, Undergraduate Student



GROUP LEADER



ICREA Prof
Arben Merkoçi

ICREA Research Professor and head of Nanobioelectronics & Biosensors Group at ICN2. Arben Merkoçi obtained his PhD at the University of Tirana working on ion selective electrodes. Since 1992 he has been doing research as postdoctoral fellow and research professor at Polytechnic Univ. of Budapest, Univ. of Ioanina, Univ. degli Studi di Padua, Univ. Politècnica de Catalunya, Univ. Autònoma

Gravagnuolo, Alfredo Maria, Visiting Doctoral Student

Heli, Bentolhoda, Visiting Doctoral Student

Herea, Dumitru-Daniel, Visiting Postdoctoral Researcher

Higueras, Eloi, Visiting Student

Khater, Mohga, Visiting Doctoral Student

Liu, Jie, Visiting Doctoral Student

Martínez Domingo, Carme, Doctoral Student

Mas, Victor, Master Student

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Nagar, Bhawna, SO Doctoral Student

Orozco Holguín, Jahir, SO Senior Postdoctoral Researcher

Pol, Roberto, Master Student

Puig Font, Anna, Scientific Group Administrator

Quesada Gonzalez, Daniel, Doctoral Student

Russo, Lorenzo, SO Doctoral Student

Sari Uzek, Esma, Visiting Doctoral Student

Sena Torralba, Amadeo, Master Student

Slama, Ichrak, Visiting Doctoral Student

Torrisi, Marcello, Visiting Student

Uzek, Recep, Visiting Doctoral Student

Wicaksono, Wiyogo Prio, Visiting Doctoral Student

Yañez Tienda, Héctor, Master Student

Zamora Gálvez, Alejandro, Doctoral Student

Zor, Erhan, Visiting Doctoral Student



de Barcelona and New Mexico State Univ. His research is focused on the integration of biological molecules and other species with micro- and nanostructures with interest for the design of novel (bio)sensors. Prof Merkoçi has been awarded the IAAM Medal 2011 and Nano Award-2013 for outstanding research in the field of nanoscience and nanotechnology by the International Association of Advanced Materials. He has published more than 230 articles and supervised around 23 PhD theses.



NEW PROJECTS & MILESTONES

During 2015 the group became involved in a new competitive national project related to nanobioconjugated paper/plastic platforms for improved diagnostics applications.

The group continued progressing in paper and nanopaper-based platforms with interest for biosensing and other devices fabrication.

Last year five of our PhD students (Lourdes Rivas, Alejandro Chamorro, Helena Monton, Flavio Pino and Everson Thiago Santos Gerôncio Da Silva) defended their PhD theses.



PUBLICATIONS

Alzheimer's disease biomarkers detection in human samples by efficient capturing through porous magnetic microspheres and labelling with electrocatalytic gold nanoparticles, de la Escosura Muñiz A., Plichta Z., Horák D., Merkoçi A., *Biosensors and Bioelectronics*; **67**: 162 - 169. 2015. 10.1016/j.bios.2014.07.086. IF: 6.409

An iridium oxide nanoparticle and polythionine thin film based platform for sensitive Leishmania DNA detection, Mayorga Martinez C.C., Chamorro García A., Serrano L., Rivas L., Quesada Gonzalez D., Altet L., Francino O., Sánchez A., Merkoçi A., *Journal of Materials Chemistry B*; **3 (26)**: 5166 - 5171. 2015. 10.1039/c5tb00545k. IF: 4.726

Annexin-V/quantum dot probes for multimodal apoptosis monitoring in living cells: Improving bioanalysis using electrochemistry, Montón H., Parolo C., Aranda Ramos A., Merkoçi A., Nogués C., *Nanoscale*; **7 (9)**: 4097 - 4104. 2015. 10.1039/c4nr07191c. IF: 7.394

Antithyroid drug detection using an enzyme cascade blocking in a nanoparticle-based lab-on-a-chip system, Kurbanoglu S., Mayorga Martinez C.C., Medina Sánchez M., Rivas L., Ozkan S.A., Merkoçi A., *Biosensors and Bioelectronics*; **67**: 670 - 676. 2015. 10.1016/j.bios.2014.10.014. IF: 6.409

Bismuth nanoparticles integration into heavy metal electrochemical stripping sensor, Cadevall M., Ros J., Merkoçi A., *Electrophoresis*; **36 (16)**: 1872 - 1879. 2015. 10.1002/elps.201400609. IF: 3.028

Eco-friendly electrochemical lab-on-paper for heavy metal detection, Medina Sánchez M., Cadevall M., Ros J., Merkoçi A., *Analytical and Bioanalytical Chemistry*; 2015. 10.1007/s00216-015-9022-6.

Electrochemical Impedance Spectroscopy (bio)sensing through hydrogen evolution reaction induced by gold nanoparticles, Mayorga Martinez C.C., Chamorro Garcia A., Merkoçi A., *Biosensors and Bioelectronics*; **67**: 53 - 58. 2015. 10.1016/j.bios.2014.05.066. IF: 6.409

Graphene quantum dots-based photoluminescent sensor: A multifunctional composite for pesticide detection, Zor E., Morales Narváez E., Zamora Gálvez A., Bingol H., Ersoz M., Merkoçi A., *ACS Applied Materials and Interfaces*; **7 (36)**: 20272 - 20279. 2015. 10.1021/acsami.5b05838.

Highly sensitive and rapid determination of Escherichia coli O157:H7 in minced beef and water using electrocatalytic gold nanoparticle tags, Abdel Rahim Hussein Abdel Azzem Hassan, Alfredo de la Escosura Muñiz, Arben Merkoçi., *Biosensors and Bioelectronics*; **67**, Pages 511 - 515. 2015. 10.1016/j.bios.2014.09.019. IF: 6.409

In situ production of biofunctionalized few-layer defect-free microsheets of graphene,

Gravagnuolo A.M., Morales Narváez E., Longobardi S., Da Silva E.T., Giardina P., Merkoçi A., *Advanced Functional Materials*; **25 (18)**: 2771 - 2779. 2015. 10.1002/adfm.201500016. IF: 11.805

Lab-in-a-syringe using gold nanoparticles for rapid immunosensing of protein biomarkers,

Nunes Pauli G.E., De La Escosura Muñiz A., Parolo C., Helmuth Bechtold I., Merkoçi A., *Lab on a Chip - Miniaturisation for Chemistry and Biology*; **15 (2)**: 399 - 405. 2015. 10.1039/c4lc01123f. IF: 6.115

Label-free impedimetric aptasensor for ochratoxin - A detection using iridium oxide nanoparticles,

Rivas L., Mayorga Martinez C.C., Quesada González D., Zamora Gálvez A., De La Escosura-Muñiz A., Merkoçi A., *Analytical Chemistry*; **87 (10)**: 5167 - 5172. 2015. 10.1021/acs.analchem.5b00890. IF: 5.636

Magnetic enzymatic platform for organophosphate pesticide detection using boron - doped diamond electrodes,

Pino F., Ivandini T.A., Nakata K., Fujishima A., Merkoçi A., Einaga Y., *Analytical Sciences*; **31 (10)**: 1061 - 1068. 2015.

Micro and nanomotors in diagnostics,

Chalupniak A., Morales Narváez E., Merkoçi A., *Advanced Drug Delivery Reviews*; **95**, 104 - 116. 2015. 10.1016/j.addr.2015.09.004.

Nanochannel array device operating through Prussian blue nanoparticles for sensitive label-free immunodetection of a cancer biomarker,

Espinoza Castañeda M., de la Escosura-Muñiz A., Chamorro A., Torres C.D., Merkoçi A., *Biosensors and Bioelectronics*; **67**: 107 - 114. 2015. 10.1016/j.bios.2014.07.039. IF: 6.409

Nanopaper as an Optical Sensing Platform,

Morales Narváez E., Golmohammadi H., Naghdi T., Yousefi H., Kostiv U., Horák D., Pourreza N., Merkoçi A., *ACS Nano*; **9 (7)**: 7296 - 7305. 2015. 10.1021/acs.nano.5b03097. IF: 12.881

Nanoparticle-based lateral flow biosensors,

Quesada González D., Merkoçi A., *Biosensors and Bioelectronics*; **73**: 47 - 63. 2015. 10.1016/j.bios.2015.05.050. IF: 6.409

Nanoparticles-based nanochannels assembled on a plastic flexible substrate for label-free immunosensing,

de la Escosura Muñiz A., Espinoza Castañeda M., Hasegawa M., Philippe L., Merkoçi A., *Nano Research*; **8 (4)**: 1180 - 1188. 2015. 10.1007/s12274-014-0598-5. IF: 7.010

On-the-Spot Immobilization of Quantum Dots, Graphene Oxide, and Proteins via Hydrophobins,

Gravagnuolo A.M., Morales Narváez E., Matos C.R.S., Longobardi S., Giardina P., Merkoçi A., *Advanced Functional Materials*; **25 (38)**: 6084 - 6092. 2015. 10.1002/adfm.201502837. IF: 11.805

Photoluminescent Lateral-Flow Immunoassay Revealed by Graphene Oxide: Highly Sensitive Paper-Based Pathogen Detection,

Morales Narváez E., Naghdi T., Zor E., Merkoçi A., *Analytical Chemistry*; **87 (16)**: 8573 - 8577. 2015. 10.1021/acs.analchem.5b02383. IF: 5.636

Triple lines gold nanoparticle-based lateral flow assay for enhanced and simultaneous detection of Leishmania DNA and endogenous control,

Rivas L., de la Escosura Muñiz A., Serrano L., Altet L., Francino O., Sánchez A., Merkoçi A., *Nano Research*; **8 (11)**: 3704 - 3714. 2015. 10.1007/s12274-015-0870-3. IF: 7.010



PROJECTS

Nanobioconjugated paper/plastic platforms for improved diagnostics applications (NAP2DIAGNOSTICS): MAT2014-52485-P, funded by **MINECO**, 01/01/2015 - 31/12/2017, Arben Merkoçi

Development of a novel highly sensitive and interference-free endotoxin detection system using new nanobiomaterials and phenomena: BIO2013-49464-EXP, funded by **MINECO**, 01/09/2014 - 31/08/2016, Arben Merkoçi

SMART PRINTED PAPER: Printed Electronics for new paper functionalities: RTC-2014-2619-7, funded by **MINECO**, 01/02/2014 - 31/12/2016, Arben Merkoçi

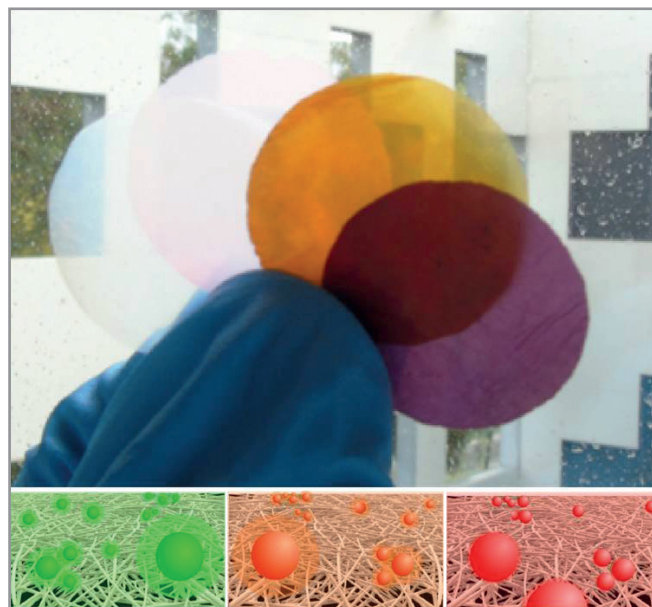
Suport a Grups de Recerca (SGR) reconeguts per la Generalitat de Catalunya (grup consolidat): 2014 SGR 260, funded by **AGAUR - Generalitat de Catalunya**, 01/01/2014 - 31/12/2016, Arben Merkoçi

Sensing toxicants in Marine waters makes Sense using biosensors (SMS). Contract number: 613844, funded by **EC**, 01/12/2013 - 31/08/2017, Arben Merkoçi

Nanosystems for early Diagnosis of Neurodegenerative Diseases (NADINE). Contract number: 246513, funded by **EC**, 01/09/2010 - 31/08/2015, Arben Merkoçi

Development of Electrochemical Peptide Nanosensors for protein and antibody detection. Contract number: 294901, funded by **EC**, 01/05/2012 - 30/04/2015, Arben Merkoçi

ICREA Workshop on Graphene Nanobiosensors, funded by **ICREA**, 01/08/2014 - 31/12/2015, Stephan Roche





CONTRIBUTIONS

Biosensors performance enhancement using nanomaterials, **The Seventh International Workshop on Biosensors for Food Safety and Environmental Monitoring**, Erfoud, Morocco, 19-21/11/2015, A. Merkoçi (Keynote)

Paper/plastic-based nanomicrofluidics and nanobiosensing enhancement opportunities, **Point-of-Care Diagnostics & Global Health World Congress**, San Diego, California, USA, 28-30/09/2015, A. Merkoçi (Keynote)

Graphene-based platforms for biosensing applications, **VI Congreso Internacional de Docencia e Investigación en Química**, Universidad Autónoma Metropolitana Unidad Azcapotzalco, Mexico DF, Mexico, 23/09/2015, A. Merkoçi (Magisterial lecture)

Nanobiosensors for diagnostics, **SPIE Microtechnologies**, Barcelona, Spain, May 04-06/05/2015, A. Merkoçi (Keynote)

Nanobiosensors and applications in diagnostics, **Nanoscience and Nanotechnology International Conference**, Porto, Portugal, 11-13/02/2015, A. Merkoçi (Keynote)

Nanomaterials and Plastic/Paper-Based Sensors for Environment Monitoring, **Workshop on environmental sensors for inland water**, Sorèze, France, 26-28/01/2015, A. Merkoçi (Keynote)

Graphene-based platforms for sensing and biosensing, **2015' International Graphene Innovation Conference (GRAPCHINA 2015)**, Qingdao China, October 28-30/10/2015, A. Merkoçi (Invited)

Paper/plastic nanobiosensors for food and environmental applications, **Chemical Engineering department, Polytechnique Montreal**, Montreal, Canadá, October 17/10/2015, A. Merkoçi (Invited)

Diagnostics with graphene-based materials, **1st edition of the Graphene & 2D Materials International Conference and Exhibition**, Montreal, Canada, 14-16/10/2015, A. Merkoçi (Invited)

Nanomaterials-based biosensors: from health to safety and security applications, **Biosensors & Bioelectronics Centre, IFM, Linköping University**, Sweden, 08/09/2015, A. Merkoçi (Invited)

Development of simple paper/plastic-based nanobiosensors for diagnostics applications, **The Gwent Group**, Pontypool, United Kingdom, 20/07/2015, A. Merkoçi (Invited)

Nanodiagnostics with simple paper/plastic-based platforms, **11th International Symposium on Pharmaceutical Science (ISOPS- 11)**, Ankara, Turkey, 09-12/06/2015, A. Merkoçi (Plenary Lecture)

Nanomaterials and plastic/paper-based sensors for diagnostics applications, **First Tunisian Chemical Society Conference on Coordination Chemistry**, Hammamet, Tunisia, 08-10/05/2015, A. Merkoçi (Plenary Lecture)

Development of simple paper/plastic-based nanobiosensors for diagnostics applications, **Nanoscience and Nanotechnology Joint Symposia Barcelona Nanocluster-RBNI Technion**, Haifa, Israel, 05-07/07/2015, Arben Merkoçi (Invited)

Paper/plastic nanobiosensors for food and environmental applications, **10th conference Food Feed Water Analysis innovations and breakthroughs**, Noorderwijkerhout, the Netherlands, 20-22/04/2015, A. Merkoçi (Invited)

Nanomaterials-based biosystems for diagnostics applications, **DATE (Design Automation and Test Conference)**, Grenoble, France, 09-13/03/2015, A. Merkoçi (Invited)

Nanomaterials-based biosensors: from health to safety and security applications, **Department of Chemistry, Faculty of Science, Chulalongkorn University**, Bangkok, Thailand, 30/03/2015, A. Merkoçi (Invited)

Nanomaterials and plastic/paper-based sensors for diagnostics applications, **Workshop: Next Generation Tools for DNA diagnostics**, Edinburgh, UK, 26/02/2015, A. Merkoçi (Invited)

Clinical and environment diagnostics using nanobiosensors, **Universitat Pompeu Fabra**, Barcelona, Spain, 20/02/2015, A. Merkoçi (Invited)

Nanobiosensors and applications in diagnostics, **University of Girona**, Girona, Spain, 18/02/2015, A. Merkoçi (Invited)

Nanochannel array device operating through prussian blue nanoparticles for sensitive label-free immunodetection of a cancer biomarker, **XX Trobada Transfronterera sobre Sensors i Biosensors**, Perpignan, France, 01-02/10/2015, M. Espinoza-Castañeda, A. de la Escosura-Muñiz, A. Chamorro, C. de Torres, A. Merkoçi (Oral)

Why graphene-related materials are an advantageous optical biosensing platform?, **2nd International Biosensor Congress**, Izmir, Turkey, 10-12/06/2015, E. Morales, A. Merkoçi (Oral)

Graphene oxide in optical biosensing, **ICREA Workshop on Graphene NanoBiosensors**, Barcelona, Spain, 25-26/05/2015, E. Morales, A. Merkoçi (Oral)

Graphene Quantum Dots-based Sensor for Specific Pesticide Detection, **XX Trobada Transfronterera sobre Sensors i Biosensors**, Perpignan, France, 01-02/10/2015, Erhan Zor, Eden Morales-Narváez, Alejandro Zamora-Gálvez, Haluk Bingol, Mustafa Ersoz, Arben Merkoçi (Oral communication)

Synthesis of biofunctionalized few-layer defect-free micro-sheets of graphene, **XX Trobada Transfronterera sobre Sensors i Biosensors**, Perpignan, France, 01-02/10/2015, Alfredo Maria Gravagnuolo, Eden Morales-Narváez, Sara Longobardi, Everson Thiago S. G. da Silva, Paola Giardina and Arben Merkoçi (Poster)

Label-free impedimetric aptasensor for ochratoxin-A detection using iridium oxide nanoparticles, **XX Trobada Transfronterera sobre Sensors i Biosensors**, Perpignan, France, 01-02/10/2015, L. Rivas, C.C. Mayorga-Martinez, D. Quesada-González, A. Zamora-Gálvez, A. de la Escosura-Muñiz, A. Merkoçi (Poster)

Fabrication of biofunctionalized few-layer defect-free microsheets of graphene, **ICREA Workshop on Graphene NanoBiosensors**, Barcelona, Spain, 25-26/05/2015, Alfredo Maria Gravagnuolo, Eden Morales-Narváez, Sara Longobardi, Everson Thiago S. G. da Silva, Paola Giardina, Arben Merkoçi (Poster)



BOOKS

Nanoporous Alumina Fabrication, Structure, Properties and Applications - Chap. 9, *Protein and DNA electrochemical sensing using anodized aluminum oxide nanochannel arrays*, De La Escosura-Muniz A., Espinoza-Castaneda M., Merkoçi A. *Springer Series in Materials Science*; **219**: 271-291. 2015. 10.1007/978-3-319-20334-8_9.

Electrospinning for High Performance Sensors - Chap. 9, *Nanoparticle/nanochannels-based electrochemical biosensors*, Espinoza-Castañeda M., de la Escosura-Muñiz A., Merkoçi A. *NanoScience and Technology*; **96**: 205-223. 2015. 10.1007/978-3-319-14406-1_9.

Agricultural and Food Electroanalysis - Chap. 10, *Electrochemical Genosensors*, Briza Pérez-López and Arben Merkoçi, pages 295–316, John Wiley & Sons, Ltd. 2015

Lab-on-a-Chip and Micro Total Analysis Systems - A Practical Guide - Chap. 6, *Microfluidic electrochemical biosensors; fabrication and applications*, Sandrine Miserere, Arben Merkoçi, pages 141-160. 2015



COURSES

Master on Nanotechnology (Subject: Nanomaterials applications for diagnostics), **Universitat Autònoma de Barcelona, Barcelona, Spain**, 22/10/2015, Dr Eden Morales

Master on Nanotechnology (Subject: Biosensoremoval nanotechnologies), **Universitat Autònoma de Barcelona, Barcelona, Spain**, 20/10/2015, Dr Jahir Orozco

Master on Industrial Chemistry and Introduction to Chemical Research (Subject: Biosensoremoval nanotechnologies), **Universitat Autònoma de Barcelona, Barcelona, Spain**, October, 2015, Dr Jahir Orozco

Master on Industrial Chemistry and Introduction to Chemical Research (Subject: Chemistry for Specific Materials of Interest to Industry and Research), **Universitat Autònoma de Barcelona, Barcelona, Spain**, 26-27/10/2015, Dr Alfredo de la Escosura



THESES

Doctorand: **Lourdes Rivas**

Title: *Electrochemical and optical nanoparticle-based biosensors for point-of-care applications*

Defense Date: 26/01/2015

Director: Prof Josefina Pons Picart / Prof Arben Merkoçi / Dr Alfredo de la Escosura Muñiz

Doctorand: **Everson Thiago Santos Gerônimo Da Silva**

Title: *Construction and development of point-of-care testing devices with electrochemical detection in paper* (Institute of Chemistry - UNICAMP, Campinas-SP, Brazil)

Defense Date: 19/05/2015

Director: Prof Arben Merkoçi / Prof Lauro T. Kubota

Doctorand: **Alejandro Chamorro**

Title: *Electrochemical and optical nanomaterial-based biosensors for diagnostic applications*

Defense Date: 09/11/2015

Director: Prof Arben Merkoçi

Doctorand: **Helena Montón**

Title: *Development of Quantum Dot-based tools for in vitro and biosensing applications*

Defense Date: 13/11/2015

Director: Prof Arben Merkoçi / Prof Carme Nogués

Doctorand: **Flavio Pino**

Title: *Development of nanomaterials for environmental monitoring*

Defense Date: 16/11/2015

Director: Prof Arben Merkoçi / Dr Carmen Mayorga Martinez

More information:

<http://www.nanobiosensors.org/>

NanoBiosensors and Bioanalytical Applications Group

Main Research Lines

- Plasmonics (SPR) and Nanoplasmonics (LSPR) Biosensors
- Nanophotonic Biosensors based on integrated optics technology (MZI & BiMW)
- MEMs based opto-nanomechanical Biosensors
- Customized polymer microfluidic devices and flow delivery systems
- Full integration in Lab-on-a-chip and point-of-care biosensor analytical platforms
- Universal biofunctionalization techniques and packaging of biochips
- Bioanalytical applications including clinical, environmental and molecular biology areas, providing application-specific functionalities



GROUP LEADER



CSIC Research Professor
Laura M. Lechuga

Prof Laura M. Lechuga received her PhD in Chemistry from the University Complutense of Madrid (Spain). She is Full Professor of the Spanish National Research Council (CSIC); From 2012 to 2015 she was Adjunct Professor at the Dept. of Physics&Technology, at the Arctic University (Norway) and since 2013 she is a Distinguished Visiting Professor at the Dept. of Microwaves and Photonics, School of Electrical and Computer Sciences, University of Campinas (Brazil). She is a Fellow of the Optical Society (OSA) since 2014.

Prof Lechuga is the Head of the Nanobiosensors and Bioanalytical Applications Group at the Catalan Institute of Nanoscience and Nanotechnology (ICN2). The principal focus of her research programme is the technological development of photonic (plasmonics and silicon-based) and BioMEM biosensors, their integration in portable lab-on-a-chip platforms and their application in clinical and environmental diagnostics.



She has published over 200 articles, book chapters and conference proceedings, has 8 families of awarded patents at European, US or international level, and has delivered more than 250 invited presentations. She has been the driving force for the establishment of one spin-off company in 2004 (SENSIA, SL) and co-founder of a new spin-off in 2010 (BIOD, SL).

Prof Lechuga is associate editor of the IEEE Photonics Journal, associate editor of the Journal Optics and Laser Technology (Elsevier) and is on the Editorial Board of the Journal of Nanobiosensors in Disease Diagnosis and of the Journal of Sensors. She is a member of the International Society for Optical Engineering (SPIE), and of the European Optical Society (EOS). She is a member of Permanent Steering Committees for the Advanced Study Course on Optical Chemical Sensors (ASCOS) and of Europt(r)ode Conference Series. She served often in scientific committees of major international conferences (15 in the last 3 years) and is regularly involved in the organization of international conferences and Workshops. She is a member of the Scientific Advisory Board of the Andalusian Center for Nanomedicine (BIONAND) (Málaga, Spain) and of the Biomedical Institute of the University of Vigo (Spain). She is regularly an expert evaluator and expert reviewer with the European Commission and REA (FP5, FP6, FP7, H2020) in diverse panel evaluations at worldwide level.



GROUP MEMBERS

Caro Salazar, Carlos, CSIC Postdoctoral Researcher

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Fernández Rico, Carla, Master Student

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Márquez Villalobos, Salomon Elieser, CSIC Visiting Doctoral Student

Medina Vite, Elizabeth, Visiting Student (CONACYT Grant)

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Ramírez Priego, Patricia, CSIC Technician

Razo Reyes, Mildred Samantha, Visiting Student (CONACYT Grant)

Rodríguez Delgado, Melissa Marlene, Visiting Postdoctoral Researcher

Sánchez Huertas, César, Postdoctoral Researcher

Soler Aznar, María, Doctoral Student

Solís Tinoco, Verónica Iraís, Doctoral Student



NEW PROJECTS & MILESTONES

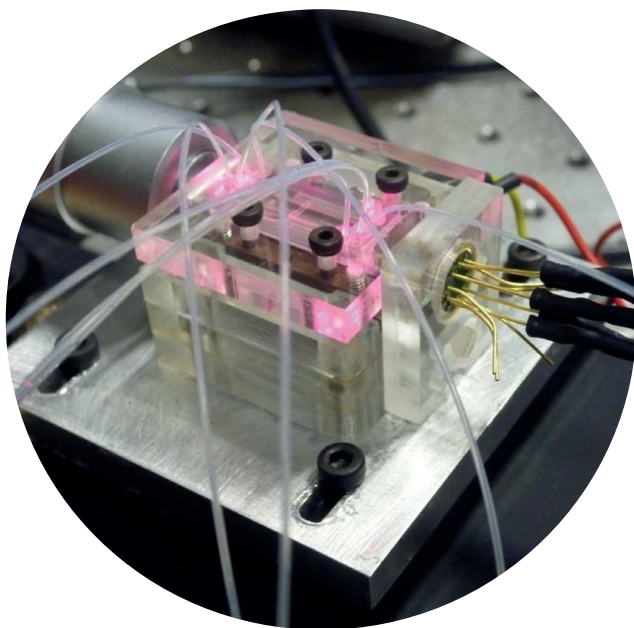
The Nanobiosensors and Bionalytical Applications Group focuses its activities in the development of novel nanobiosensors devices based on plasmonics, nanoplasmonics and silicon-based photonics principles, including surface biofunctionalization, microfluidics and complete lab-on-a-chip integration for point-of-care devices. Application of the nanobiosensors for real clinical diagnostics and environmental control is one of the main objectives of the Group. The research activities range from basic research to technological operation of complete sensing platforms, and on to the industrial transfer of our research

into products. The Group has pioneered developments at an international level in the area of photonic biosensors such as the bimodal waveguide interferometric device, the optomechanical sensor or the magnetoplasmonic biosensor. Since 2016 the Group is associated to the Networking Research Center on Biomedicine (CIBER) from the ISCIII in the CIBER Center for Bioengineering, Biomaterials and Nanomedicine (CIBER-BBN).

We have achieved important milestones in several of our research lines, for example in the research line of integrated silicon nanophotonic biosensors we are implementing a sensitive, affordable, hand-held and portable point-of-care device. The ultrasensitive limit of detection of this technology at the pM-fM level is far beyond

the state of the art and the Group has demonstrated the detection of a few copies of infectious microorganisms directly in patients' samples. A technological transfer plan with a private company was started in 2014 and it has been further developed during 2015.

The utility of our nanophotonic biosensor technologies for real bioanalytical



applications has been successfully demonstrated. The Group is focusing on point-of-care detection of diseases as for Tuberculosis (POCKET EU project); early detection of several types of cancer such as colorectal cancer (COLONTEST national project); early detection of liver complications (CIBER internal project); fast identification of the dry eye disease (CIBER internal project); monitoring of celiac or allergic patients directly in their body fluids, among others (most of them in collaboration with private companies). We have started in 2015 a new EU project (RAIS) to develop a new, point-of-care, label-free microarray platform based on a proprietary interferometric lens-less microscopy design and validate it for quantifying levels of specific Sepsis biomarkers within 30 minutes. In the environmental field, the

Group is focusing on the early detection of toxic pollutants such as pesticides, antibiotics or alga toxins (BRAAVOO EU project).

The Group has successfully established in 2015 a more fundamental research line in Molecular Biology initiated in 2014 using our nanobiosensors technology as alternative analytical techniques for the evaluation of different gene regulating pathways in order to obtain a more informative and accurate diagnosis and follow-up therapy of cancer. Our nanophotonic biosensor allows for a rapid, highly sensitive and direct analysis of these regulating routes without the need of labelling or amplification steps. Different genetic and epigenetic disorders, associated with cancer appearance and progression, have been studied taking advantage of circulating nucleic acids as target biomarkers. We have evaluated specific and clinically relevant gene regulation pathways, such as RNA alternative splicing events, micro-RNA regulation, or DNA methylation processes. All the developed methodologies have been assessed in terms of selectivity, sensitivity and reproducibility, and in some cases, they have been validated with real samples. The obtained results overcome some of the critical drawbacks of the current methodologies employed for the analysis of such processes and offer standardized protocols for a highly sensitive and selective detection with minimal sample manipulation. We have demonstrated that our biosensor technology offers the direct and effective evaluation of gene regulating pathways as new solutions for cancer diagnosis and follow-up therapy.



Design of a surface plasmon resonance immunoassay for therapeutic drug monitoring of amikacin, Losoya-Leal A., Estevez M.-C., Martínez-Chapa S.O., Lechuga L.M., *Talanta*; **141**: 253 - 258. 2015. 10.1016/j.talanta.2015.04.009. IF: 3.545

Highly sensitive dendrimer-based nanoplasmonic biosensor for drug allergy diagnosis, Soler M., Mesa-Antunez P., Estevez M.-C., Ruiz-Sanchez A.J., Otte M.A., Sepulveda B., Collado D., Mayorga C., Torres M.J., Perez-Inestrosa E., Lechuga L.M., *Biosensors and Bioelectronics*; **66**: 115 - 123. 2015. 10.1016/j.bios.2014.10.081. IF: 6.409

Linear readout of integrated interferometric biosensors using a periodic wavelength modulation, Dante S., Duval D., Farina D., Gonzalez-Guerrero A.B., Lechuga L.M., *Laser and Photonics Reviews*; **9 (2)**: 248 - 255. 2015. 10.1002/lpor.201400216. IF: 8.008

Novel nanoplasmonic biosensor integrated in a microfluidic channel, Solis-Tinoco V., Sepulveda B., Lechuga L.M., *Proceedings of SPIE - The International Society for Optical Engineering*; 9519 (95190T) 2015. 10.1117/12.2178990.

Sensitivity analysis for improving nanomechanical photonic transducers biosensors, Fariña D., Álvarez M., Márquez S., Dominguez C., Lechuga L.M. *Journal of Physics D: Applied Physics*; **48**: (33, 335401) 2015. 10.1088/0022-3727/48/33/335401. IF: 2.721

Simulation and characterization of hollow microbridge resonators for label-free biosensing, Marquez S., Alvarez M., Farina D., Dominguez C., Lechuga L.M., *Progress in Biomedical Optics and Imaging - Proceedings of SPIE*; 9518 (95180U) 2015. 10.1117/12.2178981.

Study of a low-cost trimodal polymer waveguide for interferometric optical biosensors, Ramirez J.C., Lechuga L.M., Gabrielli L.H., Hernandez-Figueroa H.E., *Optics Express*; **23 (9)**: 11985 - 11994. 2015. 10.1364/OE.23.011985. IF: 3.488

Tailored Height Gradients in Vertical Nanowire Arrays via Mechanical and Electronic Modulation of Metal-Assisted Chemical Etching, Otte M.A., Solis-Tinoco V., Prieto P., Borrísé X., Lechuga L.M., González M.U., Sepulveda B., *Small*; **11 (33)**: 4201 - 4208. 2015. 10.1002/smll.201500175. IF: 8.368



PROJECTS

*Nanobiosensors and Bioanalytical Applications (2014 SGR 624), funded by **AGAUR**, 01/01/2014 - 31/12/2016, Laura Lechuga*

*Development of a low-cost point-of-care test for Tuberculosis detection (POCKET), funded by **CE**, 01/11/2013 to 31/10/2016, Laura Lechuga*

*Biosensors, Reporters and Algal Autonomous Vessels for Ocean Operation (BRAAVOO) UE, funded by **CE**, 01/12/2013 to 30/11/2016, Laura Lechuga*

*Innovación y desarrollo de sistemas portátiles de detección biológica óptica de alta eficiencia (INNPACTO), funded by **MINECO**, 30/6/2012 - 30/6/2015, Laura Lechuga*

*Scalable, point-of-care and label free microarray platform for rapid detection of Sepsis (RAIS), funded by **CE**, 01/01/2015 to 31/12/2017, Laura Lechuga*

*Lab-on-a-chip integration of biophotonic devices to study gene expression alterations in cellular pathways (EPISENS), funded by **MINECO**, 01/01/2013 to 31/12/2015, Laura Lechuga*

Contrato asociado a licencia de patente BiMW. PROMAX, S.L., 01/04/2014 to 01/04/2015

*COLONTEST: Diseño y puesta a punto de kits para el diagnóstico del cáncer de colon en sangre basados en plataformas multiplex. Programa RETOS-COLABORACIÓN, funded by **MINECO**, 01/09/2014 to 01/09/2017, Laura Lechuga*





CONTRIBUTIONS

*Nanophotonic lab-on-chip biosensors for advanced point-of-care diagnostics, **Microfluidics & Lab on a Chip India**, Mumbai (India), 22-23/01/2015, Laura M. Lechuga (Keynote)*

*Nanophotonic lab-on-chip biosensors for the next diagnostics generation, **NanoSpain Bio&Med 2015. IMAGINENANO 2015**, Bilbao (Spain) 12-13/03/2015, Laura M. Lechuga (Keynote)*

*Point-of-care photonic nanobiosensors for global health diagnostics: Challenges and opportunities, **Nanomaterials & Applications (NANOAPP 2015)**, Maribor, Slovenia, 23-26/03/2015, Laura M. Lechuga (Plenary)*

*La llum a la nanoescala: des de Maxwell a la detecció precoç del càncer, **Dissabtes de la Física 2014-15, 15^a Edició, Barcelona (UAB)**, 28/02/2015, Ana Belén González (Invited)*

*From Science to Market: academic spin-offs, **Workshop en emprendeduría en científicos y creación de spin-offs en ICN2**, Barcelona, 20/04/2015, Laura M. Lechuga (Invited)*

*Advanced POC technologies using innovative photonic biosensors, **VIII Simpòsium Europeo sobre el Laboratorio clínico y la Industria del diagnòstico in vitro**, Barcelona (Spain). 05-06/05/2015, Laura M. Lechuga (Panel invited)*

*Aplicación de la Nanomedicina en el cuidado de la salud: el laboratorio del futuro, **XXVIII Congreso Nacional de la Asociación Española de Técnicos de laboratorio**, Girona (Spain), 21-23/05/2015, Laura M. Lechuga (Invited)*

*Nanobiosensores fotónicos para el control mediambiental in -situ, **Workshop "Sensores para el análisis medioambiental"**. Grupo **AGBAR**, Barcelona, 02-03/06/2015, Laura M. Lechuga (Invited)*

*Lab-on-a-chip nanobiosensors for the next diagnostics generation, **International Workshop on "Micro-Nano-Bio-ICT Convergence" Current Research and Future Trends (MiNaB-ICT)**, Ottranto (Lecce), Italy, 13-15/07/2015, Laura M. Lechuga (Invited)*

*Photonic Lab-on-a-chip sensor technologies, **Advanced Study Course on Optical Chemical Sensors (ASCOS 2015)**. Topic: Nanotechnology for (bio) chemical sensors, O Porto (Portugal), 22-29/07/2015, Laura M. Lechuga (Invited)*

*Micro/nano biosensor devices for real applications, **26th Micromechanics and Microsystems Europe Workshop (MME 2015)**, Toledo (Spain), 20-23/09/2015, Laura M. Lechuga (Invited)*

*Nanophotonic lab-on-a-chip biosensors for the next diagnostics generation, **11th Workshop on biosensors and bioanalytical microtechniques in environmental, food and clinical analysis (BBMEC)**, Regensburg (Germany). 26-30/09/2015, Laura M. Lechuga (Invited)*

*Integrated bimodal waveguide interferometers for advanced diagnostics, **The international Chemical Congress of the Pacific Basin Societies (Pacifichem 2015)**. Symposium on "Optical Waveguide Techniques for the Analyses of Materials and Interfaces", Honolulu, Hawaii, 15-20/12/2015, Laura M. Lechuga (Invited)*

*Lab-on-chip biosensor platforms for decentralised and real-time environmental control, Short Course on Rapid screening of aquatic organic pollution and toxicity using bioassays and biosensors. Organised by **EU Project GLOBAQUA**, Barcelona (Spain) 26-27/10/2015. Laura M. Lechuga (Oral)*

Optimization study of bimodal waveguide interferometric biosensors, **CLEO-Europe 2015**, Munich, Germany, 21-25/06/2015, D. Grajales and Laura M. Lechuga. (Oral)

Nanomedicina: la revolución en el cuidado de la salud, **75 aniversario del CSIC “Ciencia de hoy para un mañana mejor”**, Barcelona (Spain), 19/01/2015, Laura M. Lechuga (Oral)

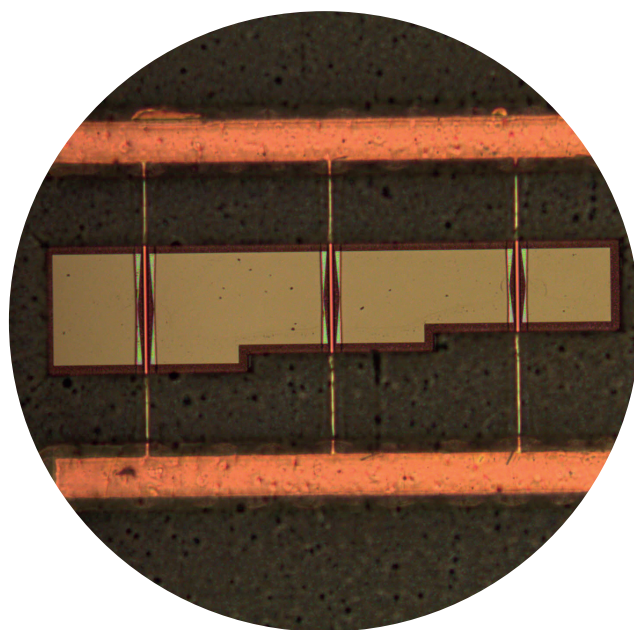
Nanophotonic lab-on-chip biosensors for the direct analysis of patients, **Workshop on biosensing**, Trento (Italy), 30/03/2015, Laura M. Lechuga (Oral)

Photonic nanobiosensors for real time monitoring of chemical contaminants in marine environment, **SETAC Europe 25th Annual Meeting**, Barcelona (Spain), 03-07/05/2015, S. Herranz, B. Chocarro, J. Sanchís, M. Farré, M.P. Marco, Laura M. Lechuga (Poster)

Simulation and characterization of hollow microbridge resonators for label-free biosensing, **SPIE Microtechnologies**, Barcelona (Spain), 04-06/05/2015, S. Marquez, M. Alvarez, D. Fariña, C. Domínguez and Laura M. Lechuga. (Poster)

Novel nanoplasmonic biosensor integrated in a microfluidic channel, **SPIE Microtechnologies**, Barcelona (Spain), 04-06/05/2015, V. Solis-Tinoco, B. Sepulveda and Laura M. Lechuga. (Poster)

Numerical study of a high sensitive polymer biosensor using a trimodal waveguide interferometer, **CLEO-Europe 2015**, Munich, Germany, 21-25/06/2015, J. C. Ramirez, Laura M. Lechuga, L.H. Gabrielli and H.E. Hernandez- Figueroa (Poster)



INVITED SEMINARS

Dispositivos nanobiosensores para la detección precoz de enfermedades infecciosas y cáncer. **Servicio d'Epidemiologia. Agència de Salut Pública de Barcelona**, Barcelona, 13/01/2015.

Nanophotonic lab-on-a-chip biosensors for advanced diagnostics. **IDIBELL**, Barcelona, 25/02/2015.

Conferencia invitada en el programa de doctorado: “Tendencias actuales en Nanociencia y Nanotecnologías”. **Universidad de Cádiz**. Curso 2014/2015. Marzo 2015.

Nanophotonic lab-on-a-chip biosensors for advanced diagnostics. **Centro de Tecnología Biomédica (CTB)**, Madrid, 17/04/2015.

Nanophotonic lab-on-a-chip as interactive diagnostics tools for advanced healthcare. BioForum, series of Seminars on Molecular Biology at the University of the Basque Country, Bilbao, 22/04/2015.

Nanophotonic lab-on-a-chip devices for mobile diagnostics, **Master de Ingeniería Informática de la Universidad de Sevilla**, Curso 2015/2016. Sevilla, 10/09/2015.

Dispositivos nanobiosensores en plataformas lab-on-chip para el diagnóstico descentralizado. Universidad de Antioquía. Medellín, Colombia, 11/11/2015.

Nanobiosensores lab-on-a-chip para el diagnóstico descentralizado. Universidad Pontificia Bolivariana. Medellín, Colombia, 13/11/2015.



BOOKS

Biological and Medical Photonics, Spectroscopy and Microscopy, Series on Photonics - *Optical waveguide biosensors*, D. Duval and L.M. Lechuga. Ed. D. L. Andrews; *John Wiley & Sons, Ins.* (New Jersey, USA) pp. 323-366 (2015)

28 historias de ciencia e innovación biomédica en España - *Diagnósticar con luz: objetivo de una vida (autobiografía)*, L.M. Lechuga. Libro 10º Aniversario Fundación M. Botín. Ed. *Fundación Botín* (2015) ISBN: 978-84-15469-49-0.

Encyclopedia of Astrobiology (New Edition), Gargaud M, Irvine W (Eds.) - *Biosensor, (Long Entry in Encyclopedia)*, L.M. Lechuga. Ed. *Springer Heidelberg*, New York Dordrecht London (2015)



COURSES

Photonic nanobiosensors: from design, fabrication and biofunctionalization to real application. Nanotechnology for diagnostics module in the official **Master in Nanoscience and advanced Nanotechnology (UAB)** 2015-2016. Dr. Ana Belén González and Dr. Adrián Fernández. *Universitat Autònoma de Barcelona (UAB)*.



THESES

Doctorand: **María Soler**
Title: Nanoplasmonic Biosensors for Clinical Diagnosis at the Point of Care.
Defense Date: 30/04/2015
Directed by Laura M. Lechuga and M^a Carmen Estévez
Departamento de Bioquímica y Biología Molecular, Facultad de Medicina, *Universidad Autónoma de Barcelona*.



AWARDS

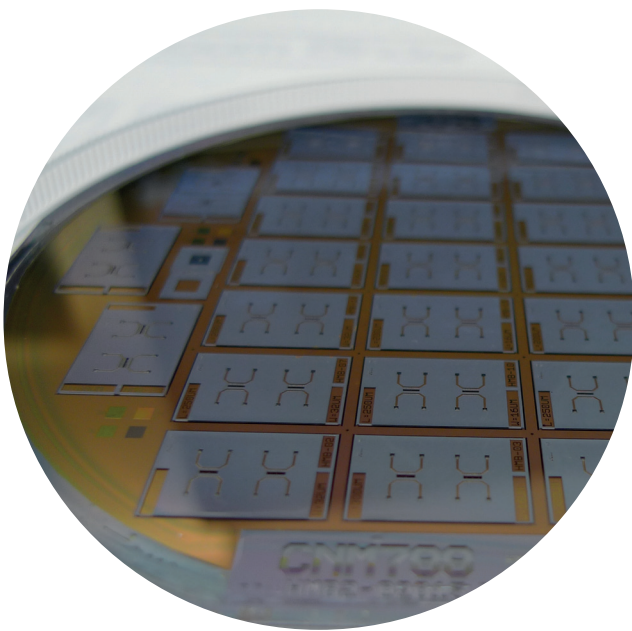
Dr. María Soler - The Institution CERCA presented the award **Doctoral Thesis Pioneer 2015**: María Soler, from nanoB2A group of Catalan Institute of Nanoscience and Nanotechnology (ICN2), for the Thesis: "Nanoplasmonic Biosensors for Clinical Diagnosis at the Point of Care" directed by Laura M. Lechuga and M^a Carmen Estévez.



TECHNOLOGY TRANSFER

Contrato asociado a licencia de patente BiMW. PROMAX, S.L., 01/04/2014 to 01/04/2015

Contrato Industrial: Detección interferométrica en guía de onda bimodal (TSI-100103-2015-7). Acción Estratégica Economía y Sociedad Digital (AEESD), Ministerio de Industria, Energía y Turismo (Minetur) y PROMAX, S.L., 11/2015 to 04/2017



More information:
<http://nanob2a.icn2.cat>

Nanostructured Functional Materials Group

Main Research Lines

- **Molecular devices**
- **Bio- and Bioinspired nanomaterials:**
 - Drug delivery and imaging
 - Catechol-based biocoatings
- **Energy-efficient nanomaterials:**
 - Chromism @ the nanoscale
 - Catalytic nanostructures



GROUP MEMBERS

Aspromonte, Soledad Guadalupe, CSIC Visiting Postdoctoral Researcher

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Bellacanzone, Christian, Doctoral Student

Castilla, Sebastián, CSIC Visiting Student

Cifuentes, Maria, CSIC Visiting Student

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Guardingo, Mireia, Doctoral Student

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Mancebo Aracil, Juan, Postdoctoral Researcher

Marcheses, Silvia, Visiting Student

Martínez Pérez, David, Visiting Master Student

Massaro, Giussepina, CSIC Visiting Doctoral Student

Montpeyó García Moreno, David, CSIC Doctoral Student



GROUP LEADER



CSIC Research Scientist
Dr Daniel Ruiz-Molina

Daniel Ruiz-Molina earned his PhD on polyradical dendrimers at the Institute of Materials Science of Barcelona (CSIC) with Prof Jaume Veciana. Afterwards he took a postdoctoral position at the UC San Diego working on single-molecule magnets and molecular switches for three years.

Since 2001 he has held a permanent position at the CSIC and more recently at CIN2 - CSIC, where he is heading the Nanostructured Functional Materials group. His main research areas are fabrication of hybrid colloids and surfaces, biomimetic functional nanostructures and micro-/ nanoparticles for smart applications and encapsulation/ delivery systems.



Moreno Villaecija, Miguel Ángel, Visiting Student

Nador, Fabiana Gabriela, Visiting Postdoctoral Researcher

Nayarassery, Adarsh, CSIC Postdoctoral Researcher

Novio Vázquez, Fernando, CSIC Postdoctoral Researcher

Pizarro, Guadalupe Del Carmen, CSIC Visiting Senior Researcher

Roscini, Claudio, Senior Postdoctoral Researcher

Ruiz Molina, Daniel, CSIC Tenured Scientist and Group Leader

Sedó Vegara, Josep, Senior Postdoctoral Researcher

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Suárez García, Salvio, Visiting Student

Torres Pierna, Hector, Visiting Student

Vázquez, Nuria Alexandra, Doctoral Student

Vilasau, Jon, Postdoctoral Researcher

Wnuk, Karolina, CSIC Doctoral Student



NEW PROJECTS & MILESTONES

1. Development of functional nanoscale coordination polymers for molecular devices
2. Development of novel coordination polymer particles for Biomedicine, including drug delivery and MRI

The objective of the Nanostructured Functional Materials group (NANOSFUN) is to obtain (bio) molecular nanostructures with tailored properties and smart responses to external stimuli, taking advantage of the flexibility and richness of (supra)molecular chemistry and self-assembly processes.



PUBLICATIONS

Covalent Grafting of Coordination Polymers on Surfaces: The Case of Hybrid Valence Tautomeric Interphases, González-Monje P., Novio F., Ruiz-Molina, D. *Chemistry - A European Journal*; **1 (28)**: 10094 - 10099 2015. 10.1002/chem.201500671. IF: 5.731

Design and Synthesis of a Noninnocent Multitopic Catechol and Pyridine Mixed Ligand: Nanoscale Polymers and Valence Tautomerism, Guardingo M., Busqué F., Novio F., Ruiz-Molina D., *Inorganic Chemistry*; **54 (14)**: 6776 - 6781. 2015. 10.1021/acs.inorgchem.5b00598. IF: 4.762

Dual T1/T2 MRI contrast agent based on hybrid SPION@coordination polymer nanoparticles, Borges M., Yu S., Laromaine A., Roig A., Suárez-García S., Lorenzo J., Ruiz-Molina D., Novio F. *RSC Advances*; **5 (105)**: 86779 - 86783. 2015. 10.1039/c5ra17661a. IF: 3.840

Liquid-Filled Valence Tautomeric Microcapsules: A Solid Material with Solution-Like Behavior, Vázquez-Mera N.A., Roscini C., Hernando J., Ruiz-Molina D., *Advanced Functional Materials*; **25 (26)**: 4129-4134 2015. 10.1002/adfm.201501166. IF: 11.805



PROJECTS

Desarrollo de nanoencapsulación funcionalizada de fragancias para aplicación en formulación de suavizantes, MICROFRAG (INNFACTO), funded by **MINECO**, 28/02/13 - 28/02/15, Daniel Ruiz Molina

Pinturas fotocromáticas en polvo para su uso en arquitectura de exteriores de alto valor añadido, ADAPTALITE (Programa RETOS-COLABORACION), funded by **MINECO**, 01/9/14 - 31/12/17, Daniel Ruiz Molina

Dispositivos Moleculares. Moldev, funded by **MINECO**, 01/01/13 - 31/12/15, Daniel Ruiz Molina

SGR, funded by **AGAUR**, 01/01/14 - 31/12/16



CONTRIBUTIONS

Coordination Polymer Nanoconstructs: From Molecular Switches to Theranostics, **1st International Caparica Christmas Congress on Translational Chemistry**, Caparica (Portugal), 07-12/12/2015, F. Novio (Invited)

Polymeric Micro and Nanocapsules for the fabrication of new functional materials, **Universidad de les Illes Balears**, Palma de Mallorca (Spain), 20/02/2015, Claudio Roscini (Invited)

Catechols at the interface: study of their adhesive and chemical properties, **Fourth International Conference on Multifunctional, Hybrid and Nanomaterials**, Sitges (Spain). 9-13/03/2015, Mireia Guardingo (Oral)

Catechol derivatives materials for bioinspired functional coatings, **Smart and Green Interfaces Conference SGIC2015**, Belgrade (Serbia). 30/03/2015 - 01/04/2015, J. Mancebo-Aracil (Oral)

Coordination Polymers at the Nanoscale: From Physicochemical Characterization to Applications in Nanomedicine, **Third International Conference on Advanced Complex Inorganic Nanomaterials**, Namur (Belgica). 13-17/07/2015, Fernando Novio (Oral)

Hybrid mesoporous silica nanoparticles with catechol-based coatings as novel controlled, delivery carriers and sacrificial templates, **Scientific workshop "Biomedical, Health and Bio-related Applications of Hybrid Materials" (HINTBCN2015)**, Bellaterra (Spain). 08-09/06/2015, Fabiana Nador (Oral)

Polymer-based nanostructures as robust spin transition platforms, **5th European Conference on Molecular Magnetism (ECMM)**, Zaragoza (Spain), 06-10/09/2015, D. Ruiz-Molina (Oral)

Theranostics Imaging and Therapy: An Action to Develop Novel Nanosized Systems for Imaging-Guided Drug Delivery, **Amorphous Coordination Polymers as innovative nanosystems for theranostics**, Estambul (Turkey), 03-04/10/2015, Fernando Novio (Oral)

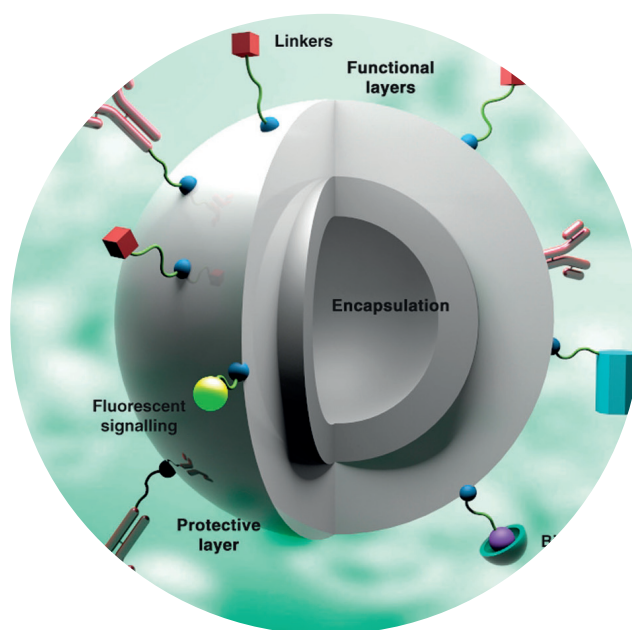
Theranostics Imaging and Therapy: An Action to Develop Novel Nanosized Systems for Imaging-Guided Drug Delivery, **NANOBIOAPP2015: Latest Advances on Nanomaterials for Biomedical Applications**, Fernando Novio (Oral), Barcelona (Spain), 21-23/09/ 2015

Hybrid Multifunctional Coordination Polymer Nanoparticles for Nanomedicine, **Fourth International Conference on Multifunctional, Hybrid and Nanomaterials**, Sitges (Spain). 09-13/03/2015, Fernando Novio (Póster)

Fabrication of supramolecular fluorescent ambiphilic particles for application in nanomedicine, **Fourth International Conference on Multifunctional, Hybrid and Nanomaterials**, Sitges (Spain). 09-13/03/2015, Karolina Wnuk (Póster)

Study of different variables affecting payload control release in pH sensitive Coordination, Polymer Particles (CPPs), **Fourth International Conference on Multifunctional, Hybrid and Nanomaterials**, Sitges (Spain). 09-13/03/2015, Fabiana Nador (Póster)

New drug loaded, single antibody targeted coordination polymer particles for cancer treatment, **XII Jornada Científica del Departament de Bioquímica i Biologia Molecular (UAB)**, Bellaterra (Spain) 02/06/2015, David Montpeyó (Póster)



β -Glucocerebrosidase encapsulation in PLGA nanocapsules and study of its stability as a promising treatment for Parkinson disease, **XII Jornada Científica del Departament de Bioquímica i Biologia Molecular (UAB)**, Bellaterra (Spain) 02/06/2015, David Martínez (Póster)

Novel coordination polymer nanoparticles as contrast agents for magnetic resonance, imaging (MRI), **XII Jornada Científica del Departament de Bioquímica i Biologia Molecular (UAB)**, Bellaterra (Spain) 02/06/2015, Salvio Suárez-García (Póster)

New nanostructured materials based on coordination polymers as contrast agents for MRI, **Scientific workshop "Biomedical, Health and Bio-related Applications of Hybrid Materials" (HINTBCN2015)**, Bellaterra (Spain). 8-9 /06/2015, Salvio Suárez-García (Póster)

New Single-Antibody, targeted Coordination Polymer Particles for Cancer Treatment, **Scientific workshop "Biomedical, Health and Bio-related Applications of Hybrid Materials" (HINTBCN2015)**, Bellaterra (Spain). 8-9 /06/2015, David Montpeyó (Póster)

New lysosomal therapeutic strategies for Parkinson diseases, **Scientific workshop “Biomedical, Health and Bio-related Applications of Hybrid Materials” (HINTBCN2015)**, Bellaterra (Spain), 8-9 /06/2015, David Martínez (Póster)

PLGA based nanoparticles: a new nasal drug delivery system for Parkinson’s disease associated to GBA mutations, **NANOBIOAPP2015: Latest Advances on Nanomaterials for Biomedical Applications**, Barcelona (Spain), 21-23/09/2015, David Martínez (Póster)

New Drug Loaded, Single-Antibody Targeted Coordination Polymer Particles (CPPs) for Cancer Treatment, **NANOBIOAPP2015: Latest Advances on Nanomaterials for Biomedical Applications**, Barcelona (Spain), 21-23/09/2015, David Montpeyó (Póster)

Novel lysosomal therapeutic based on nanotechnology for Parkinson disease, **Crossing Biological Barriers - Advances in Nanocarrier Design for Targeted Drug Delivery**, Dresden (Germany), 09-11/11/2015, Fernando Novio (Póster)



THESES

Doctorand: **Núria Vázquez**

Title: Encapsulation of stimuli-responsive molecules for the preparation of photofunctional materials.

Defense Date: 26/06/2015

Directors: Dr Daniel Ruiz-Molina / Dr Jordi Hernando / Dr José Luis Bourdelande

Doctorand: **Mireia Guardingo**

Title: Interfacial Chemistry of Catechol-based Nanostructures

Defense Date: 06/11/2015

Directors: Dr Daniel Ruiz Molina / Dr Félix Busqué Sánchez



AWARDS

Núria Vázquez - The Institution CERCA presented the award **Doctoral Thesis Pioneer 2015**: Núria Vázquez, from Nanostructured Functional Materials Group of Catalan Institute of Nanoscience and Nanotechnology (ICN2), for the thesis: "Encapsulation of stimuli-responsive molecules for the preparation of photofunctional materials" directed by Dr Daniel Ruiz-Molina, Dr Jordi Hernando and Dr José Luis Bourdelande



TECHNOLOGY TRANSFER

*US patent (US) application ICN2PAT_02_15_EMULENTRAP Nanoemulsion optical materials, with Ref. US 14968586 and priority date 14/12/2015 with **CSIC, Futurechromes, S.L. and IOT, S.A.***

More information:
<http://nanosfun.icn2.cat/>

Nanostructured Materials for Photovoltaic Energy Group

Main Research Lines

- **Organic, Hybrid, Dye-sensitized, Halide Perovskite and All-oxide Solar Cells:** materials synthesis and characterisation and complete device fabrication
- **Synthesis of metal oxides by low-cost, low-temperature and “green” solution processing methods**
- **Solution processing methods for the fabrication of solar cells (and printed electronics)**
- **Degradation studies of the stability of Solar Cells following ISOS protocols**



GROUP MEMBERS

Álvarez De Lasarte Sagrera, Irene, SO Technician
Antunes Bortoti, Andressa, CSIC Visiting Doctoral Student

Bastos, Julio, CSIC Visiting Postdoctoral Researcher

Bellacanzone, Christian, Doctoral Student

De Sousa, Mauricio, CSIC Visiting Doctoral Student

De Sousa Lima, Francisco Anderson, CSIC Visiting Doctoral Student

Echeverria Troya, Fernando, Visiting Student

Fonrodona Turon, Marta, Scientific Project Manager

Lira-Cantú, Mónica, CSIC Tenured Scientist and Group Leader



GROUP LEADER



CSIC Tenured Scientist
Dr Mónica Lira-Cantú

Mónica Lira-Cantú (Chemistry, 1992), obtained a Master and PhD degrees in Materials Science at the Materials Science Institute of Barcelona (ICMAB) / Universitat Autònoma de Barcelona (1995/1997) and completed her postdoctoral work under a contract with the company Schneider Electric/ ICMAB (1998). From 1999 to 2001 she worked as permanent Senior Staff Chemist at ExxonMobil Research & Engineering (formerly Mobil Technology Co) in New Jersey (USA) initiating a laboratory on energy-related applications. Currently, she is Group Leader of the Nanostructured Materials for Photovoltaic Energy Group (nanostructuredmaterials.icn2.cat) of the Catalan Institute of Nanoscience and Nanotechnology, ICN2.



NEW PROJECTS & MILESTONES

The Nanostructured Materials for Photovoltaic Energy Group focuses on different objectives, all related to the **development of highly efficient, highly stable and low-cost solution processable photovoltaic and optoelectronic devices:**

The synthesis of nanostructured materials, especially those involving transition metal oxides (TMOs) and graphene, applying low-cost and solution processing methods is a major goal for the group. TMOs have many possible applications as main active materials or barrier layers, but are also applied as materials for external light management. The

application of low-temperature synthesis methods (sol-gel, hydrothermal, SILAR, among many others) permits tuning and control of the properties of the final device.

The stability and long life of optoelectronic devices, especially organic solar cells, is a major limitation for these technologies to reach the marketplace. A consortium of more than 260 members, among them 60



Mingorance Ferrer, Alba, SO Doctoral Student

Reyna Velázquez, Yegraf, Visiting Student

Suárez Secilla, Javier, Visiting Student

Venancio, Cicero, CSIC Visiting Doctoral Student

Víctor, Sandra, CSIC Visiting Doctoral Student

She received different awards/fellowships as a visiting scientist to the following laboratories: University of Oslo, Norway (2003), Riso National Laboratory, Denmark (2004/2005) and the Center for Advanced Science and Innovation, Japan (2006). She obtained a permanent position in 2007 at the Spanish National Research Council (CSIC, Spain) and started the laboratory on Photovoltaic Energy at CIN2 in 2007. Since then she has directed more than 20 researchers (including Postdocs, PhD students and undergraduate students). She has been the PI of several projects (including national, industrial and European), and she is the principal coordinator of a COST Action Proposal (approved in 2013) related to the study of the stability of Organic solar cells (OPVs).

Her research interests are the synthesis and application of nanostructured materials for stable next-generation thin film solar cells: Perovskite solar cells, Dye-sensitized, Hybrid and Organic Solar Cells. Mónica Lira-Cantú has more than 70 published papers, 7 patents and 8 book chapters, h index = 25

internationally-recognized research laboratories and 17 industries from 31 countries, have joined an **EU COST Action project related to the stability of organic solar cells**. The project is led by ICN2 through Group Leader Mónica Lira-Cantú, coordinator of the consortium. The goal is to take advantage of the multiple characterisation techniques available from the different partners to elucidate the degradation mechanism of these devices and propose disruptive solutions towards highly stable Organic solar cells.

The review article **“Vertically-aligned nanostructures of ZnO for excitonic solar cells: a review”** by Irene González-Valls and Mónica Lira-Cantú, has been in the top 10 most cited articles of the journal *Energy & Environmental Science* (impact factor 15.49) since 2009.



PUBLICATIONS

Electrochemically synthesized mesoporous thin films of ZnO for highly efficient dye sensitized solar cells, Lima F.A.S., Vasconcelos I.F., Lira-Cantu M., *Ceramics International*; **41 (8, 10350)**: 9314 - 9320. 2015. 10.1016/j.ceramint.2015.03.271. IF: 2.605

Emerging thin-film photovoltaics: Stabilize or Perish, Von Hauff E., Lira-Cantu M., Brown T.M., Hoppe H., *Advanced Energy Materials*; **5 (20, 1501924)** 2015. 10.1002/aenm.201501924. IF: 16.146

Enhanced photovoltaic performance of inverted hybrid bulk-heterojunction solar cells using TiO₂/reduced graphene oxide films as electron transport layers, Morais A., Alves J.P.C., Lima F.A.S., Lira-Cantu M., Nogueira A.F., *Journal of Photonics for Energy*; **5 (1, 57408)** 2015. 10.1117/1.JPE.5.057408. IF: 1.366

Procedures and practices for evaluating thin-film solar cell stability, Roesch R., Faber T., Von Hauff E., Brown T.M., Lira-Cantu M., Hoppe H., *Advanced Energy Materials*; **5 (20, 1501407)** 2015. 10.1002/aenm.201501407. IF: 16.146

Vertically Aligned ZnO/Inx S y Core-Shell Nanorods for High Efficient Dye-Sensitized Solar Cells, Gonzalez-Valls I., Ballesteros B., Lira-Cantu M., *Nano*; **10 (7, 1550103)** 2015. 10.1142/S1793292015501039. IF: 1.090



PROJECTS

*Células Solares Nanoestructuradas
Fabricadas a partir de disoluciones: Nuevos
Nanomateriales basados en Óxidos de Metales
de Transición y Grafeno*, funded by **MINECO**,
2014-01-01 / 2016-12-31, Lira-Cantú, M.

*Nanostructured Materials for Photovoltaic
Energy - SGR*, funded by **AGAUR**, 2014-01-01
/ 2016-12-31, Lira-Cantú, M.

*Stable Next-Generation Photovoltaics:
Unravelling Degradation Mechanisms of
Organic Solar Cells by Complementary
Characterization Techniques*, funded by **CE**,
2014-06-01 / 2018-05-31, Lira-Cantú, M.

Novel Energy-Oriented Materials Group

Main Research Lines

- Hybrid electrode materials for supercapacitors and hybrid energy storage devices
- Graphene batteries. LiFePO_4 electrodes with fractal granularity for Li-ion batteries
- Nanofluids. Thermal nanofluids for heat transfer in solar conversion. Molten salts
- Electroactive nanofluids for energy storage in flow cells. Redox flow batteries based on quinones
- Graphene synthesis, hybridisation and applications in energy storage



GROUP MEMBERS

Arias, Javier, CSIC Visiting Student

Caban Huertas, Zahilia, PhD Student

Cavalcante Huguenin, Fritz, Visiting Postdoctoral Researcher

Chen, Hong, CSIC Visiting Student

Dubal, Deepak Prakash, CSIC Postdoctoral Researcher

Gómez Romero, Pedro, CSIC Research Professor and Group Leader

Gund, Girish, CSIC Postdoctoral Researcher

Wang, Jun Lian, Visiting Student

Marchante Fernández, Carlos, Technician

Montesinos, Anna, CSIC Visiting Student

Nagar, Bhawna, Doctoral Student

Rodríguez Laguna, Rocío, SO Doctoral Student

Rueda Garcia, Daniel, Doctoral Student

Ruiz, Fabricio Carlos, Visiting Postdoctoral Researcher

Slamani, Amel, Visiting Doctoral Student

Fedorkova, Andrea, Visiting Postdoctoral Researcher

Tajik, Sanaz, Visiting Doctoral Student

Wolfart, Franciele, Visiting Doctoral Student



GROUP LEADER



CSIC Research Prof
Dr Pedro Gómez-Romero

Prof Pedro Gómez-Romero (BSc and MSc Universidad de Valencia, Spain. PhD in Chemistry, Georgetown University, USA, 1987, with Distinction). CSIC Researcher since 1990 (ICMAB, 1990-2007). Sabbatical as NATO Senior Research Fellow at the National Renewable Energy Laboratory (Golden, CO, USA, 1998-99). CSIC Full Research Professor (2006-) and Group Leader of NEO-Energy lab at CIN2 (CSIC) (2007-2013) now part of ICN2. Fellow of the Royal Society



NEW PROJECTS & MILESTONES

2015 has been the year of growing productivity in the new consolidated research topics, including nanofluids, both thermal and electroactive, for solar conversion and energy storage respectively and of course hybrid electrodes and supercapacitors. In addition, graphene synthesis and graphene batteries are

getting momentum. Among them, we developed redox flow batteries based on quinones, new molten salt formulations for heat transfer and storage and the low-cost synthesis of high-quality graphene that we had begun in 2013.

Hybrid materials as improved electrodes for electrochemical supercapacitors.

The boundaries between batteries and capacitors are now quickly blurring. Nanostructure control is of great importance

of Chemistry. He leads projects on hybrid organic-inorganic nanostructures, nanocomposite materials for energy storage and conversion (lithium batteries, supercapacitors, flow cells, solar-thermal energy, nanofluids, graphene). Vicedirector of MATGAS (2010-2014).

Author of more than 200 scientific publications in refereed international journals. Scientific editor of the book *Functional Hybrid Materials* P. Gómez-Romero, C. Sánchez (Eds.) (Wiley-VCH 2004) and author of three award-winning popular science books (*Metaevolución. La Tierra en el espejo*, Celeste, 2001 *Un planeta en busca de energía*, Síntesis, 2007 and *Creadors de futur*, Bromera, 2016). <http://www.neoenergy.cat>

in the design of high-performance energy storing devices. Thus, we are developing materials with a high specific surface, and ultradispersed molecular materials, for applications in electrochemical supercapacitors that have greater power density than that of batteries. Examples of this type of electrodes prepared for the first time in our laboratory include activated carbons or graphene with polyoxometalates or oxide nanoparticles. (NANOCARHIBE MAT2012 National Project).

Micro-supercapacitors based on Si Nanowires and MnO₂ coated Si Nanowires. Also related to supercapacitors we collaborate with an international consortium led by CEA (France) on the development of nanowire electrodes for energy storage (NEST EU Project). One of our main contributions to this project has been the coating of these Nanowire electrodes with MnO₂ nanoflakes. This approach has led to micro-supercapacitors with excellent performance which are one of the main milestones of this European Project and have led to a European Patent.

Eco-friendly High-performance electrodes for rechargeable lithium batteries. It includes our work on the optimisation of micro- and nanostructures of electroactive inorganic materials such as LiFePO₄ with fractal granularity used in electrodes for lithium batteries. Here, we are aiming at low-cost, safe batteries, prepared under the mildest conditions in aqueous media with faster recharging rates (SOMABAT EU Project).

Nanofluids. The development of nanofluids, including electroactive nanofluids and heat transfer nanofluids for thermal solar energy conversion is now at full thrust. This is an internationally emergent research line with implications in fundamental science and application in new technologies such as load-levelling of renewable energies, Electric Vehicles or high temperature (concentration) solar power electricity generation.

Graphene and graphene batteries. The new kid in the Nanocarbon town is the subject of our interest too. We work on large scale methods for the preparation of high-quality graphene and its use in the synthesis of nanohybrid materials. Our materials can be tailor-made to different applications, but our favorite and the one we are working hard on is fast-charging graphene supercapacitors.



PUBLICATIONS

Nickel cobaltite as an emerging material for supercapacitors: An overview, Deepak P. Dubal, Pedro Gómez-Romero, Babasaheb R. Sankapal, Rudolf Holze, *Nano Energy*; **11**, 377-399. 2015.

Hybrid Energy Storage. The merging of battery and supercapacitor chemistries., D. P. Dubal, O. Ayyad, V. Ruiz, and P. Gómez-Romero, *Chemical Society Reviews*; **44**, 1777. 2015. DOI: 10.1039/C4CS00266K.

3D hierarchical assembly of ultrathin MnO₂ nanoflakes on silicon nanowires for high performance micro-supercapacitors in Li-doped ionic liquid, Dubal D.P., Aradilla D., Bidan G., Gentile P., Schubert T.J.S., Wimberg J., Sadki S., Gómez-Romero P. *Scientific Reports*; **5** (9771). 2015. 10.1038/srep09771.

A high voltage solid state symmetric supercapacitor based on graphene-polyoxometalate hybrid electrodes with a hydroquinone doped hybrid gel-electrolyte, Dubal D.P., Suárez-Guevara J., Tonti D., Enciso E., Gómez-Romero P., *Journal of Materials Chemistry A*; **3** (46): 23483 - 23492. 2015. 10.1039/c5ta05660h.

Anchoring cobalt oxide nanoparticles on to the surface multiwalled carbon nanotubes for improved supercapacitive performances, Sankapal B.R., Gajare H.B., Karade S.S., Dubal D.P., *RSC Advances*; **5** (60): 48426 - 48432. 2015. 10.1039/c5ra06377a.

Effect of Mn:(CuO/Cu(OH)₂) electrodes for supercapacitors application, Nikam S.R., Shinde K., Dubal D.P., Ghodake G.S., Dhaygude H.D., Relekar B.P., Lohar G.M., Fulari V.J., *Advanced Science Letters*; **21 (8)**: 2590 - 2593. 2015. 10.1166/asl.2015.6401.

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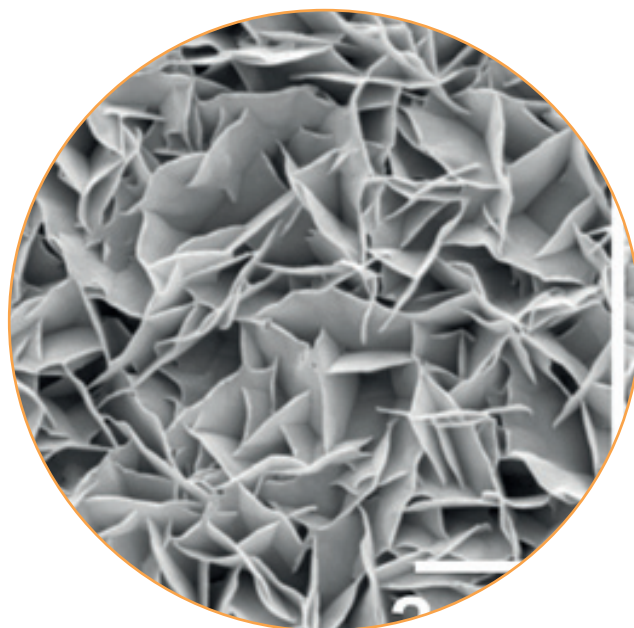
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Hierarchical 3D-flower-like CuO nanostructure on copper foil for supercapacitors, Shinde S.K., Dubal D.P., Ghodake G.S., Fulari V.J., *RSC Advances*; **5 (6)**: 4443 - 4447. 2015. 10.1039/c4ra11164h.

Influence of Mn incorporation on the supercapacitive properties of hybrid CuO/Cu(OH)₂ electrodes, Shinde S.K., Dubal D.P., Ghodake G.S., Gómez-Romero P., Kim S., Fulari V.J., *RSC Advances*; **5 (39)**: 30478 - 30484. 2015. 10.1039/c5ra01093d.

Ionically conducting PVA-LiClO₄ gel electrolyte for high performance flexible solid state supercapacitors, Chodankar N.R., Dubal D.P., Lokhande A.C., Lokhande C.D., *Journal of Colloid and Interface Science*; **460**: 370 - 376. 2015. 10.1016/j.jcis.2015.08.046.

Linker free synthesis of TiO₂/Bi₂S₃ heterostructure towards solar cell application: Facile chemical routes, Salunkhe D.B., Dubal D.P., Sali J.V., Sankapal B.R., *Materials Science in Semiconductor Processing*; **30**: 335 - 342. 2015.



Low-cost flexible supercapacitors with high-energy density based on nanostructured MnO₂ and Fe₂O₃ thin films directly fabricated onto stainless steel, Gund G.S., Dubal D.P., Chodankar N.R., Cho J.Y., Gómez-Romero P., Park C., Lokhande C.D., *Scientific Reports*; **5** (12454) 2015.

Room temperature linker free growth of CdSe quantum dots on mesoporous TiO₂: Solar cell application, Salunkhe D.B., Dubal D.P., Sali J.V., Sankapal B.R., *Ceramics International*; **41 (3)**: 3940 - 3946. 2015.

SiNWs-based electrochemical double layer micro-supercapacitors with wide voltage window (4V) and long cycling stability using a protic ionic liquid electrolyte, Aradilla D., Gentile P., Ruiz V., Gómez-Romero P., Wimberg J., Iliev B., Schubert T.J.S., Sadki S., Bidan G., *Advances in Natural Sciences: Nanoscience and Nanotechnology*; **6** (1, 15004) 2015. 10.1088/2043-6262/6/1/015004.

Temperature dependence of cationic and anionic precursor on morphological improvement of CuO electrodes and its consequent effect on electrochemical supercapacitive properties, Shinde S.K., Dubal D.P., Ghodake G.S., Dhaygude H.D., Lohar G.M., Relekar B.P., Fulari V.J., *Advanced Science Letters*; **21 (8)**: 2653 - 2656. 2015. 10.1166/asl.2015.6400.

The influence of solvents and salts on the properties of high-voltage cathode materials, Kazda T., Vondrák J., Sedlaríková M., Gómez-Romero P., Musil M., Cudek P., Fedorková Straková A., Kašpárek V., *International Journal of Electrochemical Science*; **10 (8)**: 6288 - 6301. 2015.

Three-dimensional arrays of 1D MnO₂ nanocrystals for all-solid-state asymmetric supercapacitors, Dubal D.P., Holze R., Gómez-Romero P., *ChemPlusChem*; **80 (6)**: 944 - 951. 2015. 10.1002/cplu.201500054.

Diamond coated silicon nanowires for enhanced micro-supercapacitor in ionic liquid, G. S. Gund, D. P. Dubal, D. Aradilla, W. Muller-Sebert, G. Bidan, P. Gentile, T. J. S. Schubert, J. Wimberg, S. Sadki, P. Gómez-Romero, *Proceedings ICIC*. 2015.

Asymmetric supercapacitors based on hybrid sponge@reduced graphene oxide (rGO)@CuO as a cathode and sponge@rGO as an anode, Deepak P. Dubal, Nilesh R. Chodankar, Girish S. Gund, , Rudolf Holze, Chandrakant D. Lokhande Pedro Gomez-Romero, *Energy Technology*; **3(2)**: 168 - 176. 2015. IF: 2.483

Innovative 3-D nanoforest heterostructure made of polypyrrole coated silicon nanotrees for new high performance hybrid micro-supercapacitor, David Aradilla, Dorian Gaboriau, Gérard Bidan, Pascal Gentile, Deepak Dubal, Pedro Gómez-Romero, Jan Wimberg, Thomas J. S. Schubert, and Saïd Sadki, *Journal of Materials Chemistry A*; 2015, DOI: 10.1039/C5TA03435C. IF 7.443



PROJECTS

Materiales Nanoestructurados de Carbono e Híbridos para Almacenamiento de Energía, proyecto Coordinado Plan Nacional MAT2012-39199-C02-01 (NANOCARHIBE), IP UCM Eduardo Enciso, funded by **MINECO**, 01/01/2013 - 31/12/2015, IP ICN2 and coordinator, Pedro Gómez Romero

Nanowires for energy storage "NEST", Proyecto Europeo (VII FP) **FP7-ENERGY-2012-1-2STAGE** ID 309143-2, 01/01/2013 - 31/12/2016, coordinator, G. Bidan (CEA). IP ICN2, Pedro Gómez-Romero



CONTRIBUTIONS

Nanomaterials for Energy Storage, **Nano 2015 KSR College of Technology**, Tamil Nadu, India, 7-10/12/2015, Pedro Gómez-Romero (Keynote)

The 2nd International Conference on Nanomaterials: Fundamentals and Applications 2nd NFA 2015. Pavol Jozef Šafárik University, Faculty of Science, Košice, Slovakia, 26-28/10/2015, Pedro Gómez-Romero (Plenary)

Graphene research at ICN2, **Graphene2015, ImagineNano**, Bilbao, Spain, 11-13/03/2015, Pedro Gómez Romero (Invited)

Hybrid Materials for Hybrid Energy Storage, **E-MRS 2015**, Warsaw, Poland, 15/09/2015, Pedro Gómez-Romero (Invited)

Hybrid Materials for Hybrid Energy Storage, **Multifunctional, Hybrid and Nanomaterials (HYMA2015)**, Sitges, Barcelona, Spain, 10-13/03/2015, P. Gómez-Romero (Invited)

Hybrid nanocomposite Materials for Hybrid Energy Storage, **Nanomaterials: Applications and Properties (NAP-2015)**, Lviv, Ukraine, 16-23/09/2015, Pedro Gómez-Romero (Invited)

Spicing Graphene with electroactive inorganic compounds: Graphene hybrid nanocomposites for energy storage, **GraphChina Conference**, Qingdao, China, 28-30/10/2015, Pedro Gómez-Romero (Invited)

What could be better than graphene for energy storage and conversion?, **ROCAM 2015**, Bucharest, Romania, 07-10/07/2015, Pedro Gómez Romero (Invited)

Hybrid polyoxometalate/reduced graphene oxide composites for supercapacitors, **Graphene2015, ImagineNano**, Bilbao, Spain, 11-13/03/2015, Pedro Gómez Romero (Oral)

Carbon-LiFePO₄ electrodes with fractal granularity, **Multifunctional, Hybrid and Nanomaterials (HYMA2015)**, Sitges, Barcelona, Spain, 10-13/03/2015, P. Gómez-Romero, O. Ayyad, Z. Caban-Huertas, (Poster)

Influencia del recubrimiento de carbono en el rendimiento electroquímico de catodos de LiFePO₄, **XIX Congreso de Físicoquímica y Química Inorgánica**, Buenos Aires, Argentina, 12-15/04/2015, Rita M. Humana, Omar Ayyad, Zahilia Caban-Huertas, Arnaldo Visintin, Pedro Gómez-Romero (Poster)

Influence of the electrosynthesis method on the supercapacitive properties of polypyrrole, **ECOSS-31**, CCIB of Barcelona, 31/08 - 04/09/2015, Franciele Wolfart, P. Gómez-Romero, Marcio Vidotti, Deepak P. Dubal. (Poster)

Novel hybrid micro-supercapacitor based on metal oxide and conducting polymer coated silicon nanowires, **Multifunctional, Hybrid and Nanomaterials (HYMA2015)**, Sitges, Barcelona, Spain, 10-13/03/2015, D.P. Dubal, et al. (Poster)



DISSEMINATION CONTRIBUTIONS

Historia de los materiales del futuro,
CaixaForum Zaragoza, 05/02/2015

Historia de los materiales del futuro,
Cosmocaixa, Barcelona, 19/02/2015

La Ciencia Inesperada. Historia de los descubrimientos que nadie buscó. **Jornadas de Ciencia Institut Mercè Rodoreda**, L'Hospitalet de Llobregat 13/03/2015

De los Nanómetros a los Teravatios. La nanociencia como motor de cambio del modelo energético. **Serie de Conferencias 75 Aniversario del CSIC**. Delegación del CSIC en Barcelona, 23/03/2015

Energía verde para un planeta azul, **Instituto ES, El Cairat** (Esparreguera). 15/04/2015.

Historia de los materiales del futuro, **Instituto ES, El Cairat** (Esparreguera). 15/04/2015.

Green Energy for a Blue Planet. Invited by the **Society of Spanish Researchers in the United Kingdom (SRUK-CERU)**, Sheffield, UK, 28/11/2015

From Nanometers to Terawatts. Nanomaterials for Sustainable Energy. **Center for Materials for Electronic Technologies**, Pune, India, 02/12/2015.

Hybrid materials for Hybrid energy storage devices: Recent research opportunities in Europe. **Department of Physics, Shivaji University**, Kolhapur, India, 05/12/2015



COURSES

Pedro Gómez Romero "Divulgación en el aula. Contar historias sin contar cuentos", **Participación en Jornadas Nanoeduca para profesores de secundaria** (Coord. Jordi Díaz, UB). CCiTUB (UB), Barcelona, 26/02/2015.

Pedro Gómez Romero, De los nanómetros a los teravatios. Nanociencia y nanotecnología frente al reto energético, **Curso "Nanotecnología: fundamentos y aplicaciones"**, IQS Executive Education, IQS, 17/05/2015.

Pedro Gómez Romero, De los nanómetros a los teravatios. Nanociencia y nanotecnología frente al reto energético, **Curso "Nanotecnología: la revolución del siglo XXI"**, **Universidad Internacional Menéndez Pelayo**, UIMP, Santander, 20-24/07/2015.

Pedro Gómez Romero, Invited Lecturer at the **International Summer School on Materials for Energy Conversion (SMEC2015)**, Bucharest (Romania), 06-11/07/2015.



AWARDS

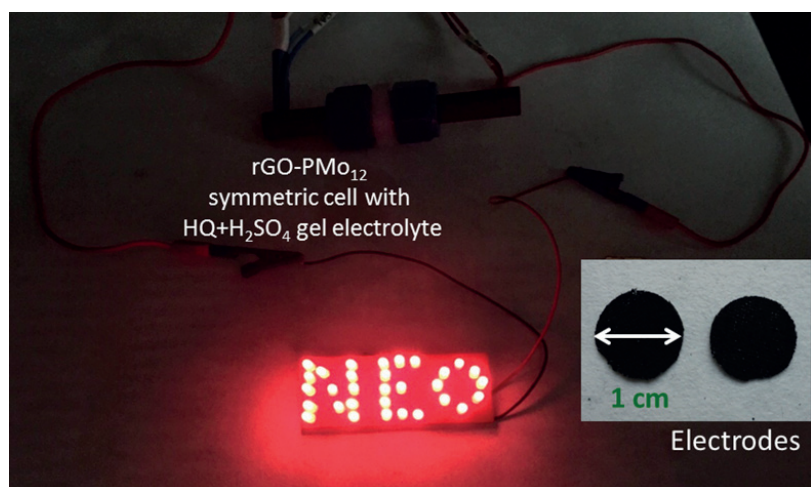
CSIC Prof Pedro Gómez-Romero, **XXI Premi Europeu de Divulgació Científica Estudi General (Ciutat d'Alzira, Universitat de València)** por su manuscrito de divulgación científica titulado "Creadores de futuro", 13/11/2015, <http://www.uv.es/uvweb/unidad-cultura-cientifica-innovacion-catedra-divulgacion-ciencia/es/premios/premio-europeo-divulgacion-cientifica/convocatorias-entregas-1285898836462.html>



TECHNOLOGY TRANSFER

The patent Ref. ICN2 PAT 10/14 *Graphene-based electroactive nanofluids as liquid electrodes in flow cells* has been filed on 20/05/2015 with filing number ES1641.1064 with **CSIC**.

European patent application CIN2PAT 01/15 *Electrode material comprising silicon nanowires covered by mesoporous oxide nanostructured coating and ionic liquid electrolytes for energy storage applications*, with Ref. EP15115811.9 and priority date 09/03/2015 with **CEA and CSIC**.



Oxide Nanoelectronics Group

Main Research Lines

- **Flexoelectricity and Piezoelectricity: fundamentals and devices**
- **Electronic and electromechanical properties of oxide thin films**
- **Domain wall nanoelectronics**
- **Ferroelectrics, multiferroics, metal-insulator transitions**



GROUP MEMBERS

Abdollahi Hosnijeh, Amir, Postdoctoral Researcher

Bhaskar, Umesh Kumar, Postdoctoral Researcher

Catalán Bernabé, Gustau, ICREA Research Professor and Group Leader

Cordero Eduards, Rohini Kumara, Doctoral Student

Domingo Marimón, Neus, Ramón y Cajal Senior Researcher

Fina, Ignasi, Postdoctoral Researcher

Martí, Xavier, Postdoctoral Researcher

Narváez, Jackeline, Doctoral Student

Pérez Tomás, Amador, SO Senior Postdoctoral Researcher

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Tenorio, María, Visiting Student

Vásquez Sancho, Fabián Norberto, Doctoral Student

Zapata Correa, James Arturo, Specialist Technician



GROUP LEADER



ICREA Prof
Gustau Catalán

Prof Gustau Catalán earned his BSc in Physics at the Universitat de Barcelona (1997), and his PhD in Physics at Queen's University of Belfast (2001). He then took research positions at the Mediterranean Institute for Advanced Studies (2002-2004), the University of Groningen (2004-2005) and the University of Cambridge (2005-2009).

In 2009 he joined CIN2 as an ICREA Research Professor and Group Leader of the Oxide Nanoelectronics (ON) Laboratory, and three years later he transferred his research from CIN2 to ICN. Both Institutions recently joined their efforts and became ICN2, where he continues to lead the Group. In 2012, he earned an ERC Starting Grant to set up the world's first dedicated laboratory of nanoscale flexoelectricity.



NEW PROJECTS & MILESTONES

This year has been a good one. We started the year reporting the highest piezoresistance ever measured at room temperature in an oxide (Domingo et al, *Nanoscale* 2015), a work that was picked up and highlighted by the national press (articles in *La Vanguardia*, *20 Minutos* and *El Mundo* among others). Pressure-induced changes in resistance were also the subject of another important article (Lu et al, *Nano Letters*) in which we showed that the conductivity of the 2D electron gas at the interface between SrTiO_3 and LaAlO_3 can be switched on and off by applying external stress gradients using the tip of an atomic force microscope.

Other noteworthy works include the first indirect evidence for surface piezoelectricity in a non-piezoelectric material (Narváez et al, *Physical Review Letters* 2015), the demonstration that the skin layer of relaxor materials remains ferroelectric well above the Curie temperature of the bulk (Domingo et al, *Physical Review B*), and a News&Views article on the subject of ferroelectric negative capacitance and the difficulties that have to be overcome for its integration into transistors capable of overcoming the so-called “Boltzmann tyranny” (Catalan et al, *Nature Materials* 2015).

In our group, researchers have autonomy to pursue their own research interests besides the core group lines. Thus, Ignasi Fina and Xavier Martí have produced relevant works on antiferromagnetic spintronics, Amador

Pérez has published about semiconductor devices, and Neus Domingo has written an article and a book chapter on the detection of surface adsorbates using scanning probe microscopy.



PUBLICATIONS

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Large Flexoelectric Anisotropy in Paraelectric Barium Titanate, Narváez J., Saremi S., Hong J., Stengel M., Catalán G., *Physical Review Letters*; **115** (3, 037601) 2015. 10.1103/PhysRevLett.115.037601. IF: 7.512

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PROJECTS

Advanced Nanoelectromechanical Devices (AND), Grup de Recerca Consolidat, **funded by SGR-AGAUR**, Generalitat de Catalunya, 01/01/2014 - 31/12/2016, Gustau Catalán

Oxide Stresstronics (OSTRESS), Plan Nacional, Proyecto de Excelencia, funded by **MINECO**, 01/01/2014 - 31/12/2016, Gustau Catalán

Flexoelectricity, European Research Council Starting Grant (ERC), funded by **EC**, 01/01/2013 - 31/12/2017, Gustau Catalán



CONTRIBUTIONS

Advanced seminar 1: Domain Wall Nanoelectronics, *Advanced seminar 2: Flexoelectricity*, **International School of Oxide Electronics (ISOE)**, Corsica (France) 15-19/10/2015, G. Catalán (Invited)

Cracking Flexoelectricity, **European Meeting of Ferroelectricity**, Portugal, 30/06/2015, G. Catalán (Invited)

Domain walls: from conductive paths to technology roadmaps, **79th Annual Meeting of the German Physics Society (DPG)**, Germany, 16/03/2015, G. Catalán (Invited)

Electromechanical Response; from violins to electrical drums, **ICMAB's AFM Day**, Bellaterra (Spain) 19/01/2015, N. Domingo (Invited)

Flexoelectric Memories, **1st International Symposium on the Physics of Data Storage**, France, 17/12/2015, G. Catalán (Invited)

Flexoelectricity vs. Piezoelectricity, **7th International Conference on Electroceramics (ICE2015)**, United States, 14/05/2015, G. Catalán (Invited)

Flexoelectricity in polar materials, **Workshop on the fundamental physics of ferroelectrics and related materials**, United States, 26/01/2015, G. Catalán (Invited)

When Flexoelectricity Met Ferroelectricity..., **22nd Workshop of Oxide Nanoelectronics**, Paris (France) 8/10/2015, G. Catalán (Invited)

A Comparative of Ferroelectric and Antiferroelectric Photovoltaic Devices, **Proceedings of 13th European Meeting on Ferroelectricity (EMF15)**, Porto, Portugal, 28/01 to 03/07/2015, A. Pérez-Tomás, A. Lima, M. Lira-Cantú, G. Catalán (Oral)

Flexoelectric MEMS on silicon, EMF conference, **13th European meeting on ferroelectricity**, Porto, 28/01 to 03/07/2015, U. Bhaskar, N. Banerjee, A. Abdollahi, Z. Wang, D. G. Schlom, G. Rijnders, and G. Catalán (Oral)

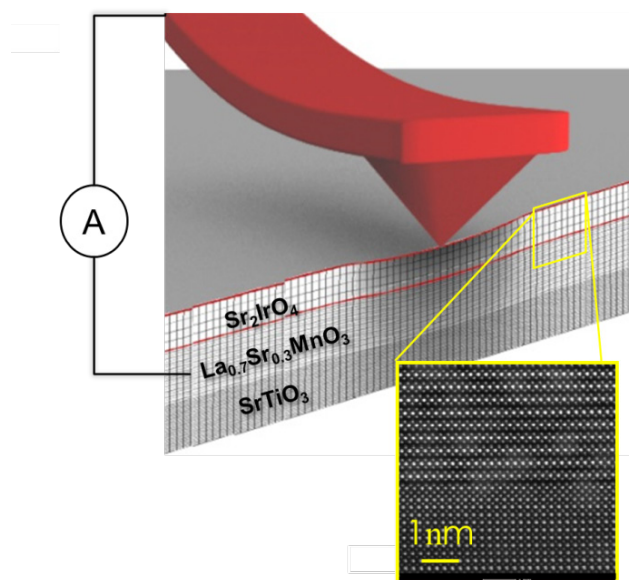
Switchable mechanical properties of ferroelectric materials due to flexoelectricity, EMF conference, **13th European meeting on ferroelectricity**, Porto, 28/01 to 03/07/2015, K. Cordero, A. Abdollahi, N. Domingo, J. Sort and G. Catalán (Oral)

Switchable mechanical properties of ferroelectric materials due to flexoelectricity, ECOSS conference, **31th European Conference on Surface Science**, Barcelona, 31/08 to 04/10/2015, K. Cordero, A. Abdollahi, N. Domingo, J. Sort and G. Catalán (Oral)

Skin layers on multiferroic and relaxor single crystals, ECOSS conference, **31th European Conference on Surface Science**, Barcelona, 31/08 to 04/10/2015, N. Domingo (Oral)

Scanning probe piezoresistance: (or what happens when you put an elephant on stilettos), **2015 Joint ISAF-ISIF-PFM Conference Singapore**, Singapore, 24-27/05/2015, N. Domingo (Oral)

Magnetoresistance at BiFeO_3 domain walls, **International Workshop on Topological Structures in Ferroic Materials**, Sydney (Australia), 19-21/05/2015, N. Domingo (Oral)





TECHNOLOGY TRANSFER

European patent (EP) application
ICN2PAT_04_15_Photoswitch_device.
*Photodiode with intense photovoltage or
photocurrents*, with Ref. EP15190177.4 and
priority date 16/10/2015 with **CSIC**.

European patent (EP) application
ICN2PAT_05_15_SI_PIEZO_SO *Flexoelectric
device*, with Ref. EP15382491.7 and priority
date 09/10/2015 with **ICREA**.

Phononic and Photonic Nanostructures Group

Main Research Lines

- Nanophononics and Nanophotonics
- Nanofabrication
- Nanometrology
- Oxide-based Nanostructures
- Optomechanics



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Medina, Juan Ignacio, Laboratory Engineer



GROUP LEADER



ICREA Prof Dr
Clivia M. Sotomayor Torres

ICREA Research Prof Dr Clivia M. Sotomayor Torres was awarded her PhD in Physics in 1984 by Manchester University (UK). She then held tenured academic appointments at St. Andrews and Glasgow Universities in the UK and became a C4 professor at Wuppertal University (Germany) in 1996. She was a research professor at University College Cork, Tyndall National Institute (Ireland) from 2004 to 2008. Since May 2007 she has been an ICREA Research Professor based at the Catalan Institute of Nanotechnology (ICN), now ICN2.

She has received awards from the Royal Society of Edinburgh, the Nuffield Foundation and an Amelia Earhart Fellowship from ZONTA International (USA). She is author of over 450 scientific publications and has edited six books (Researcher ID; E-8418-2010, Hirsch index 39, over 6000 citations). She leads a strong team working on phonon

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Sledzinska, Marianna, Laboratory Engineer

Sotomayor Torres, Clivia, ICREA Research Professor and Group Leader

Wagner, Markus, Marie Curie Postdoctoral Research Fellow



engineering and is actively engaged in European-level research. She serves in the Scientific Advisory Committees in Nanoscience and Nanotechnology in Grenoble and Paris-Saclay. She is a Member of the Board of Stakeholders of Photonic21, represents ICN2 in the Nanoelectronics ECSEL Joint Undertaking and is a Visiting Professor at the Royal Institute of Technology, KTH, in Sweden.

During 2015 Prof Sotomayor was member/jury of the following international Panels/Groups:

- Member of the Physics Panel of the Ministry of Education of Singapore for research proposals evaluation.
- Member of the Jury of the FWO Research Foundation Flanders for the 2015 Leeuw-Damry-Boullart Natural Sciences Prize and the Odysseus Programme, Belgium.
- Member of the Advisory Group of the Future and Emerging Technologies program of the European Commission.
- ERC Panel Member.



NEW PROJECTS & MILESTONES

During 2015 the Group completed two FP7 projects: **MERGING** (Membrane-based phonon engineering for energy harvesting) and **PLAST4FUTURE** (Injection-moulding production technology for multi-functional nanostructured plastic components enabled by Nano Imprint Lithography). The national project **TAPHOR** (Tailoring Acoustic Phonon Dispersion Relations) was also successfully completed.

A new H2020 project started in November 2015: **NEREID** (NanoElectronics Roadmap for Europe: Identification and Dissemination). The objective of this project is to map the future of European Nanoelectronics, starting from the needs of applications and leveraging the strengths of the European eco-system. In addition, it will aim to an early identification of promising novel nanoelectronic technologies and identify research needs and bottlenecks along the innovation chain. The P2N Group contribution is focused on mapping Beyond CMOS research.

Four projects are still ongoing: The Spanish **nanoTHERM** (Spanish CONSOLIDER project on Tailoring electronic and phononic properties of nanomaterials: Towards ideal Thermoelectricity) and three EU FP7 projects: **QUANTIHEAT** (Quantitative scanning probe microscopy techniques for heat transfer management in nanomaterials and nanodevices), **NANO-RF** (Carbon-based smart systems for wireless applications) and **NANOTHERM** (Innovative Nano and Micro Technologies for Advanced Thermo and Mechanical Interfaces).



PUBLICATIONS

A self-stabilized coherent phonon source driven by optical forces, Navarro-Urrios D., Capuj N.E., Gomis-Bresco J., Alzina F., Pitanti A., Griol A., Martínez A., Sotomayor Torres C.M., *Scientific Reports*; **5** (15733) 2015. 10.1038/srep15733. IF: 5.578

Phonon dispersion in hypersonic two-dimensional phononic crystal membranes, Graczykowski B., Sledzinska M., Alzina F., Gomis-Bresco J., Reparaz J.S., Wagner M.R., Sotomayor Torres C.M., *Physical Review B - Condensed Matter and Materials Physics*; **91** (7, 075414) 2015. 10.1103/PhysRevB.91.075414. IF: 3.736

Tuning Thermal Transport in Ultrathin Silicon Membranes by Surface Nanoscale Engineering, Neogi S., Reparaz J.S., Pereira L.F.C., Graczykowski B., Wagner M.R., Sledzinska M., Shchepetov A., Prunnila M., Ahopelto J., Sotomayor-Torres C.M., Donadio D., *ACS Nano*; **9** (4): 3820 - 3828. 2015. 10.1021/nn506792d. IF: 12.881

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Optical and mechanical properties of nanofibrillated cellulose: toward a robust platform for next-generation green technologies, Simao C., Reparaz J.S., Wagner M. R., Graczykowski B., Kreuzer M., Ruiz-Blanco Y., García Y., Malho J.M., Goñi, A., Ahopelto J., Sotomayor-Torres C.M., *Carbohydrate Polymers*; **126**: 40 - 46. 2015. IF: 4.074

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Lehr D., Wagner M.R., Flock J., Reparaz J.S., Sotomayor Torres C.M., Klaiber A., Dekorsy T., Polarz S. *Beilstein Journal of Nanotechnology*; **6 (1)**: 2161 - 2172. 2015. 10.3762/bjnano.6.222. IF: 2.670

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Ruiz-Blanco Y.B, Prieto P.J., Marrero-Ponce Y, Salgado J., García Y., Sotomayor-Torres C.M., *Journal of Theoretical Biology*; **364**: 407. 2015. 10.1021/nn506792d. IF: 2.116

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Shah V.A., Rhead S.D., Finch J., Myronov M., Reparaz J.S., Morris R.J., Wilson N.R., Kachkanov V., Dolbnya I.P., Halpin J.E., Patchett D., Allred P., Colston G., Sawhney K.J.S., Sotomayor Torres C.M., Leadley D.R., *Solid-State Electronics*; **108**: 13 - 18. 2015. 10.1016/j.sse.2014.12.004. IF: 1.504

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Gerigk M., Ehrenreich P., Wagner M.R., Wimmer I., Reparaz J.S., Sotomayor Torres C.M., Schmidt-Mende L., Polarz S., *Nanoscale*; **7 (40)**: 16969 - 16982. 2015. 10.1039/c5nr02550h. IF: 7.394

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Fernández A., Medina J., Benkel C., Guttman M., Bilenberg B., Thamdrup L.H., Nielsen T., Sotomayor Torres C.M., Kehagias N., *Microelectronic Engineering*; **141**: 56 - 61. 2015. 10.1016/j.mee.2014.11.025. IF: 1.197

Structural characterisation of slightly Fe-doped SrTiO₃ grown via a sol-gel hydrothermal synthesis,

Fuentes S., Muñoz P., Barraza N., Chávez-Ángel E., Sotomayor Torres C.M., *Journal of Sol-Gel Science and Technology*; **75 (3)**: 593 - 601. 2015. 10.1007/s10971-015-3730-4. IF: 1.473

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Simao C., Tuchapsky D., Khunsin W., Amann A., Morris M.A., Sotomayor-Torres C.M., *Physical Status Solidi*; **12 (3)**: 237. 2015.

Tuning of heat transport across Thin Films of Polycrystalline AlN via Multiscale Structural defects,

Jaramillo-Fernandez J., Ordonez-Miranda J., Ollier E., Sanatinia R., Kataria H., Chavez-Angel E., Volz S., Sotomayor-Torres C.M., *ECS Transactions*. **69 (9)**: 53-64. 2015. IF: 0.000

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Simao C., Tuchapsky D., Khunsin W., Amann A., Morris M.A., Sotomayor Torres C.M., *Proceedings of SPIE - The International Society for Optical Engineering*; **9423** (942322) 2015. 10.1117/12.2085748.

A diffractometer for quality control in nano fabrication processing based on subwavelength diffraction,

Kreuzer M., Gomis Bresco J., Sledzinska M., Sotomayor Torres C.M., *Proceedings of SPIE - The International Society for Optical Engineering*; **9424** (942426) 2015. 10.1117/12.2085924.

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Kreuzer M., Gomis Bresco J., Sledzinska M., Sotomayor-Torres C.M., *Proceedings of SPIE*. 2015. 10.1117/12.2085924.

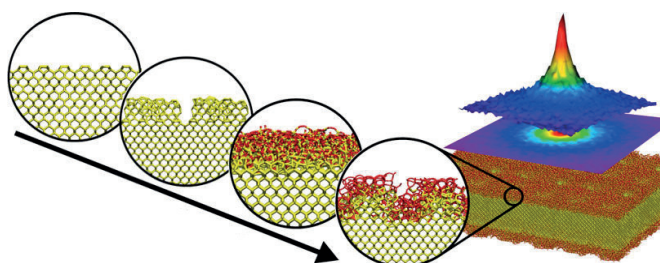
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Athanasekos L., Vasileiadis M., El Sachat A., Vainos N.A., Riziotis C., *Journal of Optics (United Kingdom)*; **17** (1, 015402) 2015. 10.1088/2040-8978/17/1/015402. IF: 2.059

Assessment of block and random copolymer overlayers on polymer optical fibers toward protein detection through electrostatic interaction, El Sachat A., Meristoudi A., Pispas S., Riziotis C., *Journal of Polymer Science, Part B: Polymer Physics*; **53 (5)**: 327 - 334. 2015. 10.1002/polb.23632. IF: 3.830

Elucidation of the wettability of graphene through a multi-length-scale investigation approach, Amadei C.A., Lai C.-Y., Esplandiu M.J., Alzina F., Vecitis C.D., Verdaguer A., Chiesa M., *RSC Advances*; **5 (49)**: 39532 - 39538. 2015. 10.1039/c5ra04397b. IF: 3.840

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PROJECTS

QUANTitative scanning probe microscopy techniques for HEAT transfer management in nanomaterials and nanodevices - QUANTIHEAT, funded by **EC**, 01/12/13 - 30/11/2017, Clivia M. Sotomayor Torres

Tailoring Electronic and Phononic Properties of Nanomaterials: Towards Improved Thermoelectricity (nanoTHERM), funded by **MINECO**, 27/12/2010 - 26/12/2016, Clivia M. Sotomayor Torres

SGR, funded by **AGAUR**, 01/01/2014 - 31/12/2016, Clivia M. Sotomayor Torres

Nanostructured ThermoElectric Systems for Green Transport & Energy Efficient applications - NANOTEG, funded by **EC**, 01/07/2011 - 28/02/2015, Clivia M. Sotomayor Torres

Membrane-based phonon engineering for energy harvesting - MERGING, funded by **EC**, 01/01/2013 - 31/12/2015, Clivia M. Sotomayor Torres

Injection moulding production technology for multi-functional nano-structured plastic components enabled by Nano Imprint Lithography - PLAST4FUTURE, funded by **EC**, 01/01/2013 - 31/12/2015, Clivia M. Sotomayor Torres

Diseño de las Relaciones de Dispersión de Fonones Acústicos - TAPHOR, funded by **MINECO**, 01/01/2013 - 31/12/2015, Clivia M. Sotomayor Torres

Carbon based smart systems for wireless applications - NANO-RF, funded by **EC**, 01/09/2012 - 31/05/2016, Clivia M. Sotomayor Torres

Innovative Nano and Micro Technologies for Advanced Thermo and Mechanical Interfaces - Consolider nanoTHERM, funded by **EC**, 01/09/2012 - 31/05/2016, Clivia M. Sotomayor Torres

NanoElectronics Roadmap for Europe: Identification & Dissemination - NEREID, funded by **EC**, 16/11/2015 - 15/11/2018, Clivia M. Sotomayor Torres



CONTRIBUTIONS

Thermal transport in free-standing silicon membranes: confinement, intrinsic and extrinsic contributions, **25th SLAFES**, Puerto Varas, Chile, 04/12/2015, Sotomayor Torres, C.M. (Invited)

Thermal transport in free-standing silicon membranes: confinement, intrinsic and extrinsic contributions, **MRS Fall Meeting 2015**, Boston, USA, 30/11/2015, Sotomayor Torres, C.M. (Invited)

Understanding thermal conductivity in ultra-thin SOI, **EU-Korea workshop on Nanoelectronics**, Lisbon, Portugal, 21/10/2015, Sotomayor Torres, C.M. (Invited)

Phonon dynamics and thermal properties of Si 2D phononic crystals and stressed Ge nano-bridges, **GDR workshop on Thermal Nanosciences and Nanoengineering 2015**, Paris, France, 13/11/2015, Wagner M. (Invited)

Optical and thermal properties of doped ZnO thin films and nanostructures, **SPIE Photonics West 2015**, San Francisco, USA, 08/02/2015, Wagner M. (Invited)

Thermal transport in free-standing silicon membranes, **CECAM-FR-IDF Workshop on Nanostructures for Thermoelectrics**, Paris, France, 07-10/07/2015, Sotomayor Torres, C.M. (Invited)

Thermal transport in nanostructured materials: Can we control thermal phonons?, **Son et Lumières Workshop**, Les Houches, France, 16-17/02/2015, Reparaz, J.S. (Invited)

Optical and thermal properties of doped ZnO thin films and nanostructures, **SPIE Photonics West**, San Francisco (USA), 07-12/02/2015, Wagner, M. (Invited)

Phonon dispersion engineering and thermal transport in Si membranes, **228th ECS Meeting**, Phoenix, USA, 11-16/10/2015, Alzina, F. (Invited)

Silicon nanomembrane-based phononics, **Phonons 2015**, Nottingham, UK, 12-17/07/2015, Graczykowski, B. (Oral)

Silicon nanomembrane-based phononics, **Phonons 2015**, Nottingham, UK, 12-17/07/2015, Alzina, F. (Oral)

Brillouin Spectroscopy of Silicon-based Phononic Crystals, **Phononics 2015**, Paris, France, 31/05 - 06/06/2015, Graczykowski, B. (Oral)

Stress-and phononic induced changes in GHz phonon propagation in thin Si membranes, **2015 International congress of Ultrasonics**, Metz, France, 10-14/05/2015, Graczykowski, B. (Oral)

A novel approach to determine the spectral bandwidth of thermal phonons and mean-free path in silicon free-standing membranes, **MRS Spring meeting 2015**, San Francisco, USA, 06-10/04/2015, Reparaz, J.S. (Oral)

Inline metrology setup for repeating nanostructures based on subwavelength diffraction, **SPIE Optical Systems Design**, Jena, Germany, 07-10/10/2015, Kreuzer, M. (Oral)

Etch-free nanoporous metallic layers and hybrid superlattices using block copolymer self-assembly templates, **EMRS 2015 Spring Meeting**, Lille, France, 15/05/2015, Simao, C. (Oral)

SrTiO₃ thin films as high efficient n-type thermoelectric materials, **EMRS 2015 Spring Meeting**, Lille, France, May 15th, 2015, Bhansali, S. (Oral)

Formation of titanium nanostructures on block copolymer templates with varying molecular weights, **EMRS 2015 Spring Meeting**, Lille, France, 15/05/2015, Kreuzer, M. (Oral)

Room temperature cavity opto-mechanics: towards a phonon source, **Imaginenano 2015**, Bilbao, Spain, 10-13/03/2015, Graczykowski, M. (Oral)

Modification of acoustic phonon dynamics and thermal conductivity in ultra-thin stressed Si membranes and phononic crystals, **MRS Spring Meeting 2015**. Material Research Society Conference, San Francisco, USA, 06-10/04/2015, Wagner, M. (Oral)

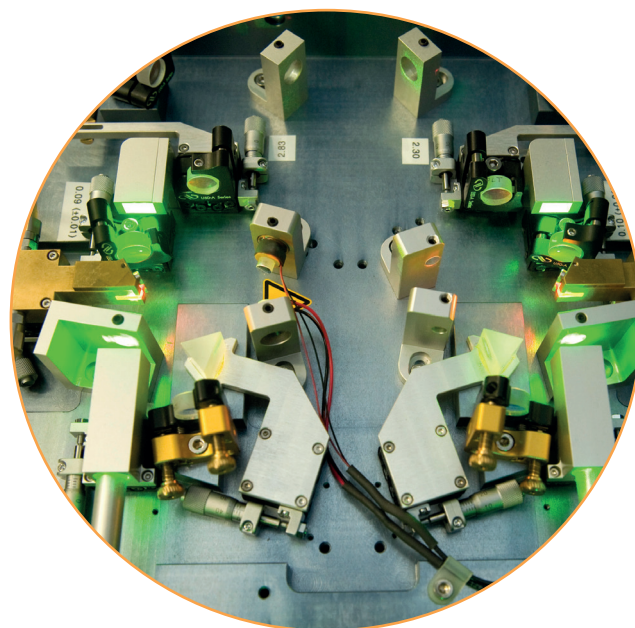
Large area hierarchical micro/nano structures for enhanced self-cleaning applications, **Micro and Nanoengineering 2015**, The Hague, The Netherlands, 21-24/09/2015, Fernández, A. (Poster)

Mapping self-assembled dots and line arrays by image analysis for quantification of defect density and alignment, **SPIE Advanced Lithography**, San Jose, USA, 22-26/02/2015, Simao, C. (Poster)

SrTiO₃ thin films as high efficient n-type thermoelectric materials, **ICT**, Dresden, Germany, 28/06 - 02/07/2015, Bhansali, S. (Poster)

A diffractometer for quality control in nano fabrication processing based on subwavelength diffraction, **SPIE Advanced Lithography**, San José, USA, 22-26/02/2015, Kreuzer, M. (Poster)

Thermal characterization of silver sintering paste as thermal interface using the 3-omega technique and Raman thermometry, **Therminic 2015**, Paris, France, 30/09 - 02/10/2015, Reparaz, S. (Oral)

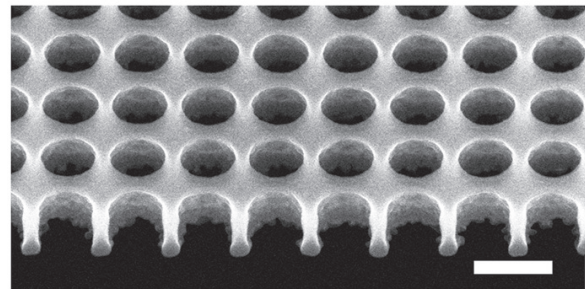
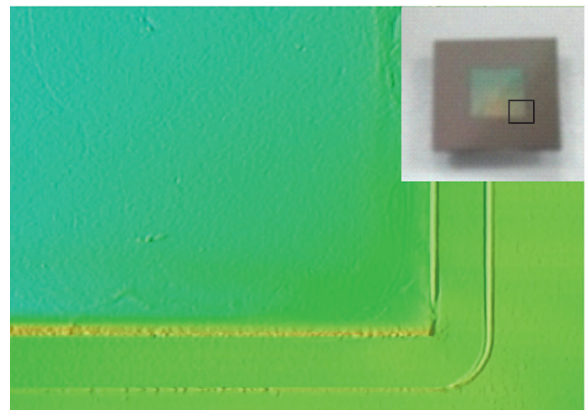




AWARDS

Sweta Bhansali was honoured with the **“Graduate Student Award” at EMRS 2015 Conference** (Young scientist award) for her work on SrTiO₃ thin films for thermoelectric applications.

ICREA Research Prof Dr Clivia M. Sotomayor Torres was honored with the **Nanoimprint Pioneer Award**.



More information:
<http://www.icn.cat/~p2n/>

Physics and Engineering of Nanodevices Group

Main Research Lines

- **Development of novel nanodevice structures and nanofabrication methods to investigate the physical properties of materials at the nanoscale and their technological relevance**
- **Spin and thermal transport in two-dimensional systems such as topological insulators, graphene and transition metal dichalcogenides**
- **Control of the magnetic state of ferro- and antiferromagnetic systems by means of the spin-orbit interaction and, particularly, the spin Hall effect**



GROUP MEMBERS

Arrighi, Aloïs, SO Doctoral Student

Bonell, Frédéric, Marie Curie Postdoctoral Researcher

Costache, Marius Vasile, Ramón y Cajal Senior Researcher

Cuppens, Jo, Postdoctoral Researcher

Gebeyehu, Zewdu Messele, Doctoral Student

González Cuxart, Marc, Doctoral Student

Sierra García, Juan Francisco, Juan de la Cierva Postdoctoral Researcher

Urgell Flores, Carles, Master Student

Valenzuela, Sergio Osvaldo, ICREA Research Professor and Group Leader

Gebeyehu, Zewdu, Doctoral Student

Raes, Bart, Postdoctoral Researcher



GROUP LEADER



ICREA Prof
Sergio Valenzuela

Prof Valenzuela obtained his PhD in Physics in 2001 at the University of Buenos Aires, Argentina, and went on to be a Postdoctoral Fellow and Research Associate at Harvard University, and a Research Scientist at the Massachusetts Institute of Technology (MIT). Since July 2008, Prof Valenzuela has been an ICREA Research Professor as well as Group Leader of ICN's, now ICN2's, Physics and Engineering of Nanoelectronic Devices Group. Prof Valenzuela's research is focused on the unique properties



NEW PROJECTS & MILESTONES

In 2015 the Physics and Engineering of Nanodevices Group continued with its progress on the ERC Starting Grant project to investigate the spin properties of materials with large spin-orbit interaction, in particular topological insulators. The project (SPINBOUND) was launched in February 2013 and, in January 2014, the first results were published in the journal *Physical Review Letters*. The work reported the role of electron-phonon coupling in the electronic properties of surface states of topological insulators, putting forward constraints that will be key for future devices based on these materials.

The group has also participated in Training Networks; hosting researcher Frédéric Bonell with a Marie Curie project (STIFNANO), which was awarded in 2013 to work on the electronic properties of ferromagnet / topological insulators heterostructures. Within this project a crucial milestone was achieved for the future activities of the group with the successful growth of high quality topological insulators in a dual-chamber Molecular Beam Epitaxial (MBE) system. In addition, the group continued with MINECO project Spintronics in 2-Dimensional Dirac Systems (S2DDS), and has been active in the investigation of the spin Hall effect (*Rev. Mod. Phys.*) and the charge and spin transport properties of graphene, reporting, for example, the electrical injection and detection of hot carriers (*Nano Lett article*). Following the



of materials in samples with nanoscale dimensions. Such studies are motivated both by their intrinsic scientific interest and by their potential importance for electronic applications, and they rely on innovative devices or innovative implementations of known devices. His research has encompassed spintronics, quantum computation with superconducting circuits, and nanoelectromechanical systems (NEMS). Prof Valenzuela received the 2009 IUPAP Young Scientist Prize in Magnetism for his contributions to the field of spintronics, and was awarded an ERC Starting Grant in 2012. He has authored over 40 papers (in *Nature*, *Science*, *Rev. Mod. Phys.*, *Nature Mater.*, *Nature Phys.*, *Phys. Rev. Lett.*, amongst others), three patents and five books or book chapters.

success of these activities, the group was invited to participate in the Graphene EU Flagship program (*2D Mater*) from early 2016. In 2015 Dr Costache was awarded the IUPAP Young Scientist medal at the 20th International Conference on Magnetism (ICM2015), in part for his contributions to magnetism during his tenure at ICN2.



PUBLICATIONS

Graphene spintronics: the European Flagship perspective, S. Roche, J. Akerman, B. Beschoten, J-C Charlier, M. Chshiev, S. P. Dash, B. Dublak, J. Fabian, A. Fert, M. Guimaraes, F. Guinea, I. Grigorieva, C. Schonenberger, P. Seneor, C. Stampfer, S. O. Valenzuela, X. Waintal, B. J. van Wees, *2D Materials*, **2**, 030202, (2015)

Hot-Carrier Seebeck Effect: Diffusion and Remote Detection of Hot Carriers in Graphene, Juan F. Sierra, Ingmar Neumann, Marius V. Costache, and Sergio O. Valenzuela, *Nano Letters*, **15**, 4000, (2015)

Spin Hall Effects, Jairo Sinova, Sergio O Valenzuela, J Wunderlich, CH Back, T Jungwirth, *Rev. Mod. Phys.*, **87**, 1213-1259, (2015)



PROJECTS

Exploring the spin physics at the boundaries of materials with strong spin orbit interaction - **SPINBOUND**, funded by **EC**, 01/02/2013 - 31/01/2018, Sergio Valenzuela

Espintrónica en Sistemas de Dirac en 2 Dimensiones - **S2DDS**, funded by **MINECO**, 01/01/2014 - 31/12/2016, Sergio Valenzuela

SGR, funded by **AGAUR**, 01/01/2014 - 31/12/2016, Sergio Valenzuela

Accionamiento y detección de movimiento mecánico mediante corrientes de espín - **SpinMechanics**, funded by **MINECO**, 01/10/2015 - 30/09/2016, Marius Costache



CONTRIBUTIONS

Isolation and detection of the Magnon-Drag Effect, **Workshop on thermospin effects**, Zaragoza, Spain, 03/07/2015, S. O. Valenzuela (Invited)

Inelastic electronic transport in single-layer graphene and at the surface of topological insulator Bi_2Se_3 , **International Conference on Magnetism 2015**, Barcelona, Spain, July 2015, S. O. Valenzuela (Invited)

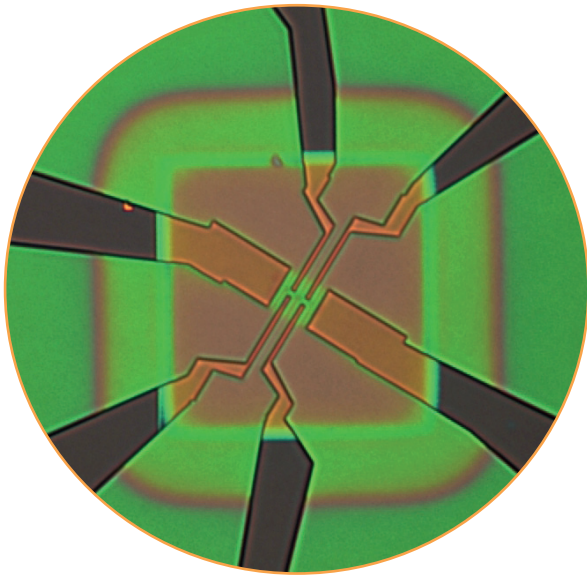
Spintronics, **ESONN'15**, European School on Nanosciences & Nanotechnologies, Grenoble, France, September 2015, S. O. Valenzuela (Invited)

Sources of Spin Currents, **2015 European School on Magnetism: From basic magnetic concepts to spin currents**, Cluj, Romania ESM, 24/08 - 04/09/2015, S. O. Valenzuela (Invited)

Inelastic electronic transport in single-layer graphene and at the surface of topological insulator Bi_2Se_3 , **VAS15, The 15th International Conference on Vibrations at Surfaces**, San Sebastian, Spain, 24/06/2015, S. O. Valenzuela (Invited)

Challenges for spin transport and manipulation in graphene, **XXII International Summer School "Nicolás Cabrera"**, New directions in Spintronics and Magnetism, Madrid, 11-16/07/2015, S. O. Valenzuela (Invited)

Spin and hot electron transport in graphene devices, **International Workshop on Organic and Graphene Electronics and Spintronics**, Barcelona, 12/03/2015, S. O. Valenzuela (Invited)



Inelastic electronic transport in single-layer graphene and at the surface of topological insulator Bi_2Se_3 , **Singapore-Spain workshop on Two-dimensional Materials**, Bellaterra, March 2015, S. O. Valenzuela (Invited)

Spin Pumping and Magnon Drag Effect, International Conference on Magnetism 2015, Barcelona, Spain, July 2015, M. V. Costache (Invited)

Spin Caloritronics, **XXII International Summer School "Nicolás Cabrera"**, New directions in Spintronics and Magnetism,, Madrid, 11-16/07/2015, M. V. Costache (Invited)

Spin Relaxation in Graphene, **IMEC, Leuven**, Belgium, 03/08/2015, Bart Raes (Invited)

Hot electron transport in graphene, **11th International workshop on Magnetism and Superconductivity at the Nanoscale**, Comarruga, Tarragona, 29/06 - 03/07/2015, J. F. Sierra. (invited)



BOOKS

Spin Currents, (paperback) (Oxford University Press, UK)
Editors: S. Maekawa, S.O. Valenzuela, E. Saitoh and T. Kimura (2015).
ISBN10: 0198744242
ISBN13: 9780198744245

Topological Insulators: Fundamentals and Perspectives, (Wiley), F Ortmann, S. Roche, S. O. Valenzuela
Editors: F. Ortmann, S. Roche, S. O. Valenzuela (2015)
ISBN: 978-3-527-33702-6



AWARDS

Dr Marius V. Costache awarded with the **IUPAP Young Scientist Medals in the field of magnetism** presented every three years, at the International Conference on Magnetism. One medal is awarded for theoretical/computational work and one other for experimental work.

A committee composed of the members of the IUPAP Magnetism Committee (C9), together with past recipients of the Magnetism Award decided the awards.

<http://www.icm2015.org/awards.html>

More information:

<http://nanodevices.icn2.cat/>

Supramolecular NanoChemistry and Materials Group

Main Research Lines

- Nanoporous Metal-Organic Frameworks and related nanoparticles
- Micro- and nano-encapsulation technologies towards the design of new multifunctional nanocarriers



GROUP MEMBERS

Albalad Alcalá, Jorge, Doctoral Student

Aríñez Soriano, Javier, Visiting Doctoral Student

Avci, Civan, Doctoral Student

Ayala Hernández, Abraham, Visiting Doctoral Student

Bellino, Martín Gonzalo, Visiting Postdoctoral Researcher

Burneo, Ivan Patricio, Doctoral Student

Çamur, Ceren, Doctoral Student

Cano Sarabia, Antonia, Senior Postdoctoral Researcher

Carbonell, Carlos, Laboratory Engineer

Cardona, Conrad, Visiting Student

Chocarro Ruiz, Blanca, SO Doctoral Student

Cruz, Jorge, Visiting Postdoctoral Researcher

Espín Marti, Jordi, Doctoral Student

Evangelio, María Emilia, Postdoctoral Researcher

Fernández De Retana, Sofía, Visiting Doctoral Student



GROUP LEADER



Born in l'Escala (Girona) in 1976. He graduated in chemistry at the Universitat de Girona and obtained his PhD in Materials Science at the Universitat Autònoma de Barcelona & Institut de Ciència de Materials de Barcelona. He then moved to Northwestern University, where he worked as a postdoctoral fellow in the group of professor Chad A. Mirkin.

ICREA Prof Daniel Maspoch



García Jimeno, Sonia, Postdoctoral Researcher
Garzón Tovar, Luís Carlos, Doctoral Student
Guasch, Elba, Visiting Student
Guillerm, Vincent, Postdoctoral Researcher
Imaz Gabilondo, Inhar, Senior Researcher
Maspoch Comamala, Daniel, ICREA Research Professor and Group Leader
Mejías Ruiz, Nereida, Postdoctoral Researcher
Municoy, Sofia, Visiting Doctoral Student
Murillo Cremaes, Nerea, Specialist Technician
Negi, Divya, Visiting Student

Pérez Carvajal, Javier, Postdoctoral Researcher
Revuelta, Mariana Valeria, Visiting Doctoral Student
Ríos Font, Raquel, Scientific Project Manager
Rodríguez Hermida, Sabina, Postdoctoral Researcher
Ruyra, Àngels, Doctoral Student
Safarifard, Vahid, Visiting Doctoral Student
Tan, Fangchang, Visiting Doctoral Student
Vignatti Abellán, Claudia, Doctoral Student
Xu, Heng, Doctoral Student
Yazdi, Amirali, SO Doctoral Student

He moved back to the Institut Català de Nanotecnologia (ICN), now ICN2, thanks to a *Ramón y Cajal* contract, and he founded the *Supramolecular NanoChemistry & Materials Group*. Since September 2011, he has been ICREA Research Professor and Group Leader at the ICN2, and in 2014 he was awarded European Research Council (ERC) Consolidator Grant.

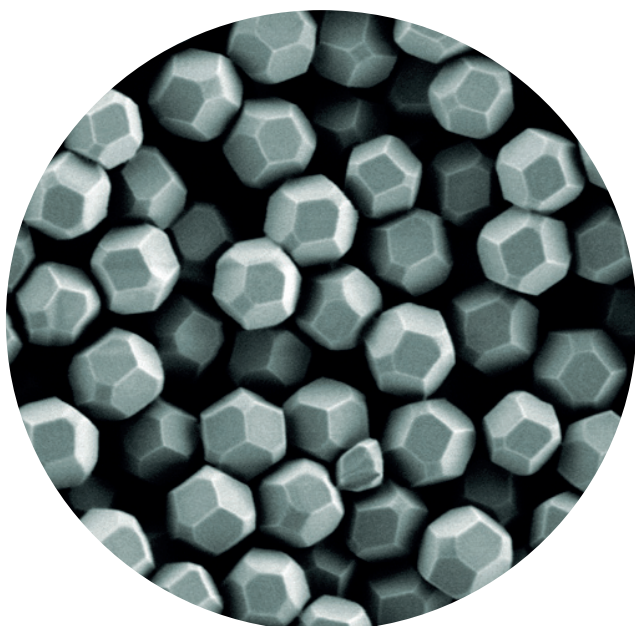
Prof Maspoch has authored 80 scientific publications and 5 book chapters, has filed 8 patents and established 14 contracts with private companies, including 1 patent licence agreement and 3 successful transfers of in-house technology for immediate application to consumer products.



NEW PROJECTS & MILESTONES

In 2015, NANO^{UP} Group completed two of its on-going projects ("**MOFs@bio**: Design and Synthesis of Metal-Organic Frameworks (MOFs) at the Nanoscale Regime for Advanced Biomedical Applications", a PLAN NACIONAL supported by MINECO, and "**DESPRO-CIDE**: Development of a new generation of biocide products with immediate and long-lasting effect, and capable of decreasing the transference of microorganisms", a project supported by MINECO under the INNPACTO Programme). The group also started to participate in the project "**ProDIA**: Production, control and Demonstration of structured hybrid nanoporous materials for Industrial adsorption Applications", funded in the frame of the H2020 program.

The Group has also continued its development of customised micro- and nanoencapsulation technologies for companies, working in parallel with 6 different entities. It is also worth mentioning that one of the patents filed by the group has been licensed to a company.



PUBLICATIONS

Biomimetic Replication of Microscopic Metal-Organic Framework Patterns Using Printed Protein Patterns, Liang K., Carbonell C., Styles M.J., Ricco R., Cui J., Richardson J.J., Maspoch D., Caruso F., Falcaro P., *Advanced Materials*; **27 (45)**: 7293 - 7298. 2015. 10.1002/adma.201503167.

Direct On-Surface Patterning of a Crystalline Lamellar Covalent Organic Framework Synthesized at Room Temperature, Delapeñaruigómez A., Rodríguez-San-Miguel D., Stylianou K.C., Cavallini M., Gentili D., Liscio F., Milita S., Roscioni O.M., Ruiz-González M.L., Carbonell C., Maspoch D., Mas-Ballesté R., Segura J.L., Zamora F., *Chemistry - A European Journal*; **21 (30)**: 10666 - 10670. 2015. 10.1002/chem.201501692. IF: 5.731

Engineering Homochiral Metal-Organic Frameworks by Spatially Separating 1D Chiral Metal-Peptide Ladders: Tuning the Pore Size for Enantioselective Adsorption, Stylianou K.C., Gómez L., Imaz I., Verdugo-Escamilla C., Ribas X., Maspoch D., *Chemistry - A European Journal*; 2015. 10.1002/chem.201501315. IF: 5.731

Healing damaged coatings using friction-sensitive hybrid microcapsules, García-Jimeno S., Cano-Sarabia M., Mejias N., Navarro V., Frances A.B., Maspoch D., *Journal of Materials Chemistry A*; **3 (35)**: 17966 - 17970. 2015. 10.1039/c5ta04147c.

Lanthanide-organic framework nanothermometers prepared by spray-drying, Wang Z., Ananias D., Carné-Sánchez A., Brites C.D.S., Imaz I., Maspoch D., Rocha J., Carlos L.D., *Advanced Functional Materials*; **25 (19)**: 2824 - 2830. 2015. 10.1002/adfm.201500518. IF: 11.805

Liposome-encapsulated bacteriophages for enhanced oral phage therapy against *Salmonella* spp., Colom J., Cano-Sarabia M., Otero J., Cortés P., MasPOCH D., Llagostera M. *Applied and Environmental Microbiology*; **81** (14): 4841 - 4849. 2015. 10.1128/AEM.00812-15.

Optimised room temperature, water-based synthesis of CPO-27-M metal-organic frameworks with high space-time yields, Garzón-Tovar L., Carné-Sánchez A., Carbonell C., Imaz I., MasPOCH D., *Journal of Materials Chemistry A*; **3** (41): 20819 - 20826. 2015. 10.1039/c5ta04923g. IF: 7.443

Post-Synthetic Anisotropic Wet-Chemical Etching of Colloidal Sodalite ZIF Crystals, Avci C., Ariñez-Soriano J., Carné-Sánchez A., Guillerm V., Carbonell C., Imaz I., MasPOCH D., *Angewandte Chemie - International Edition*; **54** (48): 14417 - 14421. 2015. 10.1002/anie.201507588.

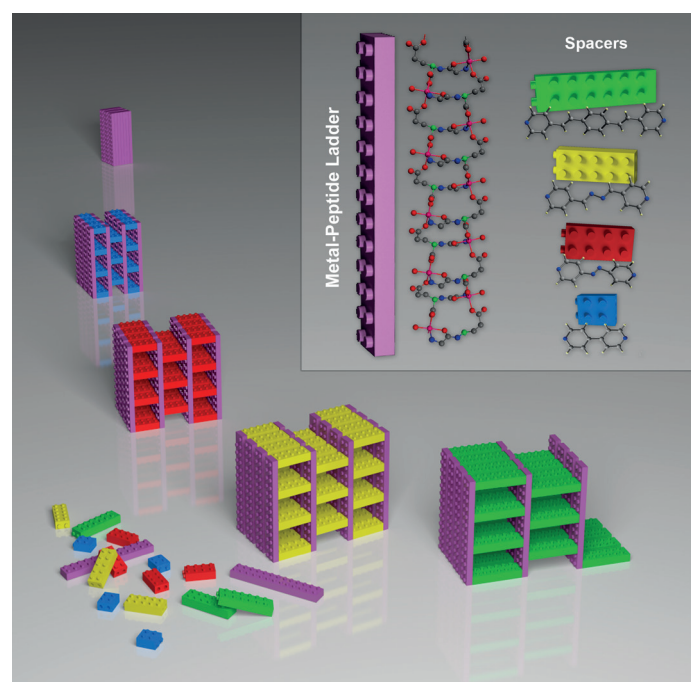
Protecting metal-organic framework crystals from hydrolytic degradation by spray-dry encapsulating them into polystyrene microspheres, Carné-Sánchez A., Stylianou K.C., Carbonell C., Naderi M., Imaz I., MasPOCH D., *Advanced Materials*; 2015. 10.1002/adma.201403827.

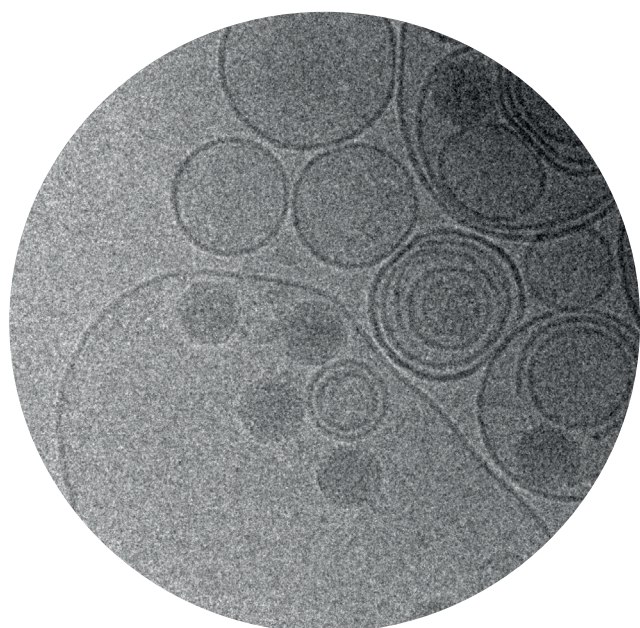
Resonant spin tunneling in randomly oriented nanospheres of Mn₁₂ acetate, Lendínez S., Zarzuela R., Tejada J., Terban M.W., Billinge S.J.L., Espin J., Imaz I., MasPOCH D., Chudnovsky E.M., *Physical Review B - Condensed Matter and Materials Physics*; **91** (2, 024404) 2015. 10.1103/PhysRevB.91.024404.

Synthesis, culture medium stability, and in vitro and in vivo zebrafish embryo toxicity of metal-organic framework nanoparticles, Ruyra A., Yazdi A., Espín J., Carné-Sánchez A., Roher N., Lorenzo J., Imaz I., MasPOCH D., *Chemistry - A European Journal*; **21** (6): 2508 - 2518. 2015. 10.1002/chem.201405380. IF: 5.731

Two New Adenine-Based Co(II) Coordination Polymers: Synthesis, Crystal Structure, Coordination Modes, and Reversible Hydrochromic Behavior, Burneo I., Stylianou K.C., Rodríguez-Hermida S., Juanhuix J., Fontrodona X., Imaz I., MasPOCH D., *Crystal Growth and Design*; **15** (7): 3182 - 3189. 2015. 10.1021/acs.cgd.5b00218. IF: 4.891

Use of autoantigen-loaded phosphatidylserine-liposomes to arrest autoimmunity in type 1 diabetes, Pujol-Autonell I., Serracant-Prat A., Cano-Sarabia M., Ampudia R.M., Rodríguez-Fernández S., Sánchez A., Izquierdo C., Stratmann T., Puig-Domingo M., MasPOCH D., Verdaguer J., Vives-Pi M., *PLoS ONE*; **10** (6, e0127057) 2015. 10.1371/journal.pone.0127057.





PROJECTS

*Multifunctional micro- and nanostructures assembled from nanoscale metal-organic frameworks and inorganic nanoparticles (InanoMOF), funded by **ERC under FP7**, 01/04/2014 - 31/03/2019, Daniel Maspoch*

*Production, control and Demonstration of structured hybrid nanoporous materials for Industrial adsorption Applications (ProDIA), funded by **EC**, 01/11/2015 - 31/10/2018, Daniel Maspoch*

*Diseño y Síntesis de Metal-Organic Frameworks Nanoscópicos para Aplicaciones Biomédicas Avanzadas - MOFs@bio, funded by **MINECO**, 1/1/2013 - 31/12/2015, Daniel Maspoch*

*SGR, funded by **AGAUR**, 01/01/2014 - 31/12/2016, Daniel Maspoch*

*Desarrollo de una nueva generación de productos biocidas con efecto inmediato, remanente y capacidad para reducir la transferencia de microorganismos - 2012 INNFACTO DM, funded by **MINECO**, 15/7/2012 - 31/12/2015, Daniel Maspoch*



CONTRIBUTIONS

*Nanoscale supramolecular materials: liposomes, metal-organic frameworks and surfaces, **V Workshop NANOUCO**, Cordoba (Spain), 06/02/2015, Daniel Maspoch (Invited)*

*Bacteriophage loaded liposomes for controlling Salmonella colonization in broilers, **NANOBIAPP 2015 (Latest Advances on Nanomaterials for Biomedical Applications)**, Barcelona (Spain), 21-23/09/2016, M. Cano-Sarabia, J. Colom, J. Otero, S. Campoy, P. Cortés, M. Llagostera, D. Maspoch (Oral)*

*Metal-Organic Frameworks for Medical Resonance Imaging, **Young Investigator EuroMOF Symposium**, Berlin (Germany), 09-10/10/2015, J. Aríñez, A. Carné-Sánchez, I. Imaz, F. Busqué, D. Maspoch (Oral)*

*Nanoscale MOFs: Synthesis, Toxicity and New Properties, **1^{er} Simposio Sobre Propiedades y Aplicaciones de MOFs y COFs**, Granada (Spain), 09-10/04/2015, I. Imaz, A. Carné-Sánchez, J. Aríñez, C. Carbonell, D. Maspoch (Oral)*

*Fagoterapia basada en nanocápsulas lipídicas de bacteriófagos, **XXV Congreso Nacional de Microbiología - SEM 2015**, Logroño (Spain), 07-10/07/2015, J. Colom, M. Cano-Sarabia, J. Otero, S. Campoy, P. Cortés, D. Maspoch, M. Llagostera (Oral + poster)*

*A new family of Zn-Metal-Organic Frameworks with amide-functionalized pores for CO₂ capture, **1st European Conference on Metal Organic Frameworks and Porous Polymers (EuroMOF 2015)**, Potsdam (Germany), 11-14/10/2015, V. Safarifard, M. Bidgeli, A. Morsali, S. Rodríguez-Hermida, C. Carbonell, V. Guillerm, I. Imaz, D. Maspoch (Poster)*

Bacteriophage loaded liposomes for controlling Salmonella colonization in broilers, **CRS (Controlled Release Society) Annual Meeting & Exposition**, Edinburgh (Scotland), 25-27/07/2015, M. Cano-Sarabia, J. Colom, J. Otero, S. Campoy, P. Cortés, M. Llagostera, D. Maspoch (Poster)

Design and synthesis of submicron diagnostic systems based on metal-organic frameworks, **Fourth International Conference on Hybrid Materials**, Sitges, Spain, 09-13/03/2015, J. Ariñez, I. Imaz, D. Maspoch (Poster)

Liposome-based immunotherapy to arrest autoimmunity in type 1 diabetes, **Immunology of Diabetes Society 14th International Congress**, Munich (Germany), 12-16/04/2015, I. Pujol-Autonell, S. Rodríguez-Fernández, M. Cano-Sarabia, R. M. Ampudia, A. Lucas, D. Maspoch, J. Verdaguer, M. Vives-Pi (poster)

Novel carborane-based dipyridine linkers for Metal-Organic Frameworks, **1st European Conference on Metal Organic Frameworks and Porous Polymers (EuroMOF 2015)**, Potsdam (Germany), 11-14/10/2015, M. Tsang, F. Teixidor, C. Viñas, J. Giner-Planas, D. Choquesillo-Lazarte, C. Verdugo-Escamilla, K. Stylianou, S. Rodríguez-Hermida, I. Imaz, D. Maspoch (Poster)

Synthesis, Culture Medium Stability, and in vitro and in vivo Zebrafish Embryo Toxicity of Metal-Organic Framework Nanoparticles, **1st European Conference on Metal Organic Frameworks and Porous Polymers (EuroMOF 2015)**, Potsdam (Germany), 11-14/10/2015, J. Espín, À. Ruyra, A. Yazdi, A. Carné-Sánchez, N. Roher, J. Lorenzo, I. Imaz, D. Maspoch (Poster)

Synthesis and selective surface functionalization of MOF composites, **1^{er} Simposio Sobre Propiedades y Aplicaciones de MOFs y COFs**, Granada (Spain), 09-10/04/2015, A. Ayala, I. Imaz, D. Maspoch (Poster)

Synthesis of MOFs superstructures and advanced MOF-based composites by spray-drying technique, **Fourth International Conference on Hybrid Materials**, Sitges, Spain, 09-13/03/2015, L. Garzón-Tovar, I. Imaz, D. Maspoch (Poster)

The influence of the enantiomeric ratio of an organic ligand on the structure and chirality of metal-organic frameworks, **Fourth International Conference on Hybrid Materials**, Sitges, Spain, 09-13/03/2015, I. Burneo, I. Imaz, D. Maspoch (Poster)



AWARDS

III Marcial Moreno Mañas Lectureship Award (2015)

<http://www.rseq.org/blog/generales/item/926-concesión-del-premio-marcial-moreno-mañas-lectureship-2015>



TECHNOLOGY TRANSFER

1 patent licence agreement

1 patent filed (*Biocidal composition with dual immediate and remnant activity - PCT*)

More information:

<http://www.nanoup.org/>

Theoretical and Computational Nanoscience Group

Main Research Lines

- Leading-edge theoretical research on quantum transport phenomena in Graphene
- Spin dynamics in Dirac Matter (graphene, topological insulators)
- Thermal properties and Thermoelectricity in two-dimensional Materials
- Predictive Modelling and Multiscale numerical simulation of complex nanomaterials and quantum nanodevices



GROUP MEMBERS

Barrios Vargas, José Eduardo, Postdoctoral Researcher

Cummings, Aron William, Postdoctoral Researcher

Dinh, Van Tuan, Postdoctoral Researcher

Gregersen, Soren Schou, Visiting Doctoral Student

Hummel, Stefan, Visiting Senior Researcher

Kotakoski, Jani, Visiting Senior Researcher

Leconte, Nicolas, Postdoctoral Researcher

Roche, Stephan, ICREA Research Professor and Group Leader

Settnes, Mikkel, Visiting Doctoral Student

Song, Kenan, SO Doctoral Student

Soriano Hernández, David, Senior Postdoctoral Researcher



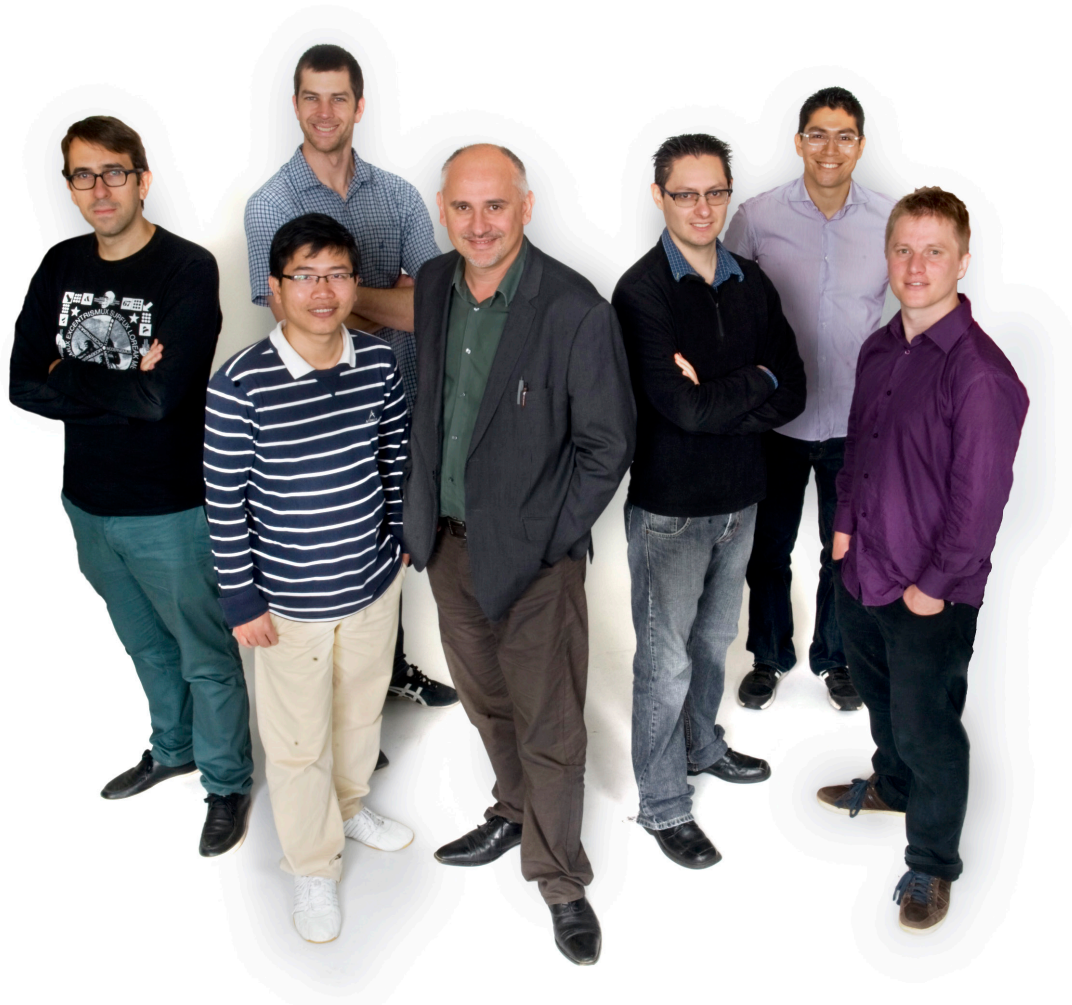
GROUP LEADER



ICREA Prof Stephan Roche

Prof Stephan Roche is a theoretician with more than twenty years of experience in the study of transport theory of low-dimensional systems, including graphene, carbon nanotubes, semiconducting nanowires, organic materials and topological insulators.

He has published more than 150 papers in journals such as *Review of Modern Physics*, *Nature Physics*, *Nano Lett.* and *Phys. Rev. Lett.* (40 papers) and he is the co-author



NEW PROJECTS & MILESTONES

1) The publication of the Spintronic roadmap for graphene and 2D Materials.

We have reviewed current challenges and perspectives in graphene spintronics, which is one of the most promising directions of innovation, given its room-temperature long-spin lifetimes and the ability of graphene

to be easily interfaced with other classes of materials (ferromagnets, magnetic insulators, semiconductors, oxides, etc), allowing proximity effects to be harvested. This work is the result of the first two-years of active research conducted within the Graphene Spintronics Work Package consortium within the Graphene Flagship project, and co-supervised by ICN2 and University of Gröningen. Based on such

of the recently published book on “Introduction to Graphene-Based Nanomaterials: From Electronic Structure to Quantum Transport” (Cambridge University Press 2014). He received the Authorisation to conduct PhD projects in 2004 at the University Joseph-Fourier (Grenoble, France), and since then he has supervised 5 PhD students and more than a dozen postdoctoral researchers in France, Germany and Spain. S. Roche has been awarded the prestigious Friedrich Wilhelm Bessel prize by the Alexander Von-Humboldt Foundation (Germany), and finally, since 2011, he has been actively involved in the Graphene Flagship project, currently as a co-leader of the Graphene spintronics workpackage.

progress, which establishes the state of the art, several novel opportunities for spin manipulation such as the generation of pure spin current (through spin Hall effect) and the control of magnetization through the spin torque phenomena are already seen in the horizon. Practical applications are within reach, but will require the demonstration of wafer-scale graphene device integration, and the realization of functional prototypes employed for determined applications such as magnetic sensors or nano-oscillators. This is the ambition of the new research phase which has started in April 2016.

2) Efficient linear scaling approach for computing the Kubo Hall conductivity.

We have developed an order-N approach to compute the Kubo Hall conductivity for disordered two-dimensional systems reaching tens of millions of orbitals, and realistic values of the applied external magnetic fields (as low as a few Tesla). A time-evolution scheme is employed to evaluate the Hall conductivity σ_{xy} using a wave-packet propagation method and a continued fraction expansion for the computation of diagonal and off-diagonal matrix elements of the Green functions. The validity of the method is demonstrated by comparison of results with brute-force diagonalization of the Kubo formula, using (disordered) graphene as the system of study. This approach to mesoscopic system sizes is opening an unprecedented perspective for so-called reverse engineering in which the available experimental transport data are used to get a deeper understanding of the microscopic structure of the samples. Besides, this will not only allow addressing subtle issues in terms of resistance standardization of large-scale materials (such as wafer scale polycrystalline graphene), but will also enable the discovery of new quantum transport phenomena in complex two-dimensional materials, out of reach with classical methods. The results were published in *Physical Review B*.

3) Spin transport in hydrogenated graphene.

We have presented the multifaceted problem of spin transport in hydrogenated graphene from a theoretical perspective in *2D Materials* journal. The current experimental findings suggest that hydrogenation can either increase or decrease spin lifetimes, which calls for clarification. We first discuss the spin-orbit coupling induced by local sigma-pi re-hybridization and sp^3 C-H defect formation together with the formation of a local magnetic moment. First-principles calculations of hydrogenated graphene unravel the strong interplay of spin-orbit and exchange couplings. The concept of magnetic scattering resonances has been revisited by describing the local magnetism through the self-consistent Hubbard model in the mean field approximation in the dilute limit, while spin relaxation lengths and transport times are computed using an efficient real space order N wavepacket propagation method. Typical spin lifetimes on the order of 1 ns are obtained for 1 ppm of hydrogen impurities (corresponding to a transport time of about 50 ps), and the scaling of spin lifetimes with impurity density is described by the Elliott-Yafet mechanism. This reinforces the statement that local defect-induced magnetism can be at the origin of the substantial spin polarization loss in the clean graphene limit.

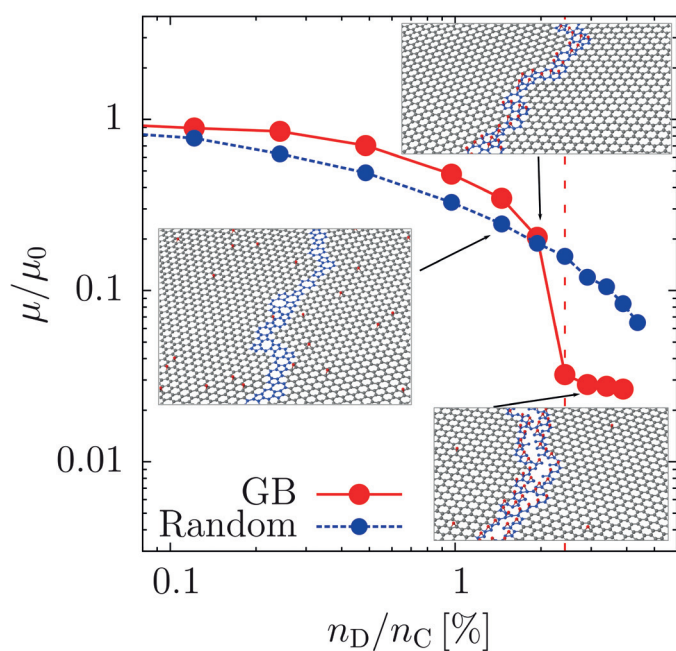


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Role of grain boundaries in tailoring electronic properties of polycrystalline graphene by chemical functionalization, Seifert M., Vargas J.E.B., Bobinger M., Sachsenhauser M., Cummings A.W., Roche S., Garrido J.A., *2D Materials*; **2** (2, 024008) 2015. 10.1088/2053-1583/2/2/024008.

Science and technology roadmap for graphene, related two-dimensional crystals, and hybrid systems, Ferrari A.C., Bonaccorso F., Fal'ko V., Novoselov K.S., Roche S., Bøggild P., Borini S., Koppens F.H.L., Palermo V., Pugno N., Garrido J.A., Sordan R., Bianco A., Ballerini L., Prato M., Lidorikis E., Kivioja J., Marinelli C., Ryhänen T., Morpurgo A., Coleman J.N., Nicolosi V., Colombo L., Fert A., Garcia-Hernandez M., Bachtold A., Schneider G.F., Guinea F., Dekker C., Barbone M., Sun Z., Galiotis C., Grigorenko A.N., Konstantatos G., Kis A., Katsnelson M., Vandersypen L., Loiseau A., Morandi V., Neumaier D., Treossi E., Pellegrini V., Polini M., Tredicucci A., Williams G.M., Hee Hong B., Ahn J.-H., Min Kim J., Zirath H., Van Wees B.J., Van Der Zant H., Occhipinti L., Di Matteo A., Kinloch I.A., Seyller T., Quesnel E., Feng X., Teo K., Rupasinghe N., Hakonen P., Neil S.R.T., Tannock Q., Löfwander T., Kinaret J., *Nanoscale*; **7** (11): 4598 - 4810. 2015. 10.1039/c4nr01600a. IF: 7.394



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Objectives, Roche S, Åkerman J, Beschoten B, Charlier J-C, Chshiev M, Prasad Dash S, Dlubak B, Fabian J, Fert A, Guimarães M, Guinea F, Grigorieva I, Schönenberger C, Seneor P, Stampfer C, Valenzuela SO, Waintal X & van Wees B 2015, *2D Materials*; **2**, 030202.



PROJECTS

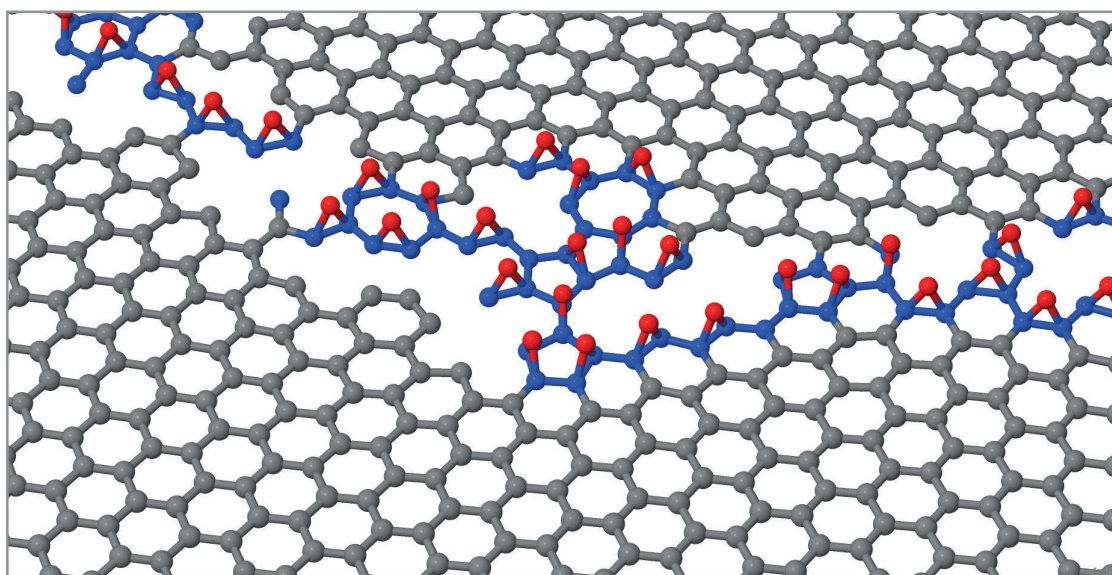
Graphene-Based Revolutions in ICT And Beyond, funded by **EC**, 01/10/13 - 31/03/2016, Stephan Roche

SGR, funded by **AGAUR**, 01/01/2014 - 31/12/2016, Stephan Roche

Simulación Multi-escala de transporte cuántico en grafeno y aislantes topológicos, funded by **MINECO**, 01/01/2013 - 31/12/2015, Stephan Roche

Multiscale simulation of charge transport properties in polycrystalline graphene - 2012 SAMSUNG SR, funded by **SAMSUNG**, 01/03/2014 - 28/02/2015, Stephan Roche

ICREA Workshop on Graphene Nanobiosensors, funded by **ICREA**, 01/08/2014 - 31/12/2015, Stephan Roche





CONTRIBUTIONS

Charge transport in polycrystalline graphene, **CNR**, Bologna, Italia, 14/09/2015, Stephan Roche (Invited)

Understanding Charge and Spin Transport in Graphene-based Materials: From Concepts to Applications, **European Conference on Surface Science (ECOSS-31)**, Sevilla, Spain, 01/09/2015, Stephan Roche (Invited)

Spin Dynamics in graphene, **CARBONHAGEN 2015**, Copenhagen, Denmark, 13/08/2015, Stephan Roche (Invited)

Charge and Spin transport in graphene based devices, **IEEE NANO 2015, 15th International Conference on Nanotechnology**, Rome, Italy, 27/07/2015, Stephan Roche (Invited)

Spin-orbit interaction and spin dynamics in Dirac Matter, **Interaction effects in graphene and related materials**, San Sebastián, Spain, 13/07/2015, Stephan Roche (Invited)

Charge and Spin Transport in Graphene-based Materials: From Concepts to Applications, **KIT**, Germany, 10/06/2015, Stephan Roche (Invited)

Charge Transport in 2D Materials, **NEST-Scuola Normale Superiore di Pisa**, Pisa, Italy, 30/03/2015, Stephan Roche (Invited)

Transport theory of two-dimensional Materials, **Chalmers University of Technology**, Sweden, 19/02/2015, Stephan Roche (Invited)

On-surface engineering of upstanding ferrocene-based molecules, **New Trends in Topological Insulators 2015 (NTTI2015)**, San Sebastián, Spain, July 2015, K. Song, R. Robles, D. Soriano, S. Roche (Poster)

More information:

<http://www.icrea.cat/Web/ScientificStaff/Stephan-Roche-523>

Theory and Simulation Group

Main Research Lines

- Development of theoretical methods, numerical algorithms and simulation tools
- Codes: SIESTA & TRANSIESTA
- First Principles simulations at the nanoscale
- Novel physical properties in 2D materials



GROUP MEMBERS

Alonso Pruneda, José Miguel, CSIC Tenured Scientist

Boskovic, Desanka, Visiting Doctoral Student

Colombo, Luciano, Visiting Professor

Cuadrado Del Burgo, Ramón, Postdoctoral Researcher

Guster, Ionel-Bogdan, Doctoral Student

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Migani, Annapaola, CSIC Ramón y Cajal Researcher

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Ruperez, Rubén, Visiting Student

Silva, José Angel, Doctoral Student

Song, Kenan, Severo Ochoa Doctoral Student



GROUP LEADER



CSIC Research Prof
Pablo Ordejón

Prof Ordejón earned his BSc in Physics (1987) and PhD in Science (1992) at the Universidad Autónoma de Madrid (Spain). He worked as a postdoctoral researcher at the University of Illinois at Urbana-Champaign (USA) from 1992 to 1995, and as Assistant Professor at the Universidad de Oviedo from 1995 to 1999. In 1999, he obtained a research staff position at the Institut de Ciència de Materials de Barcelona of the Consejo Superior de Investigaciones Científicas (CSIC). In 2007 he moved, as leader of the Theory and Simulation research Group, to CIN2 (now ICN2), where he is currently CSIC Research Profesor. Since July 2012, he has served as Director of ICN2.



He has published more than 190 scientific articles, which have received over 20,000 citations ($h = 51$). Since 2009 he has served as Co-Editor of EPL (formerly *Euro Physics Letters*) and since 2004, as Regional Editor of *Physica status solidi*. He was in charge of the Condensed Matter Physics area of the Physics Panel of the Spanish National Scientific Evaluation Agency (ANEP), from 2003 to 2006, and the Head of the Physics and Engineering Panel of the Access Committee to the Spanish Supercomputing Network, from 2005 to 2011. He became a Fellow of the American Physical Society in 2005.

His research is focused on the development of efficient methods for electronic structure calculations in large and complex systems, with contributions to the development of techniques for large-scale atomistic simulations based on first principles methods such as SIESTA. He has also been involved in the study of the fundamental properties of materials at the atomistic level. His current interests include, among many others, electronic transport in nanoscale devices and electronic processes at surfaces and 2D materials. He maintains frequent collaborations with industrial laboratories on the simulation of materials processes at the atomic level. He is co-founder of the spin-off company SIMUNE.



NEW PROJECTS & MILESTONES

One of the highlights of 2015 has been the birth of the **MaX** Center (www.max-center.eu), one of the eight 'European Centers of Excellence for HPC applications' supported by the EU under its H2020 e-INFRA-2015 call. MaX supports developers and end users of advanced applications for materials simulations, design and discovery, and works at the frontiers of the current and future High Performance Computing (HPC) technologies. It gathers leading developers and users of materials applications, together with top experts in HPC. It is based on the collaboration of 13 teams, including 5 research teams, like the ICN2 *Theory and Simulation Group*, that will focus on enhancing the capabilities of the SIESTA package, and develop new methodologies for industrial applications of simulation tools in materials science.

The group also has a leading role in NFFA-Europe (www.nffa.eu), a project funded by the EU H2020- INFRAIA-2014-2015 call "Integrating and opening existing national and regional research infrastructures of European interest". NFFA (Nanoscience Foundries and Fine Analysis) is a platform for interdisciplinary research at the nanoscale, in which the *Theory and Simulation Group* participates as an "installation" that offers access computational support to experimental users' projects.

On the scientific side, during 2015 we have pushed two new important research lines in the group:

Thermal transport at the nanoscale:

Taking advantage of the expertise of visiting Professor Colombo on thermal transport at the nanoscale, and coordinated with theoretical and experimental collaborators, the group has moved forward in this exciting topic, by developing new tools and methodologies. In particular, we are exploring the thermal transport properties of 2D materials, which have revealed

unusual behaviors (as compared to bulk systems), leading to unexpected intriguing features of large potential impact in several front-edge or emerging nanotechnologies (e.g. heat management in nanodevices, thermoelectric energy conversion, or manipulation of lattice heat to engineer phononic devices).

Magnetic properties at the nanoscale,

with new developments in SIESTA that make possible the study of systems with strong spin-orbit effects (including topological insulators), and the study of magnetic anisotropies in thin films and other nanostructured materials. We have used the working versions in the study of hybrid organic-inorganic perovskites and topological insulators. Both materials are very promising in the development of spin-based applications, which are of great interest within the institute.

With respect of previously existing research lines, we have made strong advances on:

Understanding the properties in 2D

materials: vertical stacks of transition metal dichalcogenides, grain boundaries and 1D polar discontinuities, graphene-based devices for DNA sequencing, and insights in the superconducting transition from STM experiments, are examples of our activity in 2D materials during 2015.

Theoretical modelling of photocatalysis:

Heterogeneous photocatalysis has an important impact in many fields, like solar energy, the production of fuels and chemicals, and environmental remediation. We use many-body quasiparticle GW calculations to compute the level alignment of the adsorbate and substrate levels of prototypical photocatalytic interfaces (water, methanol, catechol on rutile or anatase TiO₂). We have shown that our calculations provide a quantitative in-depth interpretation of ultraviolet photoemission spectroscopy (UPS) and two-photon photoemission (2PP) spectroscopy experiments.



Assembly of ferrocene molecules on metal surfaces revisited, Ormaza M., Abufager P., Bachellier N., Robles R., Verot M., Le Bahers T., Bocquet M.-L., Lorente N., Limot L., *Journal of Physical Chemistry Letters*; **6 (3)**: 395 - 400. 2015. 10.1021/jz5026118. IF: 7.458

Capacitive DNA Detection Driven by Electronic Charge Fluctuations in a Graphene Nanopore, Feliciano G.T., Sanz-Navarro C., Coutinho-Neto M.D., Ordejón P., Scheicher R.H., Rocha A.R., *Physical Review Applied*; **3 (3)**, 034003) 2015. 10.1103/PhysRevApplied.3.034003.

Comparing Quasiparticle H₂O Level Alignment on Anatase and Rutile TiO₂, Sun H., Mowbray D.J., Migani A., Zhao J., Petek H., Rubio A., *ACS Catalysis*; **5 (7)**: 4242 - 4254. 2015. 10.1021/acscatal.5b00529.

Electromechanical response at polar zigzag boundaries in hybrid monolayers, Martinez-Gordillo R., Pruneda M., *Physical Review B - Condensed Matter and Materials Physics*; **91 (4)**, 045411) 2015. 10.1103/PhysRevB.91.045411. IF: 3.736

FeCoCp₃ Molecular Magnets as Spin Filters, Abufager P.N., Robles R., Lorente N., *Journal of Physical Chemistry C*; **119 (22)**: 12119 - 12129. 2015. 10.1021/acs.jpcc.5b01839. IF: 4.772

Polar discontinuities and 1D interfaces in monolayered materials, Martinez-Gordillo R., Pruneda M., *Progress in Surface Science*; **90 (4)**: 444 - 463. 2015. 10.1016/j.progsurf.2015.08.001. IF: 5.696

Quasiparticle interfacial level alignment of highly hybridized frontier levels: H₂O on TiO₂(110), Migani A., Mowbray D.J., Zhao J., Petek H., *Journal of Chemical Theory and Computation*; **11 (1)**: 239 - 251. 2015. 10.1021/ct500779s. IF: 5.498

Quasiparticle spectra of 2H-NbSe₂: Two-band superconductivity and the role of tunneling selectivity, Noat Y., Silva-Guillén J.A., Cren T., Cherkez V., Brun C., Pons S., Debontridder F., Roditchev D., Sacks W., Cario L., Ordejón P., García A., Canadell E., *Physical Review B - Condensed Matter and Materials Physics*; **92 (13)**, 134510) 2015. 10.1103/PhysRevB.92.134510. IF: 3.736

Rashba and Dresselhaus Effects in Hybrid Organic-Inorganic Perovskites: From Basics to Devices, Kepenekian M., Robles R., Katan C., Saponi D., Pedesseau L., Even J., *ACS Nano*; **9 (12)**: 11557 - 11567. 2015. 10.1021/acsnano.5b04409. IF: 12.881

Tunneling and electronic structure of the two-gap superconductor MgB₂, Silva-Guillén J.A., Noat Y., Cren T., Sacks W., Canadell E., Ordejón P., *Physical Review B - Condensed Matter and Materials Physics*; **92 (6)**, 064514) 2015. 10.1103/PhysRevB.92.064514. IF: 3.736

Using G₀W₀ Level Alignment to Identify Catechol's Structure on TiO₂(110), Mowbray D.J., Migani A., *Journal of Physical Chemistry C*; **119 (34)**: 19634 - 19641. 2015. 10.1021/acs.jpcc.5b05392. IF: 4.772



PROJECTS

Simulaciones Atomísticas de Primeros Principios: Metodología y Aplicaciones en Nanociencia, funded by **MINECO**, 01/01/2013 - 31/12/2015, Pablo Ordejón

Materials at the eXascale, funded by **H2020-EINFRA-2015: "Centers of Excellence for Supercomputing Applications"**, 01/09/2015 - 28/02/2018, Pablo Ordejón

Nanoscience Foundries for Fine Analysis - Europe, funded by **INFRAIA-1-2014-2015: "Integrating and opening existing national and regional research infrastructures of European interest"**, 01/09/2015 - 31/08/2019, Pablo Ordejón

SGR - Laboratori d'estructura electrònica de materials, funded by **AGAUR**, 01/01/2014 - 31/12/2016, Enric Canadell



CONTRIBUTIONS

Density Functional Theory Simulations using the SIESTA Method, **Euro-TMCS - Theory Modeling and Computational Methods for Semiconductors**, Granada, Spain, 28-30/01/2015, Pablo Ordejón (Invited)

Polar discontinuities at grain boundaries in 2D materials, **ECOSS-31, European Conference on Surface Science**, Barcelona, Spain, 31/08-04/09/2015, M. Pruneda. (Invited)

Simulation of electronic transport in nanostructures, **The Seidman Family Lecture Series**, University of Tel Aviv (Israel), June 2015, Pablo Ordejón (Invited)

Understanding optical activity in ligand-protected noble metal nanoparticles: intrinsic and geometric chirality, **11th International Conference on Optics of Surfaces and Interfaces (OSI-11)**, Austin, Texas, USA, 28/06-03/07/2015, F. Hidalgo (Invited)

Using localized orbitals to describe electronic structure and quantum transport in two-dimensional materials, **9th International Conference of Computational Physics**, Singapur, 09/01/2015, Pablo Ordejón (Invited)

Using localized orbitals to describe electronic structure and quantum transport in two-dimensional materials, **Workshop on "Advanced Modeling of Materials: Farewell to Prof. M. Mareschal"**, ZCAM, Zaragoza, Spain, June 2015, Pablo Ordejón (Invited)

Advanced modeling of heterogeneous photocatalysis: from ground-state quasiparticle level alignment to photoreaction mechanism, **PACIFICHEM, The International Chemical Congress of Pacific Basin Societies 2015**, Honolulu, Estados Unidos, 15-20/12/2015, A. Migani (Contributed talk)

Identifying distinctive electronic features of terminal and bridging hydroxyl groups of dissociated H₂O on TiO₂(110), **ECOSS-31, European Conference on Surface Science**, Barcelona, Spain, 31/08-04/09/2015, A. Migani (Contributed talk)

On-surface engineering of upstanding ferrocene-based molecules, **ECOSS-31, European Conference on Surface Science**, Barcelona, Spain, 31/08-04/09/2015, Nicolas Bachellier, Maider Ormaza, Paula Abufager, Roberto Robles, Martin Vérot, Tangui Le Bahers, Marie-Laure Bocquet, Nicolás Lorente, Laurent Limot (Contributed talk)

Metallocene adsorption and customization on copper, **DPG Spring Meeting**, Berlín, Germany, March 2015, Nicolas Bachellier, Maider Ormaza, Paula Abufager, Roberto Robles, Martin Vérot, Tangui Le Bahers, Marie-Laure Bocquet, Nicolás Lorente, Laurent Limot (Oral)

Probing the magnetic properties of Cr atoms adsorbed on copper nitride, **DPG Spring Meeting**, Berlín, Germany, March 2015, Zsolt Majzik, Roberto Robles, Carmen Rubio-Verdú, Martina Corso, Nicolás Lorente, Nacho Pascual (Oral)

First-principles calculations of electronic and optical properties of multilayer WS₂, **11th International Conference on Optics of Surfaces and Interfaces (OSI-11)**, Austin, Texas, USA, 28/06-03/07/2015, F. Hidalgo, P. Ordejón, J. M. Pruneda, J. A. Silva-Guillen (Poster)

Lindhard response of low dimensional materials, **Psi-k 2015 Conference**, San Sebastian, Spain, September 2015, Ionel Bogdan Guster, Desanka Boskovic, Enric Canadell, Miguel Pruneda, Pablo Ordejón (Poster)

Linear Response with DFPT in SIESTA, **Psi-k 2015 Conference**, San Sebastian, Spain, September 2015, Lorenzo Riches, Javier Junquera, Alberto García, Pablo Ordejón, Miguel Pruneda (Poster)

Magnetic anisotropy of $Fe_{1-y}X_yPt-L1(0)$ [$X=Cr,Mn,Co,Ni,Cu$] bulk alloys, **ICM 2015**, Barcelona, Spain, 06/06/2015, Ramón Cuadrado (Poster)

Polar 1D interfaces in monolayered materials, **Psi-k 2015 Conference**, San Sebastian, Spain, September 2015, M. Pruneda (Poster)



BOOKS

Spin Currents, (paperback) (Oxford

“Evaluation of Leakage Current in 1-D Silicon Dangling-Bond Wire Due to Dopants”, R. Robles, M. Kepenekian, N. Lorente, in *“Nanopackaging: From Nanomaterials to the Atomic Scale”*, edited by X. Baillin, C. Joachim, G. Poupon (Springer, Cham, 2015), p.33



COURSES

Miguel Pruneda: “Simulation of Nanometric Systems”, **4th year Bachelor’s Degree in Nanotechnology**, Universitat Autònoma de Barcelona.)



THESES

Doctorand: **José A. Silva**

Title: Theoretical study of the electronic properties of 2D materials

Date: 01/07/2015

Director: Prof Pablo Ordejón/Prof Enric Canadell



TECHNOLOGY TRANSFER

Prof Pablo Ordejón is one of the founders and member of the Board of Experts of SIMUNE ATOMISTICS, S.L., a spin-off company offering atomistic simulation services for industrial, academic and research costumers working with materials. SIMUNE is based at the nanoGUNE facilities in San Sebastian (Spain), and started its activities in early 2015.

Technical Development and Support

The research support divisions and core facilities, led by Dr Gustavo Ceballos, constitute a centralized research support infrastructure that allow research scientist shared access to sophisticated and expensive instruments, technologies and specialized services and expertise. It aims to offer, for the research groups within the ICN2 and neighbouring research institutions, a collaborative platform and a repository of expertise and know-how to develop new methods, materials, instruments and techniques. A highly qualified multidisciplinary team of experts support activities within research facilities providing expertise that may be lacking in research laboratories and fostering collaborations between investigators as well as inter-disciplinary research.



RESEARCH SUPPORT DIVISIONS

The Research Support divisions are small groups led by scientists that combine service and technical support with scientific expertise in strategic areas.

- > Nanoscience Instrument Development Division
- > Electron Microscopy Division
- > Nanomaterials Growth Division

RESEARCH SUPPORT FACILITIES

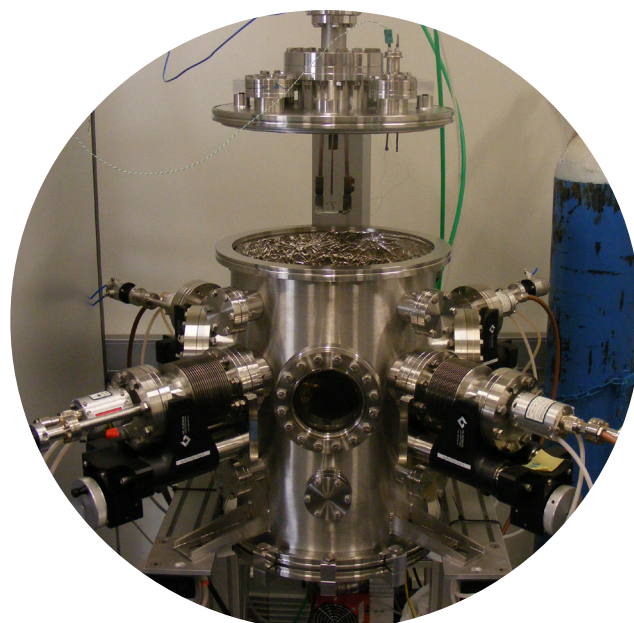
- > Nanofabrication Facility
- > Instrumental Core Research Facilities
- > Technical Facilities – Mechanical Workshop

Nanoscience Instrument Development Division

Main Research Lines

- Design, development and improvement of advanced precision Instrumentation
- Active collaboration for experimental research
- Scientific Computing, signal processing, data acquisition 3D-CAD design of precision devices

The Nanoscience Instrument Development Division was formed in 2010 and focuses on the design, development, improvement and deployment of advanced state-of-the-art instruments for nanoscience and nanotechnology. The main aim is the creation of an integrated scientific and technical platform with a highly qualified multidisciplinary team capable of addressing challenging instrumental projects both for basic nanoscience research as well as for nanotechnological applications.



DIVISION LEADER



Dr Gustavo Ceballos

Dr Gustavo Ceballos earned his BSc in Chemistry at the Central University of Venezuela in 1989. He obtained his PhD in 1996 at the Institut für Physikalische und Theoretische Chemie der Universität Bonn, Germany. In 1997 he moved to the Institut für Experimentalphysik der Freie Universität Berlin for postdoctoral studies, and from 2001 to 2002, worked at the Low-Temperature Scanning Tunnelling Microscopy (STM) Group at the Fritz-Haber-Institut der Max-



DIVISION MEMBERS

Gustavo Ceballos, Head of Scientific Technical
Research Support

Marc Maymó, Research Engineer



NEW PROJECTS & MILESTONES

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 in applied technology.



PUBLICATIONS

Substrate-induced stabilization and reconstruction of zigzag edges in graphene nanoislands on Ni(111), Garcia-Lekue A., Olle M., Sanchez-Portal D., Palacios J.J., Mugarza A., Ceballos G., Gambardella P., *Journal of Physical Chemistry C*; **119 (8)**: 4072 - 4078. 2015. 10.1021/jp511069y. IF: 4.772

Planck-Gesellschaft, also in Berlin. From 2002 to 2006 he was Research Scientist at the XSTM and Low-Temperature STM of Nanostructures Division at the Laboratorio Nazionale TASC-INFM, Trieste, Italy. In 2006 he joined ICN (now ICN2) as a Senior Scientist, where he eventually created the Nanoscience Instrument Development Division and where he actively participates in the research of the Atomic Manipulation and Spectroscopy Group.

Throughout his career, when endeavouring to perform new experiments, Dr Ceballos has frequently had to modify existing instruments or experimental setups, or develop new ones.

Electron Microscopy Division

Main Research Lines

- Use of electron microscopy techniques for nanoscience and nanotechnology research and applications
- Scientific-technical support both for internal research groups of the institute and external scientists and companies
- Study of the structure and chemistry of functional carbon nanotubes
- Exploration of 2-D layered inorganic nanotube systems
- Electron microscopy studies on graphene



DIVISION MEMBERS

Ballesteros Pérez, Belén, Division Leader

Belarre Triviño, Francisco Javier, Sample Preparation Lab Technician

Del Pozo, Marc, Visiting Student

Guerrero, Albert, Visiting Student

Pach, Elzbieta, PhD Student

Rosado Iglesias, Marcos, Specialist Technician

Vranic, Sandra, Visiting Postdoctoral Researcher



DIVISION LEADER



Dr Belén Ballesteros

Dr Belén Ballesteros earned her BSc in Chemistry with Honours at the Universitat Autònoma de Barcelona (UAB) in 2001 and obtained her PhD in 2006 at the Institut de Ciència de Materials de Barcelona (ICMAB-CSIC).

During her doctoral studies she undertook research stays at various European universities, including University of Twente (Netherlands), University of Oslo (Norway), University of



NEW PROJECTS & MILESTONES

During 2015 the Electron Microscopy Division consolidated its scientific-technical support activities, both concerning sample preparation and electron microscopy studies on a myriad of samples.

Moreover, in 2015 we expanded our already established hands-on training to our users with the organization of the *Open Knowledge Program* sessions on Introductory Notes on Electron Microscopy, which covered basic concepts on electron microscopy, Scanning electron microscopy (SEM), Transmission electron microscopy (TEM and STEM), analytical techniques (EDX and EELS) and sample preparation.

Saint Andrews (UK) and Universidad de la Laguna (Spain). In July 2006 she began postdoctoral work at the University of Oxford, where she worked in Electron Microscopy Imaging and Nanoanalysis of carbon nanotubes, inorganic nanotubes and related materials. Since April 2009 she has led the Electron Microscopy Division at ICN2.

Dr Ballesteros has authored 52 peer-reviewed articles and has around 750 citations.

During 2015 the Division hosted three visiting internship students from the *Universitat Autònoma de Barcelona* (Marc del Pozo, Albert Guerrero and Jose Antonio Peña) and a visiting postdoctoral researcher from University of Manchester (Dr. Sandra Vranic). Also, Belén Ballesteros carried out a secondment at the CNRS/Université Paris Sud in Orsay to perform CL-STEM experiments on single-layered inorganic nanotubes with Dr. Mathieu Kociak.

The Division actively participated in the outreach activities organized at the ICN2, such as the programs "Escolab", "Professors i Ciència" and the Nanoinnovation course (Introduction to Innovation & Entrepreneurship –Nanotechnology Innovation). Remarkably, Marcos Rosado and Elzbieta Pach were each awarded with a monthly price at the FEI Image Contest.

Belén Ballesteros was one of the organizers of the conference NANOBIOAPP2015 held in Barcelona in September 2015. Moreover, she and Marcos Rosado presented results at the conference MICROSCOPY AT THE FRONTIERS OF SCIENCE which took place in Porto (Portugal) in September 2015.

Researchwise the Electron Microscopy Division continued working on the study of functional carbon nanomaterials for biomedical applications in the framework of the ongoing project RADDEL. For instance, we studied the ability of functionalized MWNTs to cross the blood brain barrier in vitro with low voltage STEM imaging and the formation of single-layered inorganic nanotubes inside CNTs. Also, we optimized the procedure for studying morphology and thickness of graphene flakes by high resolution SEM and the presence of functional groups attached to both graphene or CNTs by EFTEM.



PUBLICATIONS

Cationic Liposome- Multi-Walled Carbon Nanotubes Hybrids for Dual siPLK1 and Doxorubicin Delivery in Vitro, Pereira S., Lee J., Rubio N., Hassan H.A.F.M., Suffian I.B.M., Wang J.T.W., Klippstein R., Ballesteros B., Al-Jamal W.T., Al-Jamal K.T., *Pharmaceutical Research*; **32(10)**: 3293 - 3308. 2015. 10.1007/s11095-015-1707-1. IF: 3.420

Quantitative monitoring of the removal of non-encapsulated material external to filled carbon nanotube samples, Martincic M., Pach E., Ballesteros B., Tobias G., *Physical Chemistry Chemical Physics*; **17 (47)**: 31662 - 31669. 2015. 10.1039/c5cp04664e. IF: 4.493

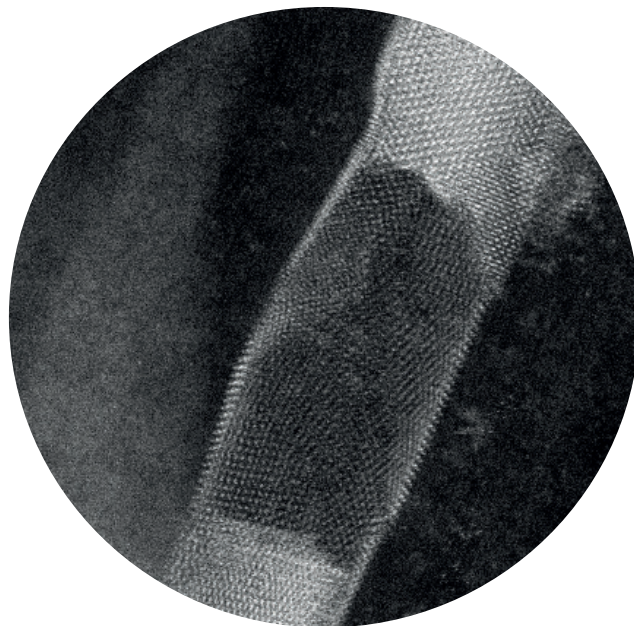
Spin density wave and superconducting properties of nanoparticle organic conductor assemblies, Winter L.E., Steven E., Brooks J.S., Benjamin S., Park J.-H., De Caro D., Faulmann C., Valade L., Jacob K., Chtioui I., Ballesteros B., Fraxedas J., *Physical Review B - Condensed Matter and Materials Physics*; **91 (3)**, 035437) 2015. 10.1103/PhysRevB.91.035437. IF: 3.736

The interaction of carbon nanotubes with an invitro blood-brain barrier model and mouse brain invivo, Kafa H., Wang J.T.W.,

Rubio N., Venner K., Anderson G., Pach E., Ballesteros B., Preston J.E., Abbott N.J., Al-Jamal K.T., *Biomaterials*; **53**: 437 - 452. 2015. 10.1016/j.biomaterials.2015.02.083. IF: 8.557

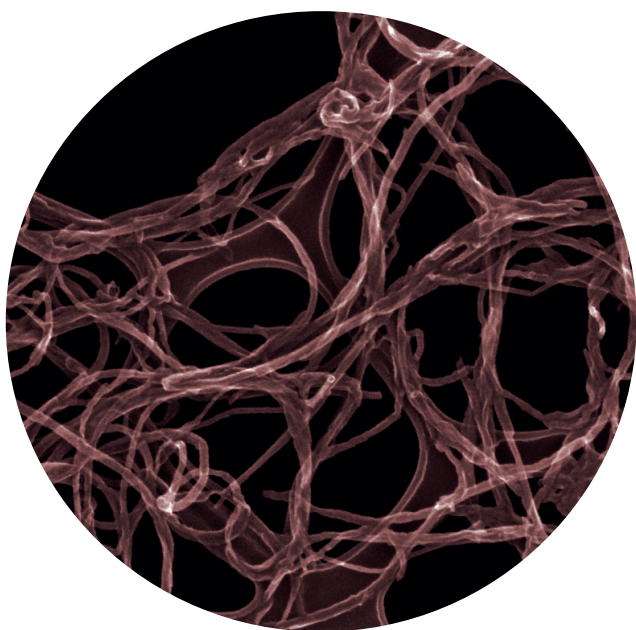
Vertically Aligned ZnO/In_xS_y Core-Shell Nanorods for High Efficient Dye-Sensitized Solar Cells, Gonzalez-Valls I., Ballesteros B.,

Lira-Cantu M. , *Nano*; **10** (7, 1550103) 2015. 10.1142/S1793292015501039. IF: 1.090



PROJECTS

Nanocapsules for targeted delivery of radioactivity, RADDEL, funded by **CE**, 01/02/12 – 31/01/16, Belén Ballesteros



Nanomaterials Growth Division

Main Research Lines

- Epitaxial thin film deposition and characterisation of different materials, mainly perovskite-structure related oxides. Interplay between strain and relaxation mechanisms, microstructure and functional properties of ultrathin films
- Present research is mainly devoted to thin epitaxial growth of mixed ionic-electronic conducting oxides and multilayers by PLD, their structure characterisation by RHEED and XRD, and high-temperature electronic transport properties. Oxide and Protonic Ionic conductivity in thin films
- Fundamental aspects of interfacial phenomena in the electrical characterisation of thin films of layered oxide materials and multilayers, for their use as components in intermediate temperature SOFCs
- Surface composition segregation and its effect on oxygen surface exchange kinetics and ageing phenomena



DIVISION LEADER



CSIC Tenured Scientist
Dr José Santiso

Dr José Santiso earned his BSc degree in Physics at the Universitat Autònoma de Barcelona (UAB), Spain, in 1988 and obtained his PhD from the University of Barcelona (UB) in 1993.

After his doctoral studies, he worked as a Visiting Scientist at Cambridge University, UK from 1994 to 1996. After this stage he joined the Material Science Institute (ICMAB) as a research associate and became CSIC staff scientist in 2002. In 2007 he moved to CIN2 as leader of the Pulsed Laser Deposition and Nanoionics Group, Nanomaterials Growth



DIVISION MEMBERS

Bagués Salguero, Núria, CSIC Doctoral Student
Caicedo Roque, José Manuel, Research Engineer
Chatterjee, Arindom, SO Doctoral Student
Gutiérrez, Araceli, Visiting Postdoctoral Researcher
Magrasó, Anna, CSIC Visiting Postdoctoral Researcher
Moreno, Roberto, CSIC Visiting Doctoral Student

Rodríguez Lamas, Raquel, Visiting Student
Rubio, Carlos, CSIC Visiting Student
Santiso López, José, CSIC Tenured Scientist and Division Leader
Van Den Bosch, Celeste, Visiting Doctoral Student



Division, which recently turned into the ICN2 Nanomaterials Growth Division that he also leads. In 2012 he received the Somiya Award of the International Union of Materials Research Society (IUMRS) for his contribution to Solid State Ionics. Recently, in 2014, he obtained a grant from the Japan Society for Promotion of Science as a 3-month visitor at the International Institute for Carbon-neutral Research, I2CNER, (Univ. Kyushu).

During 2015 José Santiso carried out one stay at the Massachusetts Institute of Technology (US) for three months (June to September). The aim of this stays was to strengthen the collaborations with some groups in the field of oxide thin films for energy applications.

Dr Santiso has authored more than 120 articles and has around 1200 citations, and H index of 20.



NEW PROJECTS & MILESTONES

In 2015 the Nanomaterials Growth Division continued working on the following closely-related main objectives:

Thin film deposition of epitaxial oxide materials by means of pulsed Laser deposition technique. In this case our division produces films for a large number of groups within the ICN2, in close collaboration with these groups. In some cases the thin film deposition required the use of Reflection high energy electron diffraction (RHEED). Our division carries out the preliminary structure characterisation concerning mostly X-Ray diffraction. (Some of the ICN2 group leaders who we collaborate with are: G. Catalan, J. Fraxedas, S. Valenzuela, C. Torres, and J. Nogués)

Investigation of the interplay between strain relaxation phenomena and functional properties in complex oxide films. Development of novel methods for the X-ray diffraction and diffuse scattering characterisation of microstructure features in epitaxial thin films. These included in-plane diffraction, GISAXS analysis, as well as 3D reciprocal space mapping (this last type of analysis required the use of synchrotron radiation source: at BM25-ESRF and KMC2-Bessy). Most of the work is carried out in collaboration with Institut de Ciència de Materials de Barcelona (ICMAB). The microstructure investigation is completed by HRTEM characterisation.

Study of fundamental aspects of ionic and electronic charge and mass transport in the electrical characterisation of thin films of layered oxide materials and multilayers, for their use as components in intermediate-temperature SOFCs. We are particularly interested in surface and interfacial oxygen exchange phenomena in order to obtain enhanced oxygen transport performance. Development of novel characterisation tools of the oxygen surface

exchange kinetics: For this purpose we have developed a novel technique that uses the subtle chemical expansion measured by X-ray diffraction produced in transition metal oxide thin films when changing their oxygen stoichiometry to in-situ probe their redox kinetics at high temperature in time intervals as short as a few seconds. The setup also allows for electrical contacts which may be used either to simultaneously measure electrical conductivity relaxation or to apply an electric field for in-operando device electrochemical characterisation.

Investigation of the surface activity for oxygen reduction in transition metal oxide perovskite thin films. Development of novel methods for determining oxygen surface exchange rate by combination of electric conductivity relaxation and time-resolved X-ray diffraction experiments. We explore surface cation composition segregation mechanisms affecting the reactivity of the surfaces. This work is mostly carried out in collaboration with different international partners (Imperial College London, I2CNER at Kyushu Univ. and MIT).

During this year we started collaboration with Prof. J. A. Garrido's group at ICN2 in order to build up a new thin film MOCVD reactor for the growth of high quality ultrathin Transition metal dichalcogenides, starting from MoS_2 . By the end of 2015 the system has been already constructed and first essays have been started.

**Enhanced conduction and ferromagnetic order at (100)-type twin walls in****La_{0.7}Sr_{0.3}MnO₃ thin films**, Balcells L., Paradinas M., Baguès N., Domingo N., Moreno R., Galceran R., Walls M., Santiso J., Konstantinovic Z., Pomar A., Casanove M.-J., Ocal C., Martínez B., Sandiumenge F., *Physical Review B - Condensed Matter and Materials Physics*; **92** (7, 075111) 2015. 10.1103/PhysRevB.92.075111. IF: 3.736**Microstructure and ionic conductivity of LLTO thin films: Influence of different substrates and excess lithium in the target**, Aguesse F., Roddatis V., Roqueta J., Garcia P., Pergolesi D., Santiso J., Kilner J.A., *Solid State Ionics*; **272**: 1 - 8. 2015. 10.1016/j.ssi.2014.12.005. IF: 2.561**On the development of proton ceramic fuel cells based on Ca-doped LaNbO₄ as electrolyte**, Norby T., Magrasó A., *Journal of Power Sources*; **282**: 28 - 33. 2015. 10.1016/j.jpowsour.2015.02.027.**Persistence of ferroelectricity above the Curie temperature at the surface of****Pb(Zn_{1/3}Nb_{2/3})O₃-12%PbTiO₃**, Domingo N., Bagués N., Santiso J., Catalan G., *Physical Review B - Condensed Matter and Materials Physics*; **91** (9, 094111) 2015. 10.1103/PhysRevB.91.094111. IF: 3.736**Reduced long term electrical resistance in Ce/Co-coated ferritic stainless steel for solid oxide fuel cell metallic interconnects**,Magraso A., Falk-Windisch H., Froitzheim J., Svensson J.-E., Haugrud R., *International Journal of Hydrogen Energy*; **40** (27): 8579 - 8585. 2015. 10.1016/j.ijhydene.2015.04.147. IF: 3.313**Strain-Engineered Ferromagnetism in****LaMnO₃ Thin Films**, Roqueta J., Pomar A., Balcells L., Frontera C., Valencia S., Abrudan R., Bozzo B., Konstantinovic Z., Santiso J., Martínez B., *Crystal Growth and Design*; **15** (11): 5332 - 5337. 2015. 10.1021/acs.cgd.5b00884. IF: 4.891**Tailoring thermal conductivity by engineering compositional gradients in****Si_{1-x}Ge_x superlattices**, Ferrando-Villalba P., Lopeandía A.F., Alvarez F.X., Paul B., de Tomás C., Alonso M.I., Garriga M., Goñi A.R., Santiso J., Garcia G., Rodriguez-Viejo J., *Nano Research*; **8** (9): 2833 - 2841. 2015. 10.1007/s12274-015-0788-9. IF: 7.010*Aspectos fundamentales del crecimiento epitaxial de heteroestructuras de óxidos y mecanismos de relajación que controlan su nanoestructura y transporte iónico-electrónico*, NANORELAX, funded by **MINECO**, 01/01/2012 - 31/12/2015, Jose Santiso*Determinación de la actividad catalítica y posibles procesos de degradación en superficies ideales de materiales cátodos para pilas de combustible de óxido sólido mediante un estudio espectroscópico de fotoemisión (XPS) y microscopía de efecto túnel (STM) en condiciones cercanas a las de operación*, funded by **MECD**, 11/06/2015 - 31/08/2015, Jose Santiso

Nanofabrication Facility

The Nanofabrication Facility focuses on the design and development of nanofabrication methods and techniques for nanoscience and nanotechnology research and applications. The mission of the facility is to provide high quality services to both internal and external users.



FACILITY MEMBERS



Xavier Borrisé, Research Engineer



Raúl Perez, Research Engineer



AVAILABLE TECHNIQUES

- Electron Beam Lithography (EBL)
- Focused Ion Beam (FIB)
- Thermal and UV Nanoimprint (NIL)
- Atomic Force Microscope (AFM)
- E-beam evaporation
- Sputter coater
- Plasma cleaner
- Wedge Wire bonder
- Spin coater
- Optical Microscope



Tailored Height Gradients in Vertical Nanowire Arrays via Mechanical and Electronic Modulation of Metal-Assisted Chemical Etching, Otte M.A., Solís-Tinoco V., Prieto P., Borrísé X., Lechuga L.M., González M.U., Sepúlveda B., *Small*; **11 (33)**: 4201 - 4208. 2015. 10.1002/smll.201500175. IF: 8.368

Au cylindrical nanocup: A geometrically, tunable optical nanoresonator, Koylina M., Alayo N., Conde-Rubio A., Borrísé X., Hibbard G., Labarta A., Batlle X., Pérez-Murano F., *Applied Physics Letters*; **107 (3)**: 33102. 2015. IF: 3.302

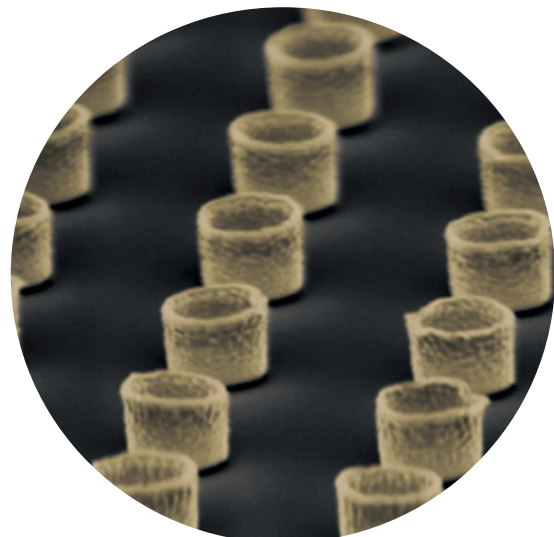
Tuning piezoresistive transduction in nanomechanical resonators by geometrical asymmetries, Llobet J., Sansa M., Lorenzoni M., Borrísé X., San Paulo A., Pérez-Murano F., *Applied Physics Letters*; **107 (7)**: 73104. 2015. IF: 3.302

Fabrication of functional electromechanical nanowire resonators by focused ion beam implantation, Llobet J., Gerboles M., Sansa M., Bausells J., Borrísé X., Pérez-Murano F., *Journal of Micro/Nanolithography, MEMS, and MOEMS*; **14 (3)**: 15026SSP. 2015. IF: 1.428

Nanoparticles with tunable shape and composition fabricated by nanoimprint lithography, Alayo N., Conde-Rubio A., Bausells J., Borrísé X., Labarta A., Batlle X., Pérez-Murano F., *Nanotechnology*; **26 (44)**, 445302). 2015. IF: 3.821

Manipulation of competing ferromagnetic and antiferromagnetic domains in exchange-biased nanostructures, Fraile Rodríguez A., Basaran A.C., Morales R., Koylina M., Llobet J., Borrísé X., Marcus M.A., Scholl A., Schuller I.K., Batlle X., Labarta A., *Physical Review B - Condensed Matter and Materials Physics*; **92 (17)**: 174417. 2015. IF: 3.736

Activity-tunable nanocomposites based on dissolution and in situ recrystallization of nanoparticles on ion exchange resins, Alonso A., Vigués N., Rodríguez-Rodríguez R., Borrísé X., Muñoz M., Muraviev D.N., Mas J., Muñoz-Berbel X., *RSC Advances*; **5 (109)**: 89971 - 89975. 2015. IF: 3.84



Instrumental Core Research Facilities

The ICN2 Research Support Facilities provide with an array of specialized equipment, technologies and services, efficiently operated by a highly qualified staff to enable scientists to achieve ambitious research goals in a cost effective way. From routine, though essential, support services to advanced technical and consulting services, these cores facilitate and enhance the important research conducted at the institute on a daily basis.



FACILITY MEMBERS



Pablo García, Research Technician of the X-ray Diffraction Facilities



Javier Saiz, Research Technician of the Molecular Spectroscopies and Physicochemical Analysis

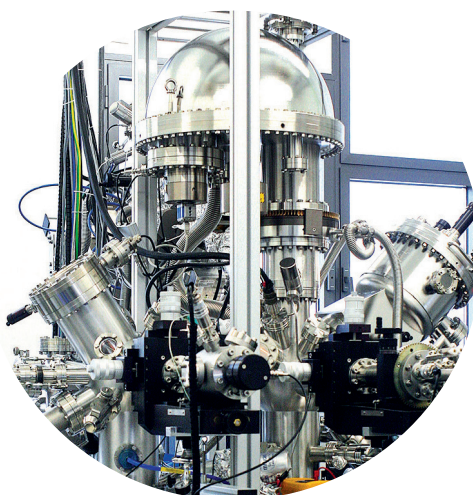


Guillaume Sauthier, CSIC Research Technician of the Photoemission Spectroscopy Facilities



AVAILABLE TECHNIQUES

- Photoemission Spectroscopy for surface analysis (XPS/ARUPS)
- Molecular Spectroscopies (UV/Vis, FT-IR, Fluorescence)
- Physicochemical Instrumental Analysis (ICP-MS, LC-MS, TGA, DSC)
- Optical Microscopy
- X-Ray Diffraction
- SQUID Magnetometry
- Bio-Lab
- DLS / Z-Potential



Technical Facilities

Mechanical Workshop

The Mechanical Workshop facility was created during 2015 with the aim to offer high precision machining services. During the setting-up of the Mechanical Workshop several equipment such as a CNC-milling machine and a manual lathe were acquired to endow the facility with the most appropriate tools for high precision milling and turning. By the end of the year the facility was running at full capacity offering a broad range of custom machining services for the design, fabrication and assembling of devices and components for the institute research.



FACILITY MEMBERS



Rafael León, SO Mechanical
Workshop Technician



AVAILABLE TECHNIQUES

- Precision milling, turning, grinding,
- Machining to close tolerances
- Mechanical assembling
- CAD (Computer Aided Design)
- CAM (Computer Aided Maching)
- CNC (Computer Numeric Control)

Nanoimprint Lithography Platform

The Nanoimprint Lithography Platform constantly develops novel approaches and methods for nano-scale device-relevant research.



Nanoimprint Lithography Platform

Main Research Lines

- Nanoimprint lithography (Thermal and/or Ultraviolet light assisted)
- Roll-to-Roll Nanoimprint lithography
- Solvent based Nanoimprint lithography
- Nano injection moulding
- Block copolymer self-assembly / Graphoepitaxy
- Step & Repeat Nanoimprint Lithography
- Hierarchical Micro/Nano-patterning
- Flexible processing In-line & off-line dimensional nano metrology



PLATFORM MEMBERS

Francone, Achille Leo, SO Postdoctoral Researcher

Kehagias, Nikolaos, Senior Researcher

Simoes, Dina Augusta, Postdoctoral Researcher



PLATFORM LEADER



Dr Nikolaos Kehagias

Since 2010 Dr Kehagias is leading the Nanoimprint Lithography Platform of ICN2. He obtained his PhD in 2007 from the National University of Ireland, Cork where he continued to work as a post-doctoral fellow until May 2008. In May 2008 he joined the Phononic and Photonic Nanostructures group in the Catalan Institute of Nanotechnology (ICN-CIN2). His research work focuses on



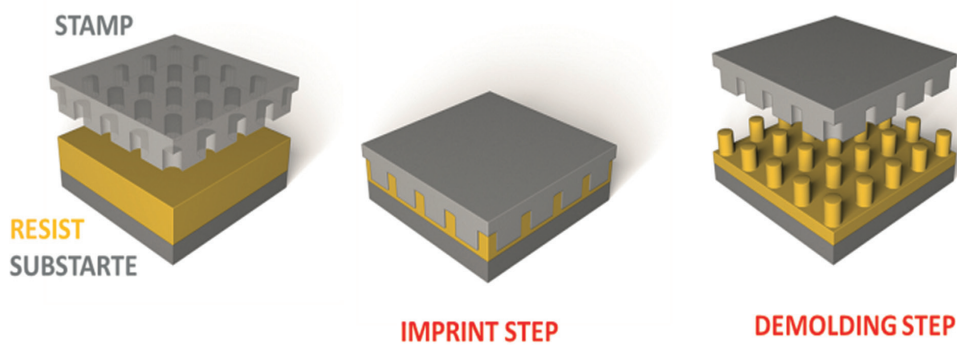
NEW PROJECTS & MILESTONES

The Nanoimprint Lithography Platform constantly develops novel approaches and methods for nano-scale device-relevant research. The flexible fabrication laboratory has pioneered research in nanofabrication (nanoimprint lithography-NIL, Roll-to-Roll nanoimprint lithography, nano-injection moulding, self-assembly and others) with the target to demonstrate large area, high volume and low cost nano-enabled products. We offer a unique set of nanoimprint lithography tools capable of imprinting up to 300 mm wafers on various materials and substrates. We combine imprint based lithography technique to achieve large are micro/nano structured functional surfaces.

Our advanced manufacturing technology has been developed to a state where 3-dimensional and sub 50 nm patterning is a feasible task, demonstrating high throughput capabilities.

Added functionality by introducing micro/nano structures on surfaces will have a big impact on various industrial sectors. Sustainable production as well as products can be expected by our novel manufacturing approach enhancing the performances of the targeted products by improved functionality and keeping the production cost effective.

The platform has developed a flexible and adaptable fabrication method to create complex hierarchical structures within polymer materials. These hybrid surfaces can exhibit both Lotus and Petal effect depending on their two distinctive mechanical behaviours.



Schematic illustration of the NIL process

the study and developed of novel nano-manufacturing methods based on imprint lithography techniques. In the last years his research efforts have been focused on developing nano-enabled plastic components and devices based on bio-mimicking properties. Dr. Kehagias had been working in the past on optical and photonic devices with an emphasis on photonic crystal applications for light extraction purposes.



PUBLICATIONS

Residual layer-free Reverse Nanoimprint Lithography on silicon and metal-coated substrates, Fernandez A., Medina J., Benkel C., Guttman M., Bilenberg B., Thamdrup L.H., Nielsen T., Sotomayor Torres C.M., Kehagias N., *Microelectronic Engineering*; **3 (141)**: 56-61. 2015. IF:1.197



PROJECTS

Project PLAST-4-FUTURE
(www.plast4future.eu) funded by **FP7-2012-NMP-ICT-FoF**.

Management and Output



- > Management and Services
- > Scientific Output
- > Projects
- > Finances
- > Facilities and Equipment
- > Technology Transfer
- > Public Outreach

Management and Services



ICN2's Management and Services team performs a wide range of functions and provides numerous support services to the Institute's Research Groups. Its members are distributed across eight departments: **Competitive Funding, Finance, Human Resources, Information Technologies, Knowledge and Technology Transfer, Maintenance and Safety, Marketing and Communication, and Strategic Development.** Additionally, the Strategic Development Department reports directly to the Director. Each department has been designed and scaled to provide services to the whole ICN2 community, including 17 Research Groups and 6 Technical Development and Support Divisions and Facilities.

● COMPETITIVE FUNDING

The Projects Department was renamed Competitive Funding with the intention of making its tasks and responsibilities more intuitive. The number of its members has stabilized and interaction with Group Project Managers and other Administrative Departments has strengthened.

The philosophy of the Department keeps based on the direct contact with the researcher and for the Project Manager to become his/her key person in all the steps related to project management. This way, researchers can devote their time almost exclusively to the technical development of projects, minimizing, as much as possible, their involvement in financial control and deadlines.

● FINANCE

All ICN2 financial management is supported by SAP, and the Finance team has been expanded to serve the 17 Research Groups and 6 Technical Development and Support Divisions and Facilities that configure ICN2.

● HUMAN RESOURCES & EDUCATION

The Human Resources Department focuses on our people on a daily basis by providing effective talent attraction, selection, development and assessment processes and people-friendly guidelines and tools.

Its mission is to support growth and career development by giving the opportunity to our scientists to enjoy a continuous learning and evolution.

The ICN2 HR policies are designed not only to support scientific and professional development of our people, but also to improve the Institute's internal communications and workflow efficiency and as a result the contribution to the overall objective of the ICN2 in becoming a scientific centre of reference worldwide. They also refer to making ICN2 a workplace with culture and a friendly environment where our people enjoy working, share their experiences, and exchange new ideas with one another. Here everyone has the freedom to be themselves.

Thanks to the commitment of the Human Resources & Education Department to our people, The European Commission awarded ICN2 as one of the scientific institutes with HR Excellence in Research.

● INFORMATION TECHNOLOGIES

In 2015, the IT department continued the implementation of the infrastructure for ICN2's new headquarters (network, IP communications, firewalls, etc.). The Department provides support to all ICN2..

● KNOWLEDGE AND TECHNOLOGY TRANSFER

ICN2's Knowledge Technology Transfer Department offers a specialised service to evaluate, protect and transfer the results of the research developed at ICN2 to the industrial sector and the society in general. Some of the major goals achieved by the Department in 2015 are: 4 European patent (EP) applications, 1 Spanish patent (ES) application, 1 United States patent (US) application, 6 PCT extension filed, 3 granted patents and the participation of ICN2 as a shareholder in the spin-off company Futurechromes, S.L., created on June 2014.

● MAINTENANCE AND SAFETY

Maintenance and Safety Department has been working with the ICN2 staff since 2007. It manages all the building facilities and plays a key role in the configuration of new spaces. Its members work to keep over 40 laboratories in optimal conditions.

The Department manages external companies providing services to ICN2 (cleaning, gardening, reception, security guard, courier, post, etc.)

Another central role of the Department is to take care of the Risk Prevention Plan (supervises and edits all Safety procedures). Additionally, it organizes the medical check up for the ICN2 members and coordinates the communications with health and safety related companies.

● MARKETING AND COMMUNICATION

The Marketing and Communication Department offers services and promotes dissemination actions to benefit the overall impact of the exciting activities developed by the ICN2 community.

The Department offers Illustration, Graphic Design and Web Design services to ensure an appealing image and message in all major publications and public materials produced by ICN2 scientists and Departments. It also supports and leads the organisation of high impact events related with the research developed by ICN2 at the nanoscale. Another main task of the Department is managing the public and media relations of the Institute.

Finally, the Department devotes time and efforts to competitive calls to raise resources that reinforce the institutional communication policy. In 2015 the Department was involved in 2 successful FECYT proposals, leading one of them, and 1 H2020 project (Nano2All), as third party. Those resources make possible, for instance, the development of classroom activities and training sessions for school teachers.

● STRATEGY

During 2015 the Strategy Department formalised ICN2's 2015-2020 Strategic Plan, which was first revised by the Institute's Scientific Advisory Board and then formally approved by the Board of Patrons. A number of framework collaboration agreements were signed with key international research centres, including CEA in France and RMIT in Australia. The Department also initiated a number of actions to support competitive project proposal preparation and led a number of institutional proposals, including an infrastructure proposal under the FEDER scheme administered by the Generalitat of Catalonia which has subsequently been granted. This project will fund the establishment of two highly specialised facilities at ICN2: a controlled environment nanofabrication laboratory and a biosecurity level 2 laboratory.

Scientific Output

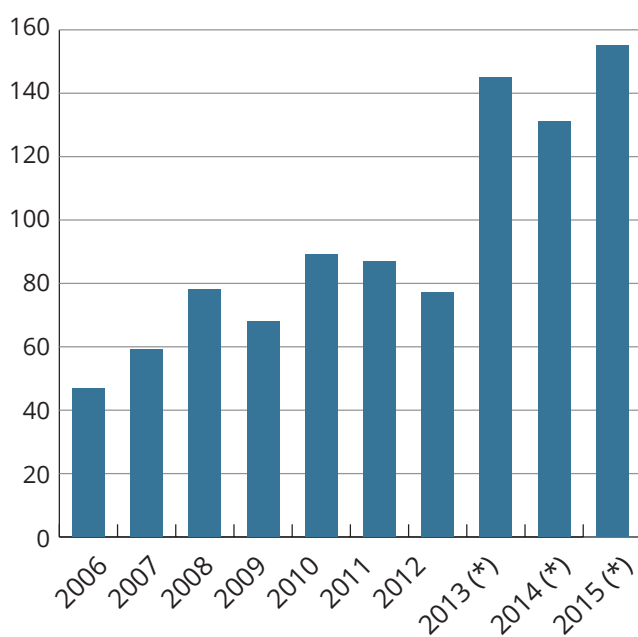
PUBLICATIONS

The scientific production of the ICN2 is remarkable. With 155 indexed publications in 2015, and an average impact factor of 6.58, the Institute achieves notable figures that are expected to increase in the years to come.

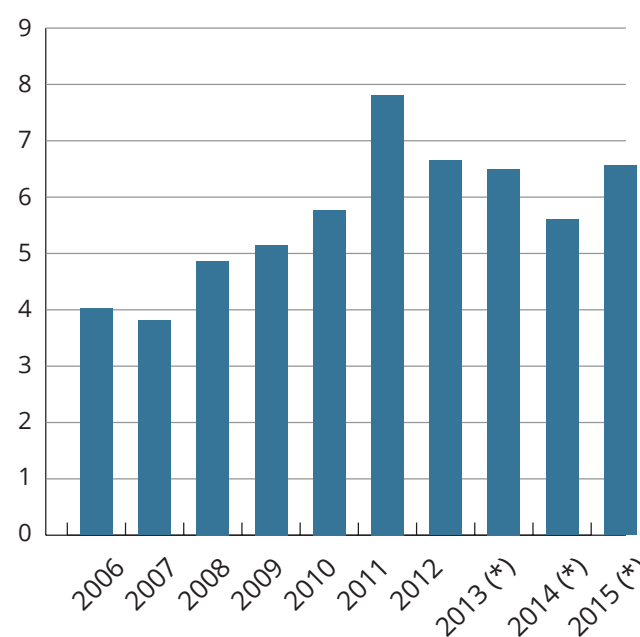
TOP 10 journals

Journal	IF	articles
Nature Materials	36.503	1
Chemical Society Reviews	33.383	1
Reviews of Modern Physics	29.604	1
Energy and Environmental Science	20.523	1
Physics Reports	20.033	1
Advanced Materials	17.493	2
Advanced Energy Materials	16.146	2
Advanced Drug Delivery Reviews	15.038	1
Nano Letters	13.592	5
ACS Nano	12.881	4

Evolution of number of indexed publications at ICN2



Evolution of average impact factor at ICN2



(*) 2013 figures include CSIC Groups' information for the first time

● ICN2 EVENTS

ICN2 researchers, with the support and collaboration of the administration departments, develop a leading role in Europe in the field of Nanoscience and Nanotechnology. It involves the organisation of international events attracting scientists from around the globe to Barcelona.

Some outstanding examples of events organized by ICN2 are:

ICREA Workshop on Graphene Nanobiosensors May 2015, Barcelona

- 2-day workshop on the design of nanobiosensors and nanobiosystems based on graphene.
- Organized by the ICN2 and funded by ICREA and other sponsors.
- 20 Posters.
- 100 participants.



FAPESP-WEEK Barcelona May 2015, Barcelona

- ICN2 played a key role in the FAPESP-WEEK Barcelona celebrated after the 2015 CERCA Conference.
- The meeting explored possible collaborations with the State of São Paulo.



31st European Conference on Surface Science (ECOSS-31) August-September 2015, Barcelona

- This well-established meeting with a longstanding tradition was held in the International Convention Center of Barcelona.
- The Conference included two sessions devoted to graphene sponsored by ICN2.



Aplicaciones Industriales de la Nanotecnología (IX AIN)
September 2015, Barcelona

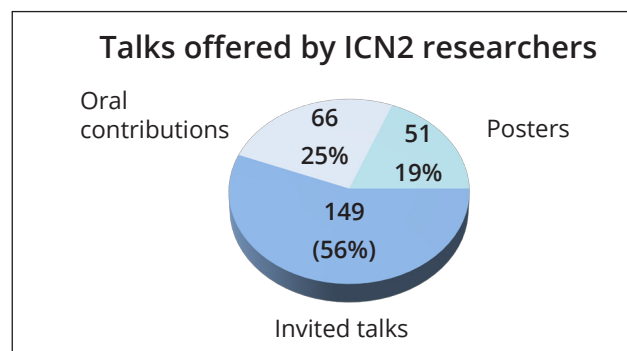
- A yearly event co-organized with the Instituto de Nanociencia de Aragón (INA). With the support of LEITAT and the Chamber of Commerce, INA joins innovation, discussion and interaction in a unique event.
- > 15 Speakers



- > 100 participants

EVENTS IN WHICH ICN2 RESEARCHERS PARTICIPATED

In 2015 ICN2 researchers made 266 contributions at conferences related to Nanoscience and Nanotechnology. A breakdown of their contributions is shown in the following graphic:



ICN2 BOOTH IN TRADE SHOWS AND FAIRS

The Knowledge and Technology Transfer Department and the Marketing and Communication Departments promote the active participation of the Institute in the major international events about nanoscience and nanotechnology. The institutional booth travels with ICN2 representatives to events such as:

ImagineNano
March 2015

- Bilbao (Spain) hosted the 3rd edition of the largest European Event in Nanoscience & Nanotechnology.
- Several conferences were held in parallel, as well as a vast exhibition, one-to-one meetings and an industrial forum.

- The event gathered the global nanotechnology community, including researchers, industry policymakers and investors.

Graphene Canada 2015
October 2015

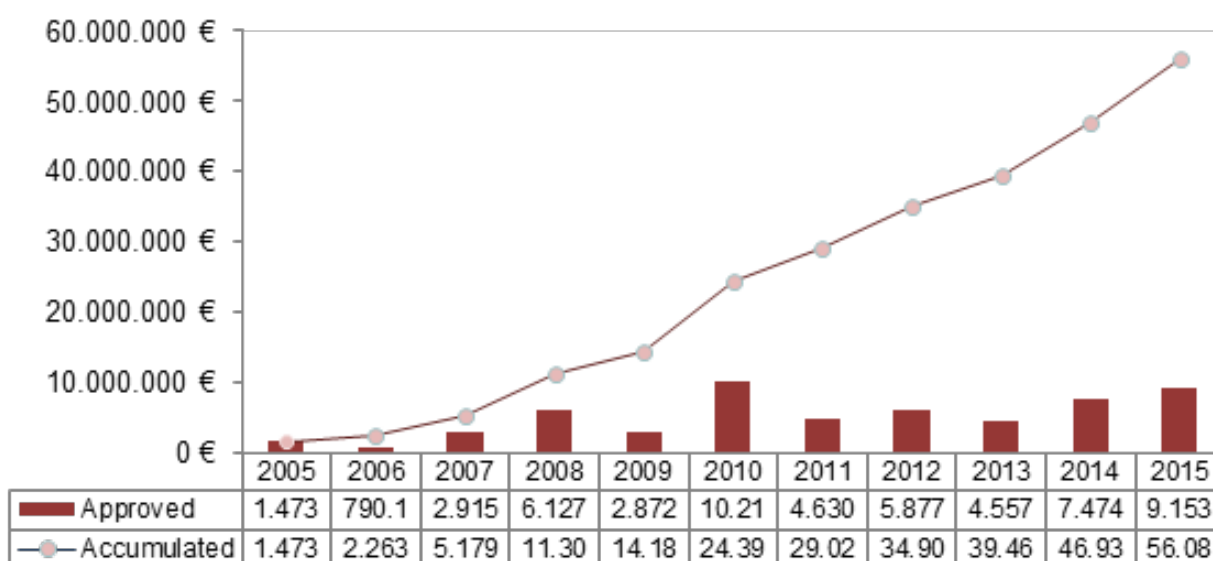
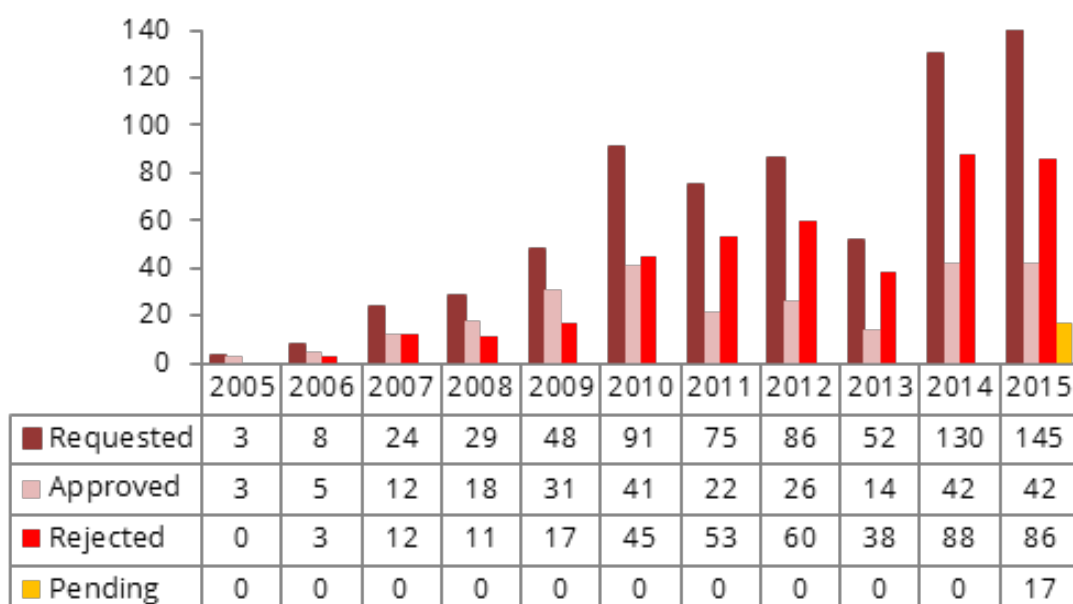
- Top industry leaders discussed recent advances in technology developments and business opportunities in graphene commercialization.
- ICN2 was among the sponsors of the event and had a leading role at the ICEX booth presenting the "Graphene" champions in Spain.

Projects

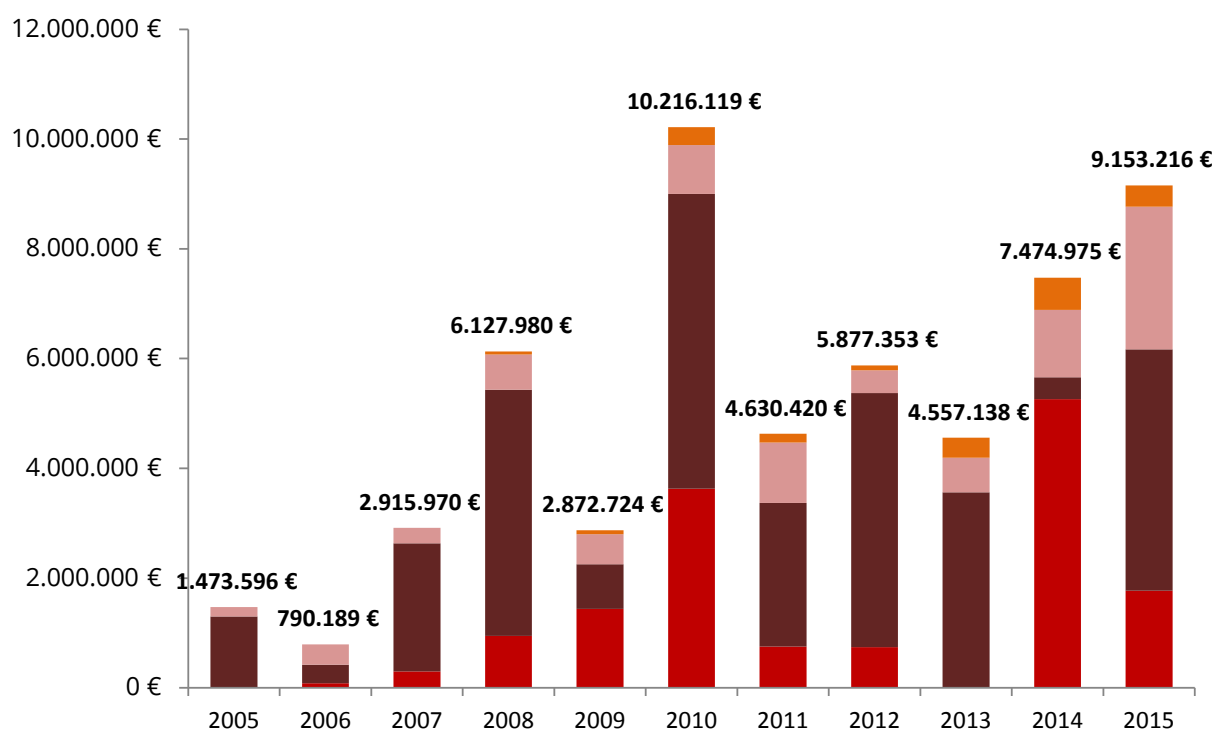
2015 was the year with the highest number of proposals submitted in the history of ICN2. Furthermore, and still with some evaluation outcomes of proposals submitted pending, it has been the best year of the past five years regarding the funding granted. This makes 2015 the second best year of ICN2, only surpassed by 2010.

The breakdown of competitive funding at ICN2 for 2015 is illustrated in the chart below:

Evolution of competitive funding 2005-2015



Evolution of Competitive Funding Approvals 2005-2015



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Commercialisation Projects	-	-	-	53,708.87	74,579.59	325,964.49	161,570	91,475.20	365,236	586,120.85	385,816
Fellowships	175,400	367,600	284,935.61	642,236.80	544,832	892,343.20	1,100,560.77	416,372.05	627,672.40	1,228,292.64	2,597,673.89
EU & Int. Projects	1,298,196	341,415	2,333,548.90	4,486,646	817,276.80	5,368,981.70	2,615,392.74	4,627,620	3,564,229.18	400,143	4,397,685
National Projects	-	81,174	297,485	945,389	1,436,035	3,628,829	752,897	741,886	-	5,260,418	1,772,040.77

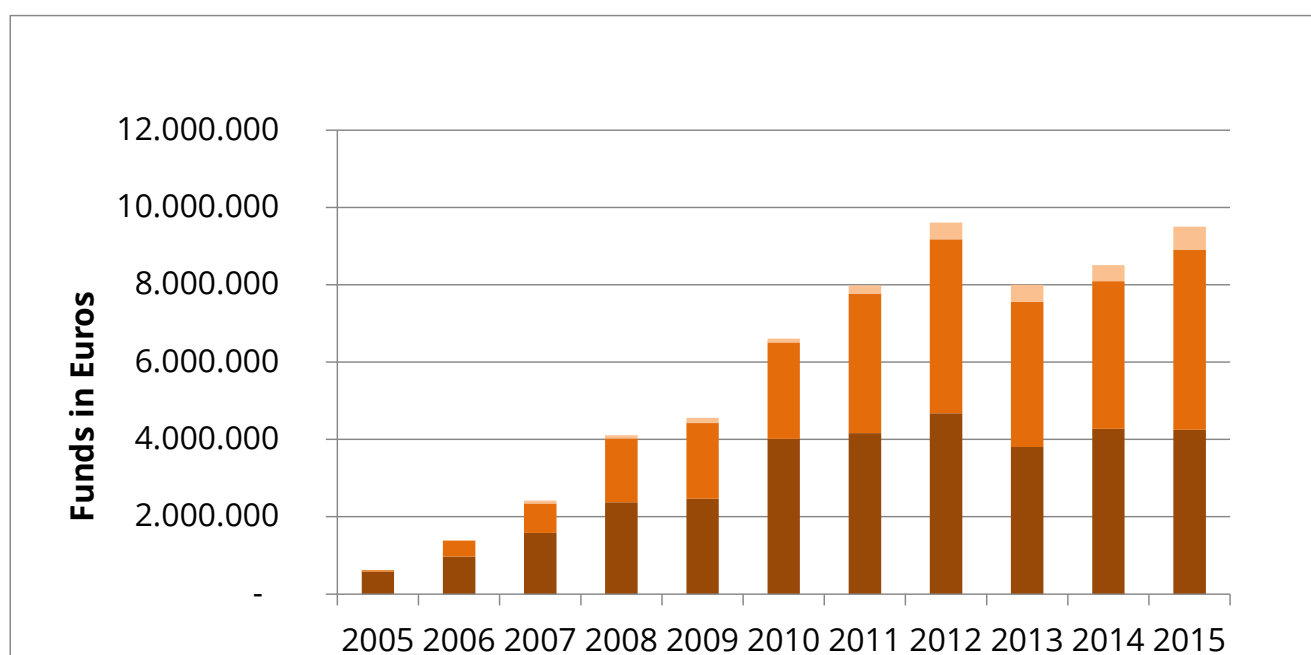
Finances

● FINANCIAL ACCOUNTS 2015

In 2015, the Finance Department has implemented SAP B1 system to provide economic information and facilitate administrative tasks to all ICN2.

During 2015, we have worked to achieve two goals, one of them has been to unify administrations ICN2 and CSIC, on the other hand, get an efficient administrative procedure of scientific services offered by the ICN2 to customers and research groups at ICN2.

Evolution of ICN2 operating funds



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015
Industry and Services	-	436	77,817	84,780	141,657	97,601	210,633	430,032	441,151	417,634	593,302
Competitive Funds	37,305	420,638	758,304	1,654,403	1,956,054	2,492,368	3,615,399	4,502,981	3,759,031	3,822,618	4,665,024
Catalan Government, CSIC & Other Funds	578,517	966,010	1,583,288	2,371,381	2,464,673	4,016,951	4,160,687	4,677,554	3,802,276	4,272,515	4,247,443

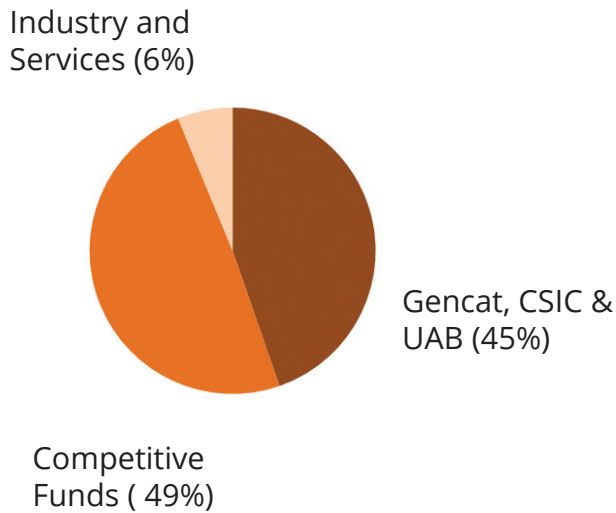
● INCOME

ICN2's total operating funds in 2015 were 9.512.789,71€. In 2015 ICN2 obtained of its operating funds from Gencat, CSIC & UAB (45%), competitive funds (49%) and industry and services (6%).

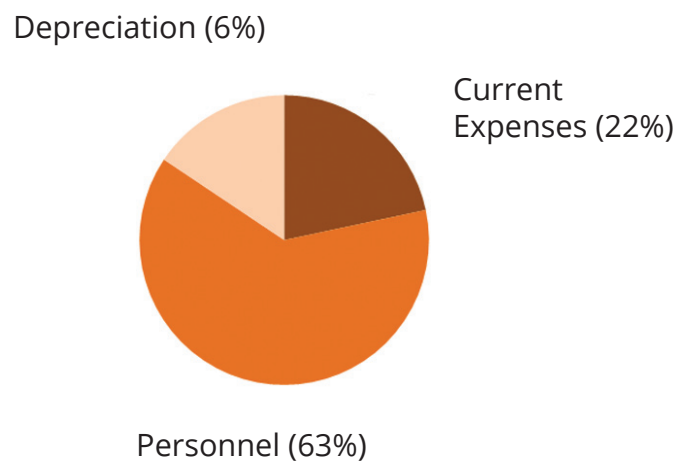
● EXPENSES

In 2015 total expenditure at ICN2 was €8,677,564. Expenses, which comprise current expenses, personnel costs and depreciation

Funds Distribution 2015



Expenses 2015



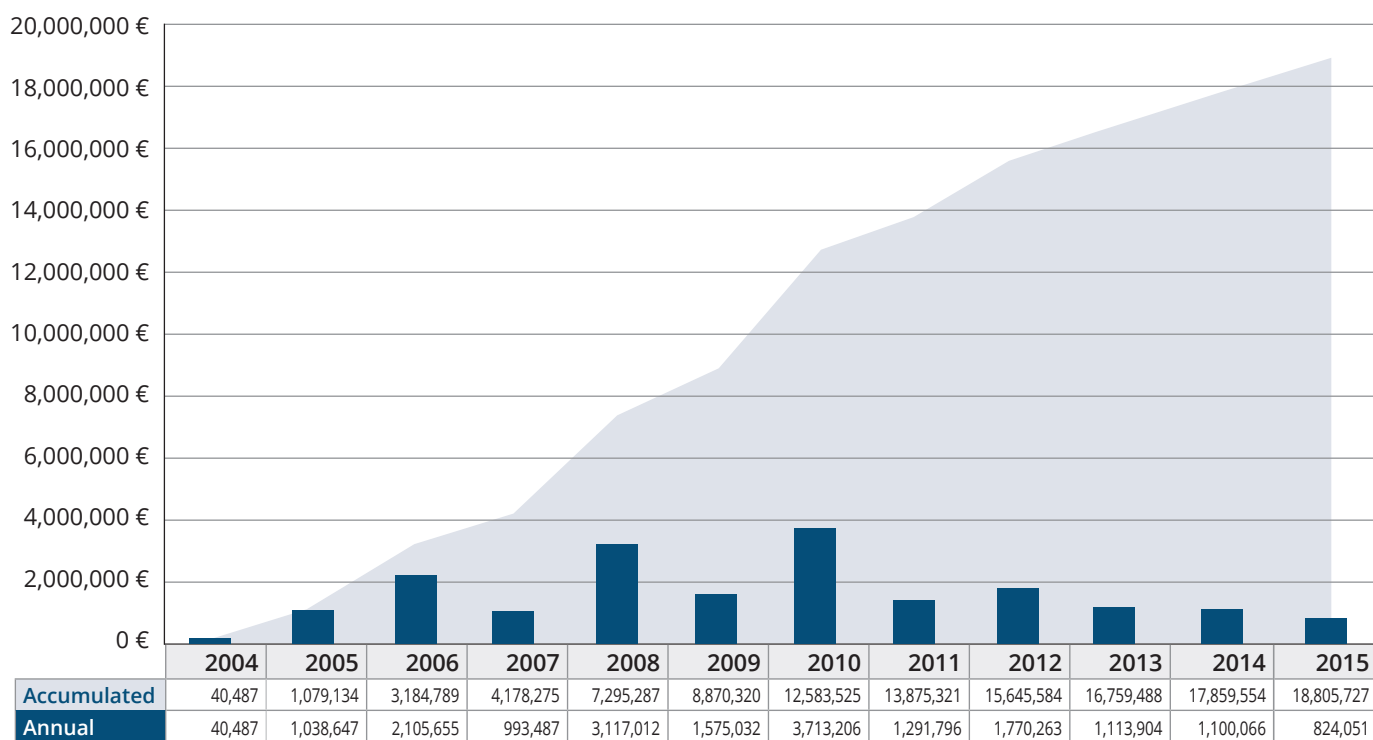
Facilities and Equipment

In 2015 ICN2's total accumulated investment including scientific equipment, common services and general infrastructure was €18,805,727. Investment for the year 2015 was €824,051.

The main scientific, technical and IT equipment acquired in 2015 comprised:

- Microscope raman system 2015-04
- Centro de mecanizado vertical
- E-Beam evaporator, power
- AFM
- Optical microscope
- Vector magnet
- Analizador fisorcion
- Nexus
- SAP BO
- CVD reactor-SV

Evolution of ICN2 total investments, 2004-2015



Technology Transfer

In 2015 the Technology Transfer Office furthered its efforts to maximise the commercialisation of ICN2's research results through intellectual and industrial property protection, R&D contracts with the industry, private and public sector collaborations, and other endeavours.

● INTELLECTUAL PROPERTY AND SPIN-OFFS

4 European patent (EP) applications

- European patent application *Electrode material comprising silicon nanowires covered by mesoporous oxide nanostructured coating and ionic liquid electrolytes for energy storage applications*. NEOS Group. Pedro Gómez-Romero and Deepak Dubal.
- European patent application *Method for monitoring radius and shape variations of atomic force microscope cantilever tips and device thereof*. Force Probe Microscopy and Surface Nanoengineering Group. Jordi Fraxedas.
- European patent (EP) application *Photodiode with intense photovoltage or photocurrents*. Nanostructured Materials for Photovoltaic Energy and Oxide Nanoelectronics Group. Monica Lira-Cantu, Amador Pérez and Gustau Catalán.
- European patent (EP) application *Flexoelectric*. Oxide Nanoelectronics Group. Gustau Catalan and Jackeline Narváez.

1 Spanish patent (ES) application:

- Spanish patent application *Graphene-based electroactive nanofluids as liquid electrodes in flow cells*. NEOS Group. Pedro Gómez-Romero, Deepak Dubal and Daniel Gómez-Casañ.

1 US patent (US) application:

- US patent (US) application *Nanoemulsion optical*. NANOSFUN Group. Daniel Ruiz-Molina and Claudio Roscini.

3 granted patents:

- The patent Ref. ICN PAT 01/08 *Conjugates comprising nanoparticles coated with Platinum containing compounds* has been granted in USA on 21/01/2015.
- The patent Ref. ICN PAT 01/11 *Method for the preparation of metal organic frameworks* has been granted in Europe on 18/05/2015.
- The patent Ref. ICN PAT 01/08 *Conjugates comprising nanoparticles coated with Platinum containing compounds* has been granted in Japan on 08/12/2015.

6 international PCT extensions filed:

- *Novel compositions comprising lipidic coated bacteriophages*.
- *Liposome-based immunotherapy*.
- *Inspecting nanostructures*.
- *Method of forming an electronic device on a flexible substrate*.
- *A reclosable adhesive strip*.
- *Biocidal composition with dual immediate and remnant activity*.

2 patent licensing agreements:

- A patent license agreement has been signed with an European company corresponding to the patent *Method for the preparation of metal organic frameworks*. The agreement lasts as long as the patent is valid. The license agreement includes a continuous collaboration project with the company.
 - A second patent licensing agreement has been signed with the ICN2 spin-off company APPLIED NANOPARTICLES, S.L., regarding the patent *Biogas Production*. A previous Option License agreement was signed last year. The agreement lasts as long as the patent is valid.
- An additional Industrial Secret know-how related to a new synthesis of graphene has been filed.

ICN2 entered into the spin-off company Futurechromes, S.L.

On April 20th 2015 ICN2 entered as a shareholder of the company Futurechromes, S.L. The company was created on June 2014.

● OTHER HIGHLIGHTS

- Technology Transfer activities include contacts and meetings with more than 114 companies, 44 NDAs signed, 8 patent license discussions, 9 R&D contracts signed, 28 R&D services performed, 14 technology assessments, two IP in-house training sessions, two industrial PhDs with local industries and the evaluation of 5 spin-off companies.
- Participation in main sector trade fairs: ImagineNano, Graphene Connect, EuroNanoForum, Novum, Trendpack and 9th *Aplicaciones Industriales de la Nanotecnología (AIN)*, among many others.
- Royalties income by licensed patents and know-how have been raised more than 360%.

Public Outreach

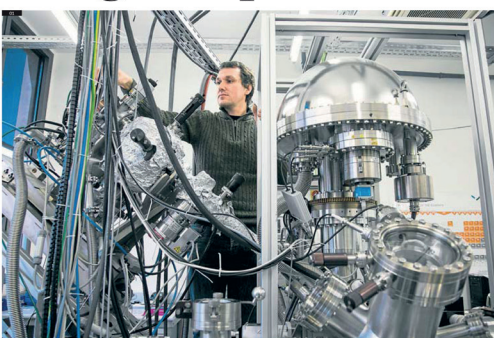
Beyond ICN2's principal mission to be a centre of scientific excellence and frontier research in Nanoscience and Nanotechnology, the Institute also has a social responsibility in Science Communication and Education. As a publicly-funded research institute, ICN2 is committed to serving, and engaging with 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 ICN2's future success in the research arena. Furthermore, providing contents created for 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.



Nanotecnologia: el poder de les coses petites

Els materials minúsculs han conquerit el nostre dia a dia i han revolucionat l'electrònica, la medicina i la construcció



NEERAZA CASALLAS BARCELONA
 Els materials minúsculs han conquerit el nostre dia a dia i han revolucionat l'electrònica, la medicina i la construcció. Els nanomaterials són aquells que tenen dimensions entre 1 i 100 nanòmetres, és a dir, menys d'un mil·límetre. Però en els últims anys, aquests materials han estat revolucionant molts aspectes de la nostra vida. Per exemple, en el camp de la medicina, s'utilitzen per crear dispositius que poden detectar malalties a nivell molecular o per administrar medicaments de manera més precisa. També s'utilitzen en el desenvolupament de nous materials amb propietats úniques, com els nanotubos de carboni o els nanofils, que són molt més resistents que els materials convencionals.

El futur de la nanotecnologia està molt prometedor. Els científics estan treballant per superar les limitacions dels materials actuals i crear nous materials amb propietats úniques. A més, la nanotecnologia està revolucionant molts aspectes de la nostra vida, des de la medicina fins a la construcció i l'energia.

UNOS
 L'aplicació d'aquesta tecnologia arriba a tots tipus de dispositius. Els nanomaterials són molt petits, però tenen propietats úniques que els fan molt útils. Per exemple, els nanotubos de carboni són molt resistents i conductors, cosa que els fa molt útils en el desenvolupament de nous materials. També s'utilitzen en el desenvolupament de nous dispositius electrònics, com els transistors de nanotubos de carboni, que són molt més petits i eficients que els transistors convencionals.

INVESTIGACIÓ
 Els nanomaterials són molt petits, però tenen propietats úniques que els fan molt útils. Per exemple, els nanotubos de carboni són molt resistents i conductors, cosa que els fa molt útils en el desenvolupament de nous materials. També s'utilitzen en el desenvolupament de nous dispositius electrònics, com els transistors de nanotubos de carboni, que són molt més petits i eficients que els transistors convencionals.

Falten més estudis toxicològics i un marc legal
 L'impacte ambiental de les nanotecnologies és un tema que està guanyant força. Els nanomaterials són molt petits, però poden tenir efectes tòxics a nivell molecular. Per això, és important fer més estudis toxicològics per entendre millor els riscos dels nanomaterials. A més, cal establir un marc legal que reguli l'ús dels nanomaterials i protegeixi la salut pública i l'ambient.

EL MUNDO / AÑO XIV / MARTES 5 DE MARZO DE 2015
 El grup de TICN2 competeix en múltiples àrees amb treballs pràctics de la recerca. 63. Fabrice Ordière, director del grup.

INNOVADORS 3
 Imagen de un dispositiu de experimentació fabricat amb un silici de ICN2. Aquesta imatge mostra un dispositiu de experimentació fabricat amb un silici de ICN2, que està dissenyat per estudiar les propietats dels nanomaterials.



CIENCIA

Salto en la eficiencia energética de dispositivos electrónicos

Investigadores del Instituto Catalán de Nanociencia y Nanotecnología, junto con otros centros europeos, han descubierto propiedades en el silicio que pueden ayudar a reducir el consumo energético y la emisión de calor de los aparatos electrónicos. Por Alex Carambut

Cuando trabajamos con un ordenador portátil sobre las pizarras, pronto sentimos el calor que emite, y eso es algo que todos podemos haber experimentado. Pero los investigadores de ICN2 han conseguido reducir el consumo energético y la emisión de calor de los aparatos electrónicos. Esto se logra gracias a la descubierta de nuevas propiedades en el silicio, un material que se utiliza ampliamente en la fabricación de dispositivos electrónicos.



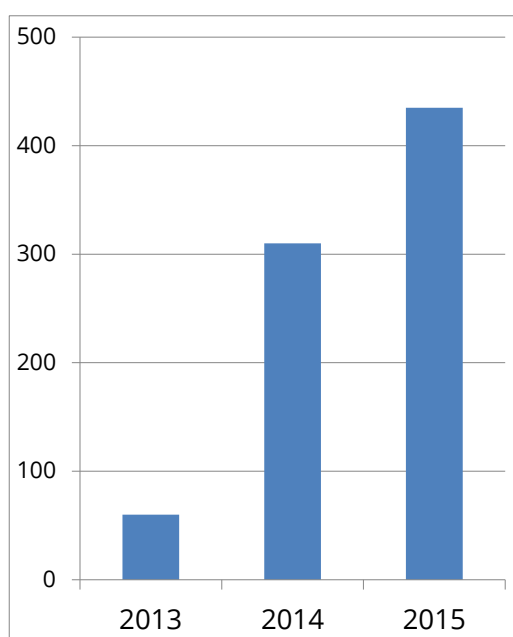
La conductividad térmica está determinada por la composición química
 Los investigadores de ICN2 han descubierto que la conductividad térmica de los materiales depende de su composición química. Esto significa que podemos diseñar materiales con propiedades térmicas específicas, lo que es muy útil para mejorar la eficiencia energética de los dispositivos electrónicos.

Habría una alternativa limpia a los líquidos de enfriamiento de los grandes 'data servers'
 Los grandes servidores de datos generan mucho calor, lo que requiere sistemas de enfriamiento complejos y costosos. Los investigadores de ICN2 han descubierto una alternativa limpia y eficiente para enfriar estos dispositivos, lo que podría reducir significativamente el consumo energético de los centros de datos.

● HIGHLIGHTS 2015

Media relations: In 2015 ICN2 redoubled its efforts to reach the general public through the media. The following chart shows the number of Online Impacts on journalistic websites during the last two years.

Online impacts on journalistic websites



Traditional media appearances of ICN2 in 2014

Magazines	4
Newspapers	14
Radio	4
TV	3

NanoEduca Kits: Scientists, teachers and communicators work together in an ICN2 co-funded initiative, involving UB, UAB and CESIRE, to design a program to bring nanoscience into the classrooms: NanoEduca. It includes the production of a kit of nanoscience-related educative experiments. The kits are intended to offer teachers a set of interactive experiences involving nanoscience that are linked to subjects such as Chemistry, Physics, Mathematics or even Philosophy.

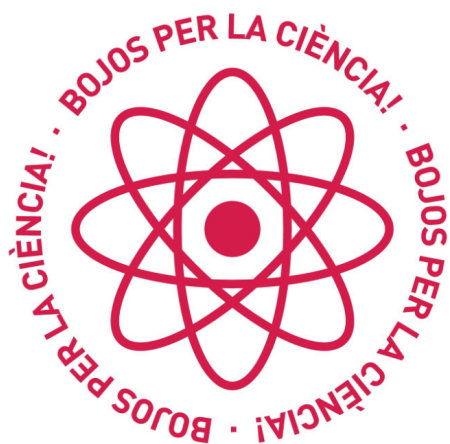


The Project is funded by the *Fundación Española para la Ciencia y la Tecnología - Ministerio de Economía y Competitividad*, the ICN2 Severo Ochoa Program and the *Fundació Catalana per a la Recerca i la Innovació (FCRi)*. The kits are now being tested in a Pilot program involving 20 schools.

Mad for Physics (*Bojos per la Física*):

The Fundació Catalunya / La Pedrera has developed a Program to open the doors of the most relevant research institutes to the most excellent High School students. ICN2 and IFAE have developed a pilot program to offer in 2016 the first edition of Mad for Physics (*Bojos per la Física*).

This initiative allows 25 students to interact with researchers from ICN2, IFAE, UAB and the Alba Synchrotron during 10 work sessions. The challenge is to design an experimental experience for the students in addition to share some concepts and ideas about what does being a researcher in physics mean.



Young Ones and Science (*Joves i Ciència*):

The *Fundació Catalunya / La Pedrera* offers to excellent High School students the opportunity to enjoy a short stay at selected research centers. Traditionally ICN2 Groups participate yearly in this initiative that offers the first research experience to potential future researchers. The students visit the ICN2 during 1-2 weeks to complete a 30-40 hours program that offers them a global view about the research in a nanoscience laboratory and a more detailed experience in a selected topic.



ESCOLAB. Lab tours offer young students the opportunity to enter a Research Facility and interact with real scientists. Those activities are short term actions that, combined with other actions defined afterwards, make possible a real bond with young students and engagement with science in general and nanoscience in particular.

ESCOLAB is an initiative led by the Barcelona City Hall. ICN2 has been part of it from the very beginning.



100xCiència: Communicating Frontier Science.

This two day encounter, held in La Palma on October 2015, joined the 20 Severo Ochoa Centres of excellence in Spain. It was focused on the communication challenges and the frontier research developed by those centers. The Program included plenary sessions with the Severo Ochoa Centres and invited communicators, round table sessions with interchange of ideas on good praxis and examples of success.



Pedro Gomez Romero wins the XXI European Science Communication Award. The prize recognizes the dissemination skills of the CSIC researcher and Group Leader at ICN2 Prof Pedro Gómez-Romero. "Creators of the future", the awarded work, will be published in the collection of science dissemination books *Sense Fronteres*, co-published by the University of Valencia and Edicions Bromera. The award was presented at the gala of the *XXVII Premis Literaris Ciutat d'Alzira* on November 2015.



Annual Report 2015

© **Institut Català de Nanociència i Nanotecnologia (ICN2)**

Marketing and Communication Department

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