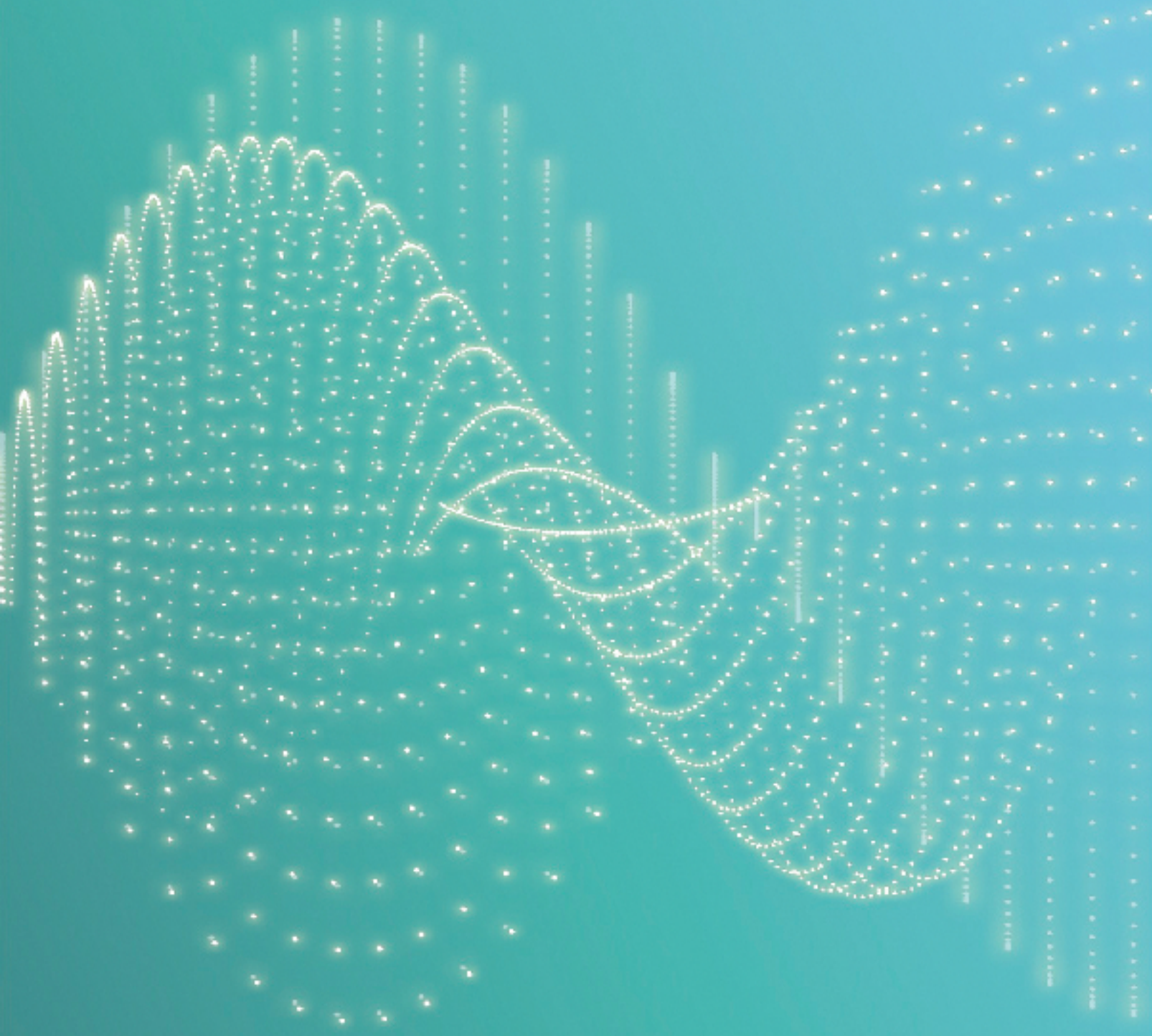
ANNUAL REPORT 2016

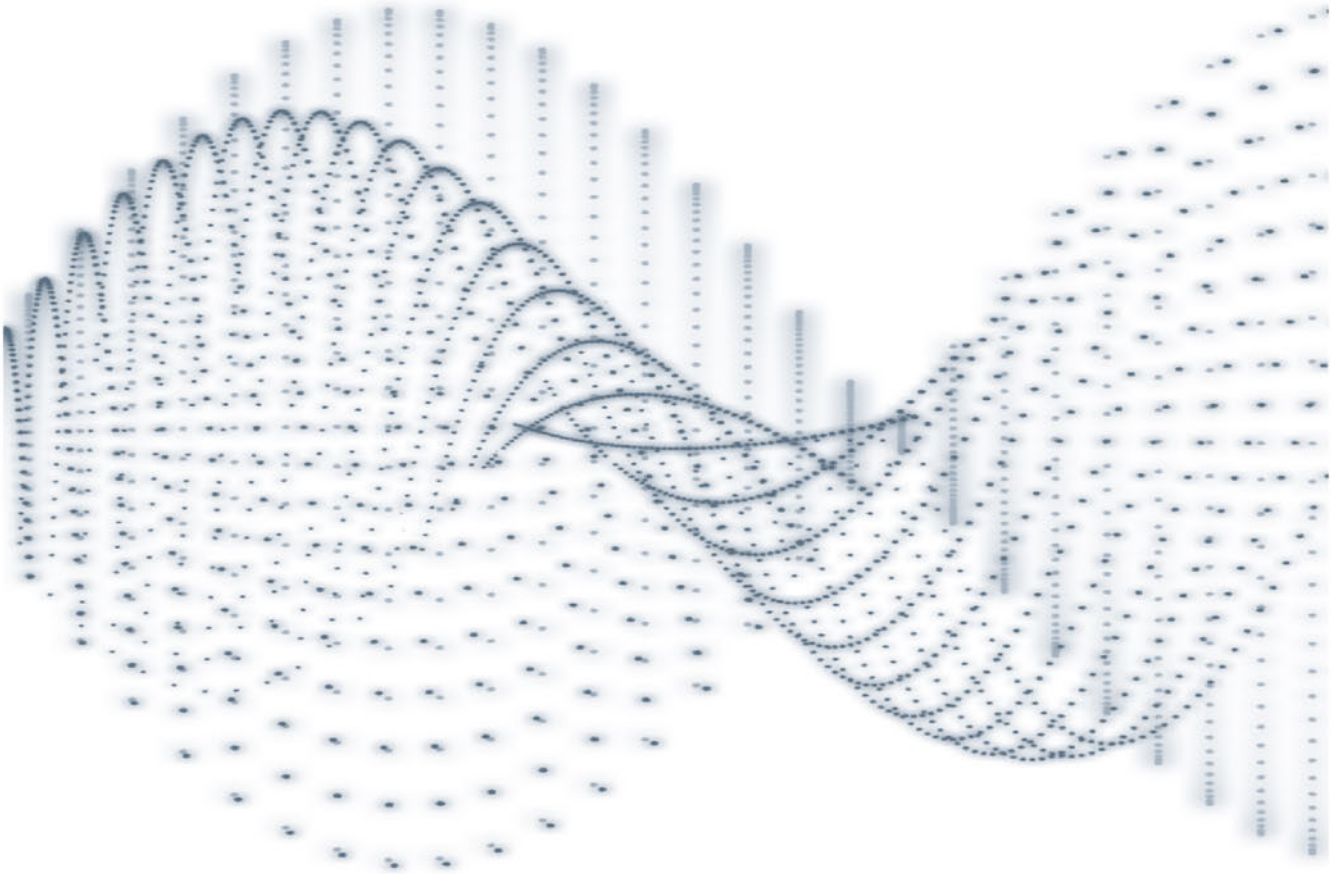


ICN2

Institut Català
de Nanociència
i Nanotecnologia

EXCELENCIA
SEVERO
OCHOA

ANNUAL REPORT 2016



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Letter from the Director

Prof. Pablo Ordejón
Director, ICN2

2016 was once again a year of growth and intense activity for the Catalan Institute of Nanoscience and Nanotechnology (ICN2).

The scientific production of the ICN2 has experienced a boost this year, with a total of 206 indexed publications (a remarkable increase of 32% with respect to the figures of the previous year), while maintaining a very high average impact factor, which has even slightly increased to 6.75.

The ICN2's most important institutional project, the "Severo Ochoa Centre of Excellence", had its mid-term evaluation and assessment during the second half of 2016. The outcome of this process was very positive, highlighting not only the high level of scientific excellence made possible through this source of funding, but also the advances made in areas like technology transfer, internal collaboration, training, outreach and common infrastructure.

The ICN2 continues to be strongly involved in the European Commission's Graphene Flagship. Specifically, in 2016 the ICN2 coordinated the launch of a new work package devoted to biomedical technologies, co-led by Prof. Jose A. Garrido. This joins the other work package co-led by the ICN2 since the start of this FET Flagship, on spintronics. Together these roles afford the ICN2 a strong presence in project leadership and a solid base from which to make contributions to its scientific goals.

Meanwhile, cooperation within the Barcelona Institute of Science and Technology (BIST) has also strengthened, consolidating a research initiative that delivers high scores across all excellence indicators. 2016 was a period of intense planning, strategy development and resource consolidation. Specific projects have been defined and, in many cases, launched, although they are expected to bloom more fully during 2017. Overall, BIST continues to be a strategic alliance for the future of all of its members, not least the ICN2.

In this Annual Report you will also find figures of our successful track record in securing national and international competitive funding. We also outline our achievements in technology transfer, which are the result of a focused strategy launched in 2012 to promote these activities within the ICN2, which is already producing impressive results.

Overall this year has seen the further consolidation of the ICN2 as one of Spain's top research centres. It is my pleasure to present this Annual Report, and I invite you to explore its pages and join us on our journey to the nanoworld.

Sincerely,

Prof. Pablo Ordejón
Director, ICN2

Prof. Ordejón earned his degree in Physics (1987) and PhD in Science (1992) at the *Universidad Autónoma de Madrid*. 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 to the former CIN2 (now ICN2) as the leader of the Theory and Simulation Group, where he is currently a CSIC Research Professor. Since July 2012 he has served as Director of the ICN2.

He has published nearly 200 scientific articles, which have received over 22,000 citations (h-index of 53). 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 oversaw the Condensed Matter Physics subject area of the Physics Panel of the Spanish National Evaluation and Foresight Agency (ANEP) from 2003 to 2006, and was 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 electronic transport in nanoscale devices and electronic processes at surfaces and 2D materials, among many others. He maintains frequent collaborations with industrial laboratories on the simulation of material processes at the atomic level. He is a co-founder of the spinoff company SIMUNE.

Organisation and People

OUR MISSION

Our goal is to become a leading international centre for research in nanoscience and nanotechnology

ROLE IN SOCIETY

The research developed at the ICN2 encompasses not only basic science, primarily through European and national collaborative projects, but also more applied technological science. It draws on in-house expertise and industrial collaborations to fulfil its role to enable and encourage the uptake of nanotechnologies by both industry and society at large. It also nurtures strong partnerships with universities and the scientific community, other research and technology centres, the private R&D sector and society in general to this end.

A LITTLE BIT OF HISTORY

The *Institut Català de Nanociència i Nanotecnologia* (Catalan Institute of Nanoscience and Nanotechnology, ICN2) is a non-profit international research institute located in Barcelona, Spain. It was created in 2013 as the final stage in a process of bringing together nanoscientists working for the *Consejo Superior de Investigaciones Científicas* (Spanish National Research Council, CSIC) and the former *Institut Català de Nanotecnologia* (ICN), itself established in 2003 by the Ministry of Innovation, Universities and Enterprise (DIUE) of the *Generalitat de Catalunya* (Government of Catalonia) and the *Universitat Autònoma de Barcelona*. The *Centro de Investigación en Nanociencia y Nanotecnología* (CIN2) was established as a first approximation to this goal in 2006, a move that was later consolidated by the incorporation of CSIC into the Board of Trustees of the former ICN. And thus the ICN2 was born, with the goal of strengthening its international leadership through frontier research and a focus on technology transfer.

The building that houses the ICN2 was officially inaugurated on 20 January 2014. Shortly afterwards, the institute became an accredited Severo Ochoa Centre of Excellence, the highest national recognition of scientific excellence and leadership that served by way of confirmation that we were on the right track.

The ICN2 is one of the founding members and current patrons of the **Barcelona Institute of Science and Technology (BIST)**, whose mission is to consolidate and promote multi-disciplinary, cutting-edge research in science and technology with and between its member institutions. Fellow members include the Centre for Genomic Regulation (CRG), the Institute for Photonic Sciences (ICFO), the Institute of Chemical Research of Catalonia (ICIQ), the High Energy Physics Institute (IFAE) and the Institute for Research in Biomedicine (IRB Barcelona).

ORGANISATION

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

Research activities are directed by group leaders, senior scientists of international repute who lead teams focused on their respective areas of expertise. Their activities are supported by specialised laboratory engineers, and technical and administrative staff.

The ICN2 comprises 17 research groups, and six research support divisions and facilities covering different areas of nanoscience and nanotechnology. The 7 administration departments, overseen by the ICN2 General Manager Mr. Lluís Bellafont, also provide support to the in-house researcher community.

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 Nanophysics 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
- Nanoimprint Lithography Platform

BOARD OF PATRONS

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Minister for Business and Knowledge, Government of Catalonia.

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General Director for Research, Ministry of Business and Knowledge, Government of Catalonia.

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Rector of the Universitat Autònoma de Barcelona (UAB).

Lluís Calvo,
Institutional CSIC Coordinator in Catalonia.

Arcadi Navarro,
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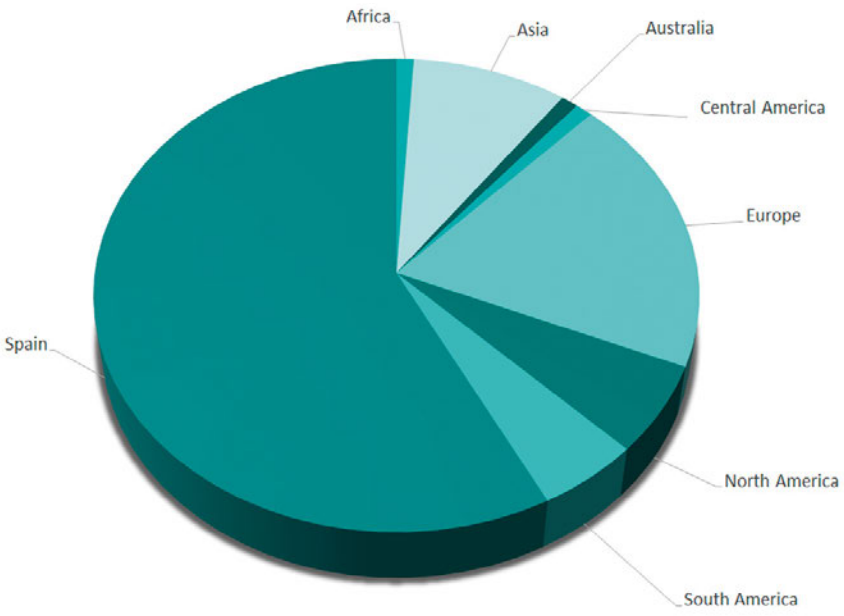
Distribution of the research community by gender and role in 2016		
Job by Role	Male	Female
Group Leader	14.0	3.0
Senior Researcher	9.0	3.8
Ramón y Cajal Researcher	2.1	1.0
Postdoctoral Researcher	33.2	9.9
Doctoral Student	42.5	16.8
Laboratory Engineer	0.0	1.0
Technician	6.1	1.9
Project Manager	0.0	4.8
Total	106.9	42.2

Nationality	
Africa	1%
Asia	9%
Australia	1%
Central America	1%
Europe	19%
North America	6%
South America	6%
Spain	57%



THE ICN2 TEAM

The ICN2 is defined by its people. From its senior researchers to the administration staff, the people at the ICN2 work as a team, pooling their creativity, energy, dedication and hard work to further the goals of the institute.

The ICN2 prides itself on being an attractor of talent. The work environment it provides to its entire staff and the image it cultivates draw talented scientists, technicians and support personnel from around the world. It boasts highly-qualified scientific personnel and prolific scientific output. Many of the researchers who complete their PhD or postdoctoral stay at the ICN2 have moved on to such prestigious institutes as Harvard, Yale, the Max Planck institutes, CNRS and CEA. This in turn means the ICN2 is continuously able to offer new positions for junior scientists.

The ICN2 is an equal opportunity employer committed to diversity and the inclusion of people with disabilities, and strives to achieve a workforce that is diverse in age, culture nationality and gender. Over the course of 2016, the ICN2 had an annual average workforce of 261 people.

Research and Technical Development

Severo Ochoa Award - Nanodevices for Social Challenges

The impact of the research developed at the ICN2 reaches far into the fields of life sciences (medicine, health and the environment), energy, and ICT. This is one of the main reasons that prompted the Spanish Ministry of Economy, Industry and Competitiveness to award the Institute with its Severo Ochoa Centre of Excellence accreditation in 2014. This award is the highest national recognition of scientific excellence and leadership, and denotes those research institutes in Spain that are among the best in the world in their field. It also places value on their potential for industrial and social impact, and their ability to attract talent. When the ICN2 received its accreditation, only 18 research centres could boast this recognition. As of 2016 this count now stands at 23 centres.

The funding provided by the Severo Ochoa accreditation is devoted to the ICN2's Severo Ochoa "Nanodevices for Social Challenges" research programme. Largely focused on the recruitment of staff and equipment procurement, it is enabling the ICN2 to make great strides in the development of devices for a broad range of applications.

Furthermore, the programme has catalysed internal collaborations between the different research groups at the ICN2, setting a fast pace for advances in the search for practical applications of the knowledge generated at the Institute. As a result, scientific advances in areas such as flexoelectricity, spintronics, nanofluids, encapsulated nanoparticles, graphene growth, nanopatterning and nanophotonics have led to new device concepts and new emerging technologies.

In 2016 the "Nanodevices for Social Challenges" programme underwent a mid-term evaluation, the results of which underlined the positive impact of the Severo Ochoa accreditation and funding on institutional performance indicators. The award has also served to enhance the ICN2's international visibility, which in turn has considerably boosted its level of international collaboration and networking activities. The success of the Institute's H2020 funding bids and technology transfer actions, combined with the growing presence of the ICN2 in the media and other outreach actions, all speak to the impact of the Severo Ochoa accreditation on the Institute, and of the Institute on industry and society at large.

CROSS-DISCIPLINARY APPROACHES

The Severo Ochoa programme is based on four interdisciplinary approaches:

• Growth and synthesis of nanomaterials

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

• Nanofabrication

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

• Characterisation and metrology

World-class expertise in a broad range of characterisation techniques, some of which have been developed by ICN2 researchers. Experience in nanometrology, including two patent applications and plans to establish a dedicated industrial nanometrology centre in collaboration with private sector partners.

• Theory and simulation

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

RESEARCH AREAS

The research carried out under the Severo Ochoa "Nanodevices for Social Challenges" programme will lead to specific market-oriented applications and devices that offer 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 on point-of-care devices and biosensors, an ERC grant to develop nanomaterials for diagnostics and therapy, commercialisation in the form of licensed patents and two spin-off companies in 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, and spectroscopy and characterisation. Leadership in EU projects and platforms (Graphene Flagship, Photonics platform, ERC grant in piezoelectrics), collaborative prototyping with industry for 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, heat transfer, and nanodevice fabrication and characterisation.

In 2009 the European Commission identified a series of key enabling technologies (KET), highlighted for their potential to strengthen European industry and capacity for innovation. Specifically,

the six technologies identified are nanotechnology, micro-/nanoelectronics, advanced materials, photonics, industrial biotechnology, and advanced manufacturing. To a greater or lesser extent, the "Nanodevices for Social Challenges" programme involves all six, making the research carried out at the ICN2 hugely relevant at the European and international levels.

BEYOND RESEARCH

In addition to the cross-disciplinary scientific goals, the ICN2 is in the midst of a comprehensive **recruitment and training campaign** aimed at attracting and developing the professional careers of talented researchers, junior and senior, contracted under the Severo Ochoa programme. This includes the PhD, postdoctoral and visitors programmes; the ICN2-User Programme Training; Academia Intern Programme; and periodic workshops and seminars). The actions taken so far have allowed the Institute to obtain the Human Resources Excellence in Research Badge by the European Commission.

The ICN2 Severo Ochoa programme also encompasses other ambitious actions, including the creation of a gender action plan, and international knowledge dissemination and outreach activities. The ICN2's public profile has already been boosted through media engagement actions, while other outreach actions have focused on piquing the interest of a young public, from school children through to undergraduates.

Meanwhile, the Scientific Advisory Board of ICN2 acts as external **Scientific and Industrial Advisory Committee** (SIAC) for the Severo Ochoa project, providing advice as to strategic directions and project progress. The work plan is divided into **seven work packages**, one for each area of application and interdisciplinary approach.

Overall management is led by the **Project Management Committee**, made up of one representative from each work package, plus two additional members representing dissemination and technology transfer.

Research Groups

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

Advanced Electron Nanoscopy Group

Main Research Lines

- **Advanced transmission electron microscopy (TEM) 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 behaviour of materials at the nano and atomic scales, from growth mechanisms to their physical properties**

GROUP MEMBERS

Arbiol Cobos, Jordi, ICREA Research Professor and Group Leader

de la Mata Fernández, María, Postdoctoral Researcher

Genç, Aziz, Visiting Postdoctoral Researcher

Lindberg, Anna Helmi Caroline, Visiting Doctoral Student Student

Martí Sánchez, Sara, Doctoral Student Student

Roselyne, Jeanne-Brou, Undergraduate Student

Schlafer, Johannes, Postdoctoral Researcher

Tang, Pengyi, Visiting Doctoral Student Student

GROUP LEADER

Prof. Jordi Arbiol

Prof. Jordi Arbiol was born in Molins de Rei (Catalonia), 1975. Having graduated in Physics from the *Universitat de Barcelona* (UB) in 1997, he went on to obtain his PhD (European Doctorate and PhD Extraordinary Award) in 2001 from this same institution in the field of transmission electron microscopy (TEM) applied to nanostructured materials.

He was an assistant professor at the UB. From 2009 to 2015 he was a group leader at the *Institut de Ciència de Materials de Barcelona*, ICMAB-CSIC, as well as the scientific supervisor of its electron microscopy facilities. He has held the position of vice-president of the Spanish Microscopy Society (SME) since 2013, having been a member of its Executive Board since 2009.

Since 2015 he has been the leader of the Advanced Electron Nanoscopy Group at the ICN2. He was awarded the 2014 EMS Outstanding Paper Award, the 2014 EU40 Materials Prize (E-MRS) and was listed in the Top 40 under 40 Power List (2014) by The Analytical Scientist. He has more than 283 peer-reviewed publications and more than 9500 citations.

NEW PROJECTS & MILESTONES

Led by ICREA Research Prof Jordi Arbiol, the aim of this group is to apply advanced electron microscopy tools and related spectroscopies (EELS, EDX and CL) to the understanding of the nanoworld down to the atomic scale. The increasing interest in materials science, nanoscience and nanotechnology has created a major global demand for nanoscopy tools that enable the observation and chemical analysis of synthesized nanostructures at atomic scale.

Exploring the limits of physical resolution in advanced electron microscopy, and understanding the behaviour and related properties of materials at the nanoscale are the central aims of the research carried out by this group. The newest research lines being pursued are based on single atom recognition and localisation in embedded quantum structures. In parallel the group works to develop new methodologies for performing a direct correlation between the structural and chemical properties at the atomic scale and the physical properties at sub-nanometre scale (photonics, plasmonics and phononics), together with a detailed atomic-level study of the growth mechanisms in nanostructures using 3D models.

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Ultrafast Epitaxial Growth Kinetics in Functional Oxide Thin Films Grown by Pulsed Laser Annealing of Chemical Solutions, Queraltó, A., Pérez Del Pino, A., De La Mata, M., Arbiol, J., Tristany, M., Obradors, X., Puig, T., *Chemistry of Materials*; **28 (17)**: 6136-6145. 2016. IF: 9.407

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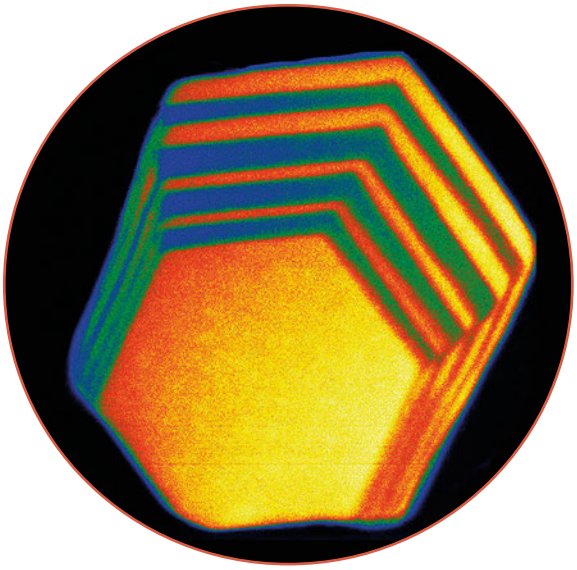
UV Photosensing Characteristics of Nanowire-Based GaN/AlN Superlattices, Lähnemann, J., Den Hertog, M., Hille, P., De La Mata, M., Fournier, T., Schörmann, J., Arbiol, J., Eickhoff, M., Monroy, E., *Nano Letters*; **16 (5)**: 3260-3267. 2016. IF: 13.779



PROJECTS

Detección de Átomos Individuales mediante Nanoscopias Electrónicas Avanzadas, Funded by **Ministerio de Economía, Industria y Competitividad, Spain** (EUROPA EXCELENCIA Call), 18/06/2015 to 31/03/2016, Jordi Arbiol

e-Nanoscopías y Hetero-Multicapas para Dispositivos y Sistemas Tandem Basados en Nanoestructuras para Transformación de la Energia Solar en Combustibles Solares, Funded by **Ministerio de Economía, Industria y Competitividad, Spain** (RETOS Call), 01/01/2015 to 31/12/2017, Jordi Arbiol

CONTRIBUTIONS

Non-planar nanostructures at atomic scale, **YUCOMAT 2016**, Herceg Novi, Montenegro, 07/09/2016, Jordi Arbiol (plenary talk)

A close look to the atoms: a journey to the nanoworld through advanced electron microscopy, **Applied Nanotechnology and Nanoscience International Conference 2016 (ANNIC 2016)**, Barcelona, Spain, 11/09/2016, Jordi Arbiol (plenary talk)

Hollow Metal Nanostructures for Enhanced Plasmonics, **SPIE Photonics West 2016 (SPIE BIOS 2016)**, San Francisco, USA, 13/02/2016, Jordi Arbiol (invited speaker)

Insight on the fine structure of Nanowires down to single atom detection: correlation to their growth and morphological properties, **EMN Meeting on Nanowires**, Amsterdam , The Netherlands, 17/05/2016, Jordi Arbiol (invited speaker)

2D Semiconductor nanostructures at atomic scale, **2016 EMN 2D Materials Meeting**, San Sebastian, Spain, 20/05/2016, Jordi Arbiol (invited speaker)

Non-Planar Nanostructures at atomic scale: from atomic structure to photonics in the (S) TEM, **ISM Golden Jubilee 2016**, Haifa, Israel, 31/05/2016, Jordi Arbiol (invited speaker)

Insight on the fine structure of Semiconductor Nanowires down to single atom detection: correlation to their physical properties, **European Microscopy Congress 2016 (EMC2016)**, Lyon, France, 30/08/2016, Jordi Arbiol (oral)

Combined TEM/STEM and In-situ c-AFM Characterization of 2D Nanoflake-like Heterostructures for Energy Storage and Conversion Applications, **European Microscopy Congress 2016 (EMC2016)**, Lyon, France, 31/08/2016, Peng-Yi Tang (poster)

InAs/InSb: From Nanowires to Nanomembranes, **European Microscopy Congress 2016 (EMC2016)**, Lyon, France, 31/08/2016, Maria de la Mata (poster)

Structural and chemical characterization and 3D modelling of metal oxide core-shell nanoparticles with complex morphology, **European Microscopy Congress 2016 (EMC2016)**, Lyon, France, 31/08/2016, Sara Martí (poster)

DISSEMINATION CONTRIBUTIONS

Veure els àtoms de prop: UN VIATGE AL NANOMON, **Dilluns de la Ciència al CSIC**, Barcelona, Spain, 18/04/2016, Jordi Arbiol (invited talk)

Non-planar Nanostructures at Atomic Scale, **ICIQ–Institut Català d'Investigació Química**, Tarragona, Spaim, 23/05/2016, Jordi Arbiol (invited talk)

Non-planar Nanostructures at Atomic Scale, **Niels Bohr Institute of Copenhagen**, Copenhagenm Denmark, 07/06/2016, Jordi Arbiol (invited talk)

Non-planar Nanostructures at Atomic Scale, **Ecole Polytechnique, Palaiseau**, France, 10/10/2016, Jordi Arbiol (invited talk)

Non-planar Nanostructures at Atomic Scale, **Instituto de Ciencia de Materiales de Madrid (ICMM)**, Madrid, Spain, 17/10/2016, Jordi Arbiol (invited talk)

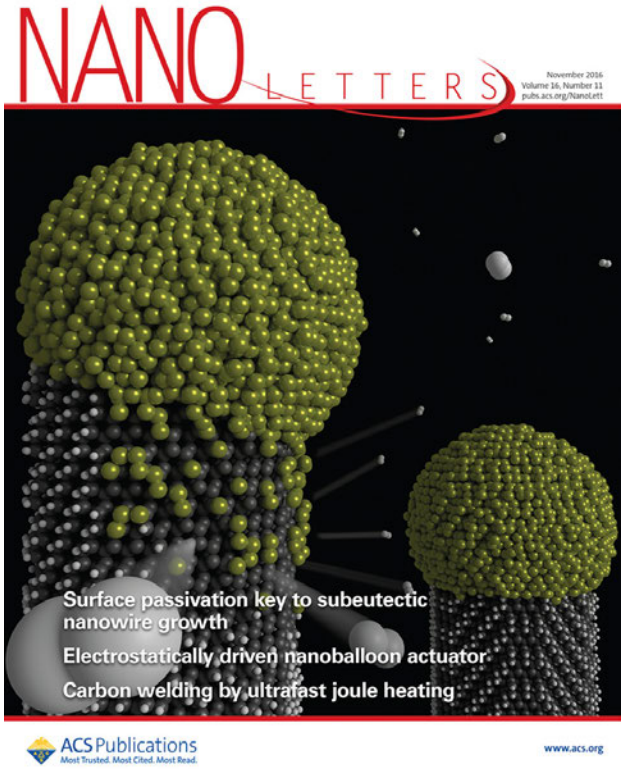
Veient els àtoms de prop: UN VIATGE AL NANOMÓN, **21ª edició de la Setmana de la Ciència**, Sabadell, Barcelona, 16/11/2016, Jordi Arbiol (invited talk)

PARTICIPATED CONGRESSES

Flanders research Foundation (FWO), Belgium, 2015-2018. Jordi Arbiol - Expert panel member

International Conf. on Modern Materials & Technologies 2016 (CIMTEC 2016), Perugia, Italy, 5-9 June, 2016. Jordi Arbiol - Member of the Scientific Committee (International advisory board)

Applied Nanotechnology and Nanoscience International Conference 2016 (ANNIC 2016), Barcelona, Spain, 9-11 November, 2016. Jordi Arbiol - Chairs committee member



Advanced Electronic Materials and Devices Group

Main Research Lines

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

GROUP MEMBERS

Bonaccini Calia, Andrea Prieto, Doctoral Student
Bousquet, Jessica, Postdoctoral Researcher
Bullock, Christopher John, Visiting Doctoral Student
De la Cruz Sánchez, José Manuel, Doctoral Student
Del Corro García, Elena, Postdoctoral Researcher
García Cortadella, Ramón, Doctoral Student
Garrido Ariza, Jose Antonio, ICREA Research Professor and Group Leader
Hebert, Clement, Postdoctoral Researcher
Kunze, Igor, Doctoral Student
Schäfer, Nathan, Doctoral Student
Viana Casals, Damiá, Doctoral Student
Walston, Steven, Visiting Postdoctoral Researcher

GROUP LEADER

ICREA Prof. Jose Antonio Garrido

Jose Antonio Garrido is an ICREA Research Professor and leader of the ICN2 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 Prof. Jose A. Garrido, the Advanced Electronic Materials and Devices Group joined the ICN2 in September 2015. The group focuses on the materials science and technology aspects of novel electronic materials, with a strong emphasis on carbon materials, such as graphene, as well as other 2D materials (MoS2). The group also works towards the development of technological applications based on these materials in such as electronics, bioelectronics and biosensing, energy storage and conversion, etc.

He received his Master's and PhD degrees in Telecommunication Engineering from the *Universidad Politécnica de Madrid* in 1996 and 2000, respectively. From 2001 to 2004 he worked as a postdoc at the Walter Schottky Institute, *Technische Universität München* (Germany), before becoming the leader of its Functional Carbon Materials Group. He also qualified in experimental physics at this university in 2010, and from 2011 to 2015 held a lecturer (privatdozent) position at its Department of Physics. Jose A. Garrido is an editor for the journal *Diamond and Related Materials* and co-coordinator of the biomedical technologies work package for the European Graphene Flagship initiative.

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

PUBLICATIONS

Flexible graphene transistors for recording cell action potentials, Blaschke B.M., Lottner M., Drieschner S., Calia A.B., Stoiber K., Rousseau L., Lissourges G., Garrido J.A., *2D Materials*; **3** (2, 025007) 2016. IF: 9.611

High surface area graphene foams by chemical vapor deposition, Drieschner S., Weber M., Wohlketzetter J., Vieten J., Makrygiannis E., Blaschke B.M., Morandi V., Colombo L., Bonaccorso F., Garrido J.A., *2D Materials*; **3** (4, 045013) 2016. IF: 9.611

Suppression of Photoanodic Surface Oxidation of n-Type 6H-SiC Electrodes in Aqueous Electrolytes, Sachsenhauser M., Walczak K., Hampel P.A., Stutzmann M., Sharp I.D., Garrido J.A., *Langmuir*; **32 (6):** 1637-1644. 2016. IF: 3.993

Surface State Mediated Electron Transfer Across the N-Type SiC/Electrolyte Interface, Sachsenhauser M., Sharp I.D., Stutzmann M., Garrido J.A., *Journal of Physical Chemistry C*; **120 (12):** 6524-6533. 2016. IF: 4.509

α,ω -dihexyl-sexithiophene thin films for solution-gated organic field-effect transistors, Schamoni H., Noever S., Nickel B., Stutzmann M., Garrido J.A., *Applied Physics Letters*; **108** (7, 073301) 2016.IF: 3.142

PROJECTS

High-density cortical implants for cognitive neuroscience and rehabilitation of speech using braincomputer interfaces, funded by **EC - H2020-FETPROACT-2016-2017**, 01/12/2016 - 30/11/2021, Jose A. Garrido

CONTRIBUTIONS

Graphene Biotechnical Innovation, **Workshop on Graphene Biotechnical Innovation**, Grenoble, France, 23/02/2016, Jose Antonio Garrido (invited speaker)

Graphene bioelectronics and neural interfaces, **BioEl2016 International Winterschool on Bioelectronics**, Kirchberg, Austria, 15/03/2016, Jose Antonio Garrido (invited speaker)

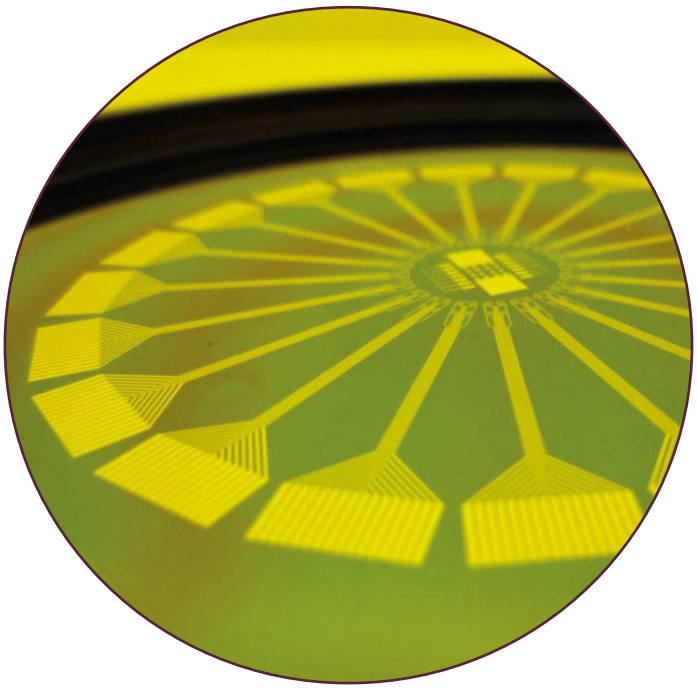
Graphene flexible electronics for neuroprosthetics, **E-MRS Spring 2016**, Lille Symposium Z: Two dimensional crystals and van der Waals heterostructures for nanoelectronics, Lille, France, 03/05/2016, Jose Antonio Garrido (invited speaker)

Graphene flexible electronics for neuroprosthetics, **Graphene Week - Nature Symposium: Exploring graphene for biomedical applications**, Warsaw, Poland, 16/06/2016, Jose Antonio Garrido (invited speaker)

Graphene electronics for flexible neural implants, **2016' International Graphene Innovation Conference (GRAPCHINA 2016)**, Qingdao, China, 23/09/2016, Jose Antonio Garrido (invited speaker)

Graphene flexible electronics for neuroprosthetics, **NanoBioMed2016**, Spain, 23/11/2016, Jose Antonio Garrido (keynote speaker)

Frequency Response of Electrolyte-gated Graphene Electrodes and Transistors, **International Conference on Diamond and Carbon Materials**, Le Corum, Montpellier, France, 05/09/2016, Jose Antonio Garrido (oral)



Atomic Manipulation and Spectroscopy Group

Main Research Lines

- Metal-organic hybrid interfaces
- Graphene-based nanostructures
- Topological insulators

GROUP MEMBERS

Gastaldo, Michele, Doctoral Student
González Cuxart, Marc, SO Doctoral Student
Moreno Sierra, César, Postdoctoral Researcher
Mugarza Ezpeleta, Aitor, ICREA Research Professor and Group Leader
De Oliveira Parreiras, Sofia, Visiting Doctoral Student
Panighel, Mirco, Postdoctoral Researcher
Paradinas Aranjuelo, Marcos, Laboratory Engineer
Peña García, Jose Antonio, Visiting Student
Schirone, Stefano, Doctoral Student
Takahashi, Yukio, Visiting Doctoral Student
Valbuena Martínez, Miguel Angel, Postdoctoral Researcher

GROUP LEADER

Prof. Aitor Mugarza

Prof. Mugarza earned his degree in Physics in 1997 and his PhD in Physics in 2002, both at the *Euskal Herriko Unibertsitatea* (University of the Basque Country). He was awarded a Marie Curie Fellowship to work as a postdoctoral scientist at the Lawrence Berkeley National Laboratory (USA) and the *Institut de Ciència de Materials de Barcelona* (ICMAB). In 2007 he joined the then ICN with a *Ramon y Cajal* Fellowship. He was appointed group leader

NEW PROJECTS & MILESTONES

The main activities of the group in 2016 are related to the synthesis and characterization of carbon-based nanostructures and hybrid metalorganic networks. The studies are carried out within collaboration with national partners via SUPERHYBRID, a project funded by the Spanish Ministry of Economy, Industry and Competitiveness (MINECO). The main objective of the project consists on developing on-surface synthesis routes for the bottom-up fabrication of covalent nanostructures, and methods to manipulate their electronic and magnetic properties via chemical doping with atomic precision and interfacing with different materials. The main lines of research within this project are listed below:

of the ICN2 Atomic Manipulation and Spectroscopy Group in 2013 and has been an ICREA Research Professor since 2015.

His research activity is based on investigating quantum electronic and magnetic phenomena at the nanoscale and developing strategies for their manipulation with atomic precision. By combining scanning tunnelling microscopy (STM) techniques with synchrotron radiation spectroscopy, he correlates microscopic phenomena to macroscopic observables of relevance to the understanding and design of new materials and devices. He is currently focused on novel materials including molecular and graphene nanostructures, topological insulators and other 2D materials with strong spin-orbit interaction.

Graphene nanostructures: we have developed a CVD method to synthesize graphene nanoislands of the size of a few nanometers that can find interesting applications as quantum dots for spintronics, optoelectronics or biosensing. We have demonstrated that, as one scales down, the increasing role of edge and boundary energetics can give rise to structures that are exclusive to the nanoscale. We have also shown how polycrystalline, ill-defined structures can heal into shape-selected single-crystal nanoislands by following thermal treatment.

Graphene nanoribbons: By employing on-surface chemistry, we have been able to synthesize graphene nanoribbons of non-conventional edge and chemical structure. Using precursors with specific design, synthesized by our collaborators at the University of Santiago de Compostela, we have been able to control the morphology and chemical structure of edges with atomic precision. On the other hand, metallic templates with nanostructured surfaces have been exploited to guide the growth and produce ordered arrays of nanoribbons.

Metalorganic networks: Similar on-surface methods have also been tested to produce covalent metalorganic networks. The aim of the covalent bonding strategy is to enhance electronic transport across molecular layers and enhance magnetic interactions between the metallic ions.

In parallel, we have continued our activities related to the synchrotron-based characterization of electronic and magnetic properties of nanomaterials. We have continued our collaboration with the BOREAS beamline of ALBA, by coupling one of our scanning probe microscopes for in-situ structural and electronic/magnetic characterization. We have employed the coupled STM-BOREAS experimental station for our own studies on magnetic properties of metalorganic networks and impurities on topological insulators, and also to continue several collaborations with groups from international (ETH Zurich, CNR, Uni Padova) and national (IMDEA, Uni Zaragoza, Nanogune) institutions.

PUBLICATIONS

Film Quality and Electronic Properties of a Surface-Anchored Metal-Organic Framework Revealed by using a Multi-technique Approach, Liu, J., Paradinas, M., Heinke, L., Buck, M., Ocal, C., Mugnaini, V., Wöll, C., *ChemElectroChem;* **3 (5):** 713-718, 2016. IF: 3.506

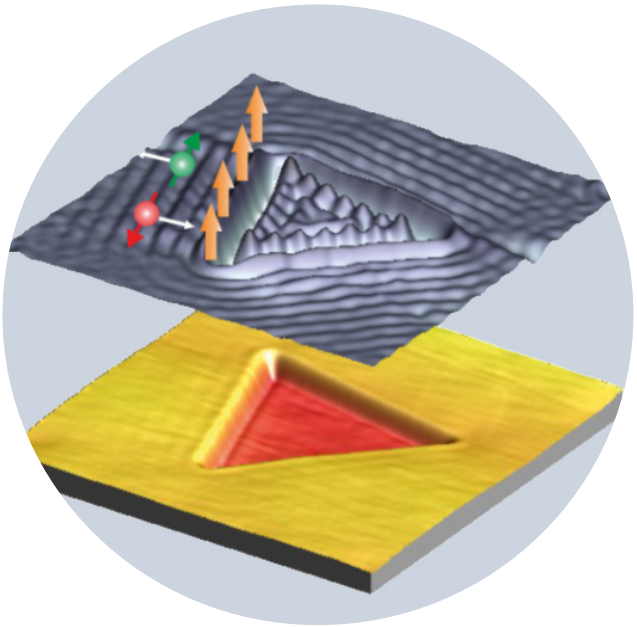
High Temperature Ferromagnetism in a $GdAg_2$ Monolayer, Ormaza, M., Fernández, L., Ilyn, M., Magana, A., Xu, B., Verstraete, M.J., Gastaldo, M., Valbuena, M.A., Gargiani, P., Mugarza, A., Ayuela, A., Vitali, L., Blanco-Rey, M., Schiller, F., Ortega, J.E., *Nano Letters* (21); **16 (7):** 4230-4235, 2016. IF: 13.779

Manipulating the Topological Interface by Molecular Adsorbates: Adsorption of Co-Phthalocyanine on Bi_2Se_3, Caputo, M., Panighel, M., Lisi, S., Khalil, L., Santo, G.D., Papalazarou, E., Hruban, A., Konczykowski, M., Krusin-Elbaum, L., Aliev, Z.S., Babanly, M.B., Otrokov, M.M., Politano, A., Chulkov, E.V., Arnau, A., Marinova, V., Das, P.K., Fujii, J., Vobornik, I., Perfetti, L., Mugarza, A., Goldoni, A., Marsi, M., *Nano Letters;* **16 (6):** 3409-3414, 2016. IF: 13.779

Microfluidic pneumatic cages: A novel approach for in-chip crystal trapping, manipulation and controlled chemical treatment, Abrishamkar, A., Paradinas, M., Bailo, E., Rodriguez-Trujillo, R., Pfattner, R., Rossi, R.M., Ocal, C., Demello, A.J., Amabilino, D.B., Puigmartí-Luis, J., *Journal of Visualized Experiments;* **2016 (113):** art. no. e54193, 2016. IF: 1.113

Superparamagnetism-induced mesoscopic electron focusing in topological insulators, Sessi, P., Rüßmann, P., Bathon, T., Barla, A., Kokh, K.A., Tereshchenko, O.E., Fauth, K., Mahatha, S.K., Valbuena, M.A., Godey, S., Glott, F., Mugarza, A., Gargiani, P., Valvidares, M., Long, N.H., Carbone, C., Mavropoulos, P., Blügel, S., Bode, M., *Physical Review B - Condensed Matter and Materials Physics;* **94 (7):** art. no. 075137, 2016. IF: 3.718

Misfit Dislocation Guided Topographic and Conduction Patterning in Complex Oxide Epitaxial Thin Films, Sandiumenge, F., Bagués, N., Santiso, J., Paradinas, M., Pomar, A., Konstantinovic, Z., Ocal, C., Balcells, L., Casanove, M.-J., Martínez, B., *Advanced Materials Interfaces;* **3 (14):** art. no. 1600106, 2016. IF: 3.365



PROJECTS (Active during 2016)

Híbridos covalentes en superficies, funded by **Ministerio de Economía, Industria y Competitividad, Spain**, 01/01/2014 - 31/12/2016, Aitor Mugarza

2014 SGR 715, funded by **AGAUR**, 01/01/2014 - 30/04/2017, Aitor Mugarza

CONTRIBUTIONS

Metal-organic interfaces: is the metallic surface a problem or an advantage?, **Universidad de Santiago de Compostela- CIQUS**, Santiago de Compostela, Spain, 20/05/2016, A. Mugarza (invited speaker)

Electronic and magnetic properties at the metal-organic interface, **Institute of Physics of the Czech Academy of Scienc**, Prague, Czech Republic, 06/12/2016, A. Mugarza (invited speaker)

Manipulating charge and spin at the metal-organic interface, **Energy Materials Nanotechnology Spring Meeting**, Taipei, Taiwan, 8-11/3/16, A. Mugarza (invited speaker)

Engineering electronic and magnetic properties of metal organic – topological insulator heterostructures, **JPHD 2nd Scientific Meeting of BNC-b Students**, Barcelona, Spain, 29-30/6/16, M. G. Cuxart (oral)

Magnetic impurities on Heavy Metal-Silver surface alloys, **JPHD 2nd Scientific Meeting of BNC-b Students**, Barcelona, Spain, 29-30/6/16, S. Schirone, M.A. Valbuena, R. Robles, N. (oral)

Engineering edge structure and electronic properties of graphene nanoislands by Au intercalation, **JPHD 2nd Scientific Meeting of BNC-b Students**, Barcelona, Spain, 29-30/6/16, M. Gastaldo, G. Ceballos, A. Mugarza (oral)

Effect of functional groups on the formation and self-assembly of graphene nano-ribbons, **On-Surface Synthesis International Workshop**, San Sebastián, Spain, 27/06/2016, Mirco Panighel (poster)

Engineering edge structure and electronic properties of graphene nanoislands by Au intercalation, **Graphene 2016**, Genova, Italy, 18-22/4/16, M. Gastaldo, G. Ceballos, A. Mugarza (poster)

Twin-free Bi_2Te_3 thin films grown by molecular beam epitaxy, **New Trends in Topological Insulators 2016**, Würzburg, Germany, 24-29/7/16, M. G. Cuxart (poster)

On-surface synthesis of periodic 7-13 armchair graphene nanoribbons, **On-Surface Synthesis International Workshop**, San Sebastián, Spain, 27-30/6/16, C. Moreno, M. Panighel, S. Quiroga, M. Vilas, D. Peña, G. Ceballos, A. Mugarza (poster)

Structural and Electronic properties of metalloporphyrin networks before and after covalent bonding, **On-Surface Synthesis International Workshop**, San Sebastián, Spain, 27-30/6/16, J. Hieulle, R. Robles, C. Moreno, A. Mugarza, (poster)

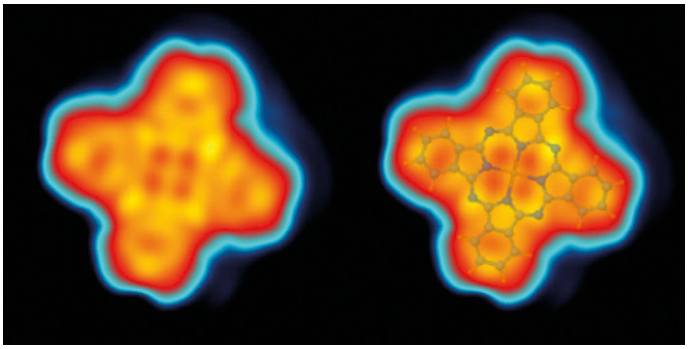
On-surface synthesis of periodic 7-13 armchair graphene nanoribbons, **Fuerzas y Tunel 2016**, Girona, Spain, 5-7/9/16, C. Moreno, M. Panighel, S. Quiroga, M. Vilas, D. Peña, G. Ceballos, A. Mugarza (poster)

Structural and Electronic properties of metalloporphyrin networks before and after covalent bonding, **Fuerzas y Tunel 2016**, Girona, Spain, 5-7/9/16, J. Hieulle, R. Robles, C. Moreno, A. Mugarza (poster)

Magnetic impurities on Heavy Metal-Silver surface alloys, **Fuerzas y Túnel 2016**, Girona, Spain, 5-7/9/16, S. Schirone, M.A. Valbuena, R. Robles, N. (poster)

Engineering edge structure and electronic properties of graphene nanoislands by Au intercalation, **Fuerzas y Túnel 2016**, Girona, Spain, 5-7/9/16, M. Gastaldo, G. Ceballos, A. Mugarza (poster)

Effect of functional groups on the formation and self-assembly of graphene nano-ribbons, **Fuerzas y Túnel 2016**, Girona, Spain, 5-7/9/16, Mirco Panighel (poster)



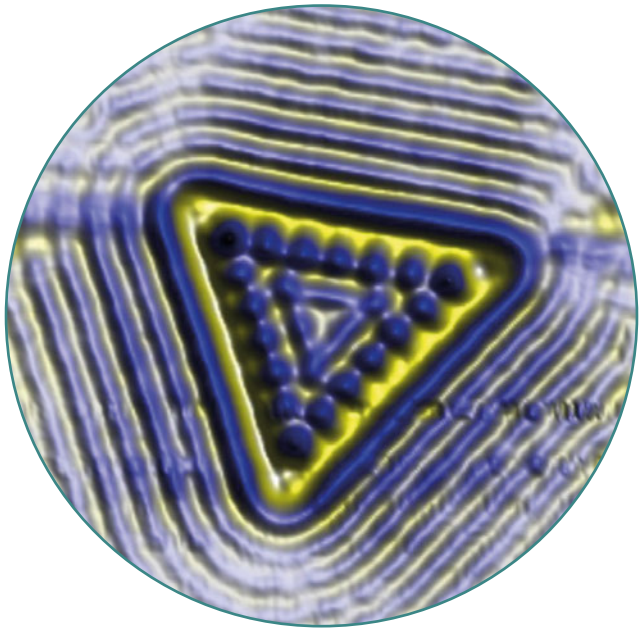
COURSES

NFFA-Europe Summer School on Synchrotron Radiation, **Universitat Autònoma de Barcelona, Barcelona, Spain**, A. Mugarza

Master en Nanociència i Nanotecnologia Avançades, **Universitat Autònoma de Barcelona, Barcelona, Spain**, A. Mugarza

PARTICIPATED CONGRESSES

Fuerzas y Tunel 2016, Girona, Spain, 5-7/9/16. A. Mugarza - Organising Committee



More information:
http://ams.icn2.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

Bastos Arrieta, Julio, Visiting Postdoctoral Researcher
Colás Ortiz, Oriol, Visiting Master's Student
Contreras Encinas, Mº Carmen, Visiting Student
Esplandiu Egido, María José, CSIC Tenured Scientist
Evangelio Araujo, Laura, Visiting Doctoral Student
Fraxedas Calduch, Jordi, CSIC Scientific Researcher and Group Leader
Gramazio, Federico, Doctoral Student
Latorre Lázaro, Núria, Undergraduate Student
Martínez García, Pedro, Visiting Master's Student
Pach, Elzbieta, Technician
Sáez Zapata, Adrián, Visiting Master's Student
Salavert Otal, Rita, Visiting Student
Sarrià Pascual, Alba, Visiting Student
Seco Guix, Marc, Visiting Master's Student
Verdaguer Prats, Albert, CSIC Tenured Scientist
Wakamatsu, Yuji, Master's Student
Wilhelms, Edward, Master's 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 *Universität 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 holding a postdoctoral position at the European Synchrotron Radiation Facility (ESRF) in Grenoble (France)

NEW PROJECTS & MILESTONES

The group has participated in several projects at the European and Spanish level. Within the European FP7 and H2020 funding programmes, the group has been involved in the development of advanced atomic-force microscopy (AFM) instrumentation in collaboration with leading European universities and companies. A prototype of an AFM head has been successfully tested in an industrial environment, with a robot arm providing real-time information on the mechanical properties of surfaces of industrial interest (plastic injection moulds and pieces, and solar cells). A fast-scan AFM module is also under design.

At the Spanish level, the group has participated in two projects focused on tailoring the affinity of water to surfaces and to micro/nanofluidics using carbon-based materials (nanotubes and graphene). The main objective is to be able to control the dynamics of water at different interfaces, for instance structuring water as ice at temperatures above 0°C or inducing mass transport via electrokinetic processes.

In terms of technology transfer, the group has secured a European patent (PCT/EP2016/057782) and a Spanish trade secret.

and an established researcher position at the European Laboratory for Particle Physics (CERN) in Geneva (Switzerland), he joined the *Institut de Ciència de Materials de Barcelona* (ICMAB-CSIC) in 1995. He later worked as a research associate 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 is the author of the books *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

Carbon nanotubes allow capture of krypton, barium and lead for multichannel biological X-ray fluorescence imaging, Serpell, C.J., Rutte, R.N., Geraki, K., Pach, E., Martincic, M., Kierkowicz, M., De Munari, S., Wals, K., Raj, R., Ballesteros, B., Tobias, G., Anthony, D.C., Davis, B.G., *Nature Communications*; **7:** art. no. 13118, 2016. IF: 11.329

Effect of Steam-Treatment Time on the Length and Structure of Single-Walled and Double-Walled Carbon Nanotubes, Kierkowicz M., Pach E., Santidrián A., Tobías-Rossell E., Kalbáč M., Ballesteros B, Tobias G., *Chem Nano Mat*; **2 (2):** 108-116, 2016.

Evaluating the compressive stress generated during fabrication of Si doubly clamped nanobeams with AFM, Lorenzoni, M., Llobet, J., Gramazio, F., Sansa, M., Fraxedas, J., Perez-Murano, F., *Journal of Vacuum Science and Technology B: Nanotechnology and Microelectronics*; **34 (6):** art. no. 06KK02, 2016. IF: 1.398

Imaging water thin films in ambient conditions using Atomic Force Microscopy, Santos, S., Verdaguer, A., *Materials*; **9 (3):** art. no. 182, 2016. IF: 2.728

Key parameters controlling the performance of catalytic motors, M.J. Esplandiu; A. Afshar-Farniya; D. Reguera, *Journal of Chemical Physics*; **144 (12):** 124702, 2016. IF: 2.894

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Multiscale study of mononuclear CoII SMMs based on curcuminoid ligands, Díaz-Torres, R., Menelaou, M., Roubeau, O., Sorrenti, A., Brandariz-De-Pedro, G., Sañudo, E.C., Teat, S.J., Fraxedas, J., Ruiz, E., Aliaga-Alcalde, N., *Chemical Science*; **7 (4):** 2793-2803, 2016. IF: 9.144

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Synthesis, characterization, and thermoelectric properties of superconducting $(BEDT\text{-}TTF)_2I_3$ nanoparticles, Chtioui-Gay, I., Faulmann, C., De Caro, D., Jacob, K., Valade, L., De Caro, P., Fraxedas, J., Ballesteros, B., Steven, E., Choi, E.S., Lee, M., Benjamin, S.M., Yvenou, E., Simonato, J.-P., Carella, A., *Journal of Materials Chemistry C*; **4 (31):** 7449-7454, 2016. IF: 5.066

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PROJECTS

Automated In-line Metrology for Nanoscale Production (AIM4NP), funded by **EU - FP7 NMP-2012-SME 6**, 1/3/2013-31/6/2016, Jordi Fraxedas

Nanoscòpia i Nanoenginyeria de Superfícies, funded by **AGAUR**, 01/01/2014 - 30/04/2017, Jordi Fraxedas

CONTRIBUTIONS

Silicon-based chemical motors activated with visible light, **International workshop on micro and nanomachines (MNM2016)**, Hannover, Germany, 29/6/16 - 1/7/16, M.J. Esplandiu, A. Afshar Farniya, A. Bachtold. (invited speaker)

The non-equilibrium operation of catalytic micropumps, **NESC16: Advances in theory and simulation of non-equilibrium systems**, Sheffield, United Kingdom, 25-27/7/16, M.J. Esplandiu; A. Afshar Farniya; D. Reguera (invited speaker)

Continuous monitoring of tip radius during atomic force microscopy imaging using higher harmonics, **NanoTech France 2016/ NanoMetrology 2016**, Paris, France, June, 2016, Enrique Rull Trinidad, Federico Gramazio, Matteo Lorenzoni, Francesc Pérez-Murano, Urs Staufer, Jordi Fraxedas (oral)

Continuous Tip Monitoring and Sensing of Surface Mechanical Properties during atomic Force Microscopy Imaging using Higher Harmonics, **Fuerzas y Túnel 2016**, Girona, Spain, 5-7 September, 2016, F. Gramazio, J. Fraxedas, M. Lorenzoni, F. Pérez-Murano, E. Rull Trinidad, U. Staufer (oral)

Continuous tip monitoring using higher harmonics, **Euro AFM Forum**, Geneva, Switzerland, June, 2016, Jordi Fraxedas, Francesc Pérez-Murano, Federico Gramazio, Matteo Lorenzoni, Enrique Rull Trinidad, Urs Staufer (oral)

Measuring capillary forces and imaging of water thin films in ambient conditions using Atomic Force Microscopy, **6th Multifrequency AFM Conference**, Madrid, Spain, 30/3/16 - 1/4/16, A. Verdaguer (oral)

Probing the interaction of surface adsorbates with ferroelectric domains, **ISAF/ECAPD/PFM Conference**, Darmstadt, Germany, 21-25/8/16, I. Gaponenko, N. Stucki, A. Verdaguer, and P. Paruch (oral)

Role of interface energies in the directed self-assembly of block copolymers in wide chemical patterns, **Europolymer Conference 2016 (EUPOC 2016)**, Gargnano, Italy, May, 2016, L. Evangelio, W. Li, M. Lorenzoni, J. Fraxedas, M. Mueller, F. Pérez-Murano (oral)

Water assisted surface charge screening on $LiNbO_3$ by Near Ambient Pressure X- ray Photoelectron Spectroscopy (NAPPS), **ISAF/ECAPD/PFM Conference**, Darmstadt, Germany, 21-25/8/16, A.Verdaguer, K. Cordero, L. Rodriguez, M.J. Esplandiu, C. Escudero, V. Pérez, A. Calò, N. Domingo (oral)

Continuous monitoring of tip radius using higher harmonics, **6th Multifrequency AFM conf**, Madrid, Spain, March, 2016, Jordi Fraxedas, Enrique Rull Trinidad, Urs Staufer, Federico Gramazio, Matteo Lorenzoni, Francesc Pérez-Murano (poster)

Effect of Temperature on the Growth of Single Crystalline Monolayer Graphene by Chemical Vapor Deposition (CVD), **Graphene 2016**, Genova, Italy, 9-22/4/16, Z. Messele Gebeyehu, J. Cuppens, M.J. Esplandiu, S.O. Valenzuela (poster)

Fluent solver expanded to the nano-world, **Polymer Replication on Nanoscale, 3rd International Conference**, Windish, Switzerland, May, 2016, J. Pina-Estany, J. Fraxedas, F. Perez-Murano, C. Colominas, J.M. Puigoriol-Forcada, A.A. Garcia-Granada (poster)

Simulation of plastic injection for nano roughness replication, **Second International Workshop on Software Solutions for Integrated Computational Materials Engineering**, Barcelona, Spain, April, 2016, J. Pina-Estany, J. Fraxedas, F. Perez-Murano, C. Colominas, J.M. Puigoriol-Forcada, A.A. Garcia-Granada (poster)

Simulation of plastic injection for nanostructure pattern replication, **International MicroNanoConference 2016**, Amsterdam, The Netherlands, December, 2015, J. Pina-Estany, J. Fraxedas, F. Perez-Murano, C. Colominas, J.M. Puigoriol-Forcada, A.A. Garcia-Granada (poster)

Submodelling simulation of plastic injection for nano roughness replication, **Industrial Technologies 2016**, Amsterdam, The Netherlands, June, 2016, J. Pina-Estany, J. Fraxedas, F. Perez-Murano, C. Colominas, J.M. Puigoriol-Forcada, A.A. Garcia-Granada (poster)

Water adsorption on ferroelectric thin film surfaces as a function of polarization, **ISAF/ECAPD/PFM Conference**, Darmstadt, Germany, 21-25/8/16, A. Verdaguer, K. Cordero, L. Rodriguez, M.J. Esplandiu1, C. Escudero, V. Pérez, A. Calò, N. Domingo (poster)

COURSES

Graphene, a material that will revolutionize the world, **Permanent Seminar of Physics and Chemistry**, Barcelona, Spain, 11/11/2016, M.J. Esplandiu

Nanoscience and Nanotechnology, **UAB Summer course for high school students**, Barcelona, Spain, jul-16, M.J. Esplandiu

Introduction to Nanoscience and Nanotechnology, **UAB Bachelor's Degree in Nanoscience and Nanotechnology**, Barcelona, Spain, Course 2015/2016 and course 2016/2017, M.J. Esplandiu

Introduction to Nanoscience and Nanotechnology, **UAB International Summer School**, Barcelona, Spain, June - July 2016, M.J. Esplandiu

NFFA-Europe Summer School on Synchrotron Radiation, **Universitat Autònoma de Barcelona**, Barcelona, Spain, J. Fraxedas (Organizing Committee)

Microscopies: electron microscopy (SEM, TEM) and proximity microscopy (AFM and STM), **UAB Master in Industrial Chemistry and Introduction to Research**, Barcelona, Spain, November, 2016, M.J. Esplandiu

Chemistry for specific materials of interest in industry and research, **UAB Master in Industrial Chemistry and Introduction to Research**, Barcelona, Spain, November, 2016, M.J. Esplandiu

PARTICIPATED CONGRESSES

Fuerzas y Tunel 2016, Girona, Spain, 5-7/9/16. Albert Verdaguer - Organising Committee

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

Barbero, Francesco, Doctoral Student
Busquets Fité, Martí, Visiting StudentFranco
Puntes, Víctor, ICREA Research Professor and Group Leader
Girona Alarcón, Marta, Internship Student
Gómez Bastus, Neus, Senior Researcher
Iguaz Juan, Joaquim, Undergraduate Student
Merkoçi Xhelo, Florindi, Technician
Patarroyo Rengifo, Javier, Doctoral Student
Piella Bagaria, Jordi, Doctoral Student
Rovira Esteva, Muriel, Postdoctoral Researcher
Yudina, Tetyana, Doctoral Student

GROUP LEADER

ICREA Prof.
Víctor F. Puntes

ICREA Research Prof. Víctor F. Puntes' 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. Puntes 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*

NEW PROJECTS & MILESTONES

In 2016 the Inorganic Nanoparticles Group continued work on its several ongoing projects on the design and synthesis of inorganic nanoparticles for interaction with biological systems and energy harvesting (see list of projects). Additionally, three new projects kicked-off in 2016: DANAE, a national project funded by the Spanish Ministry of Economy, Industry and Competitiveness (MINECO) for the design of advanced inorganic nanocrystal complexes for the transformation and storage of energy; HISENTS (High-level Integrated Sensor for NanoToxicity Screening), a European collaborative project funded under H2020; and the PANDORA project to promote the safety assessment of nano-objects by defining their impact on the immune and defensive

Barcelona (UB), working with Prof. Xavier Batlle and Prof. Amilcar Labarta on giant magnetoresistance in granular alloys. He then spent more than three years at the University of California, Berkeley, and the Lawrence Berkeley National Laboratory (LBNL) in the groups led by 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 UB. In 2005 he obtained an ICREA Professorship at the then ICN to create the Inorganic Nanoparticles Group, which he currently leads.

By the end of 2016, Prof. Puntes had 153 peer-reviewed publications and over 10,500 citations. He is also well-known for his work in science communication to the general public, his industrial and commercial efforts, and for his endeavours linking science and art.

response of organisms in the environment, a Marie Curie ITN project also funded under H2020. Meanwhile, the MINE project to develop new strategies for the production of viable hybrid nanocrystals with applicability in energy conversion and photocatalysis, funded by a Marie Curie Career Integration Grant, came to an end this year.

Nanoparticles are engineered and designed in view of their applicability in materials science, catalysis, energy, harvesting, environmental remediation, 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 nanoparticle in the desired system and increase nanoparticle functionality.

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, optimise the features of nanoparticles to enhance the production of hydrogen or boost 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

Assessing the Immunosafety of Engineered Nanoparticles with a Novel in Vitro Model Based on Human Primary Monocytes, Yang Li, Paola Italiani, Eudald Casals, Dirk Valkenborg, Inge Mertens, Geert Baggerman, Inge Nelissen, Victor F. Puntes, and Diana Boraschi, *ACS Applied Materials & Interfaces;* **8 (42):** 28437-28447, 2016. IF: 7.145

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Enhanced detection with spectral imaging fluorescence microscopy reveals tissue- and cell-type-specific compartmentalization of surface-modified polystyrene nanoparticles, Kenesei, K., Murali, K., Czéh, Á., Piella, J., Puntes, V., Madarász, E., *Journal of Nanobiotechnology*; **14 (1):** art. no. 55, 2016. IF: 4.239

Influence of Nanomaterial Compatibilization Strategies on Polyamide Nanocomposites Properties and Nanomaterial Release during the Use Phase, Fernández-Rosas, E., Vilar, G., Janer, G., González-Gálvez, D., Puntes, V., Jamier, V., Aubouy, L., Vázquez-Campos, S., *Environmental Science and Technology*; **50 (5):** 2584-2594, 2016. IF: 5.393

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Nanoparticle Interaction with Biomolecules: How it Shapes the Nano-Effects on Immunity, Victor Puntes, *Current Bionanotechnology*; **2 (1):** 11-19, 2016.

Properties of silver nanoparticles influencing their uptake in and toxicity to the earthworm Lumbricus rubellus following exposure in soil, Makama, S., Piella, J., Undas, A., Dimmers, W.J., Peters, R., Puntes, V.F., van den Brink, N.W., *Environmental Pollution*; **218,** 870-878, 2016. IF: 4.839

Quantifying the Sensitivity of Multipolar (Dipolar, Quadrupolar, and Octapolar) Surface Plasmon Resonances in Silver Nanoparticles: The Effect of Size, Composition, and Surface Coating, Bastús, N.G., Piella, J., Puntes, V., Langmuir; **32 (1):** 290-300. 2016. IF: 3.993

Shell or Dots - Precursor Controlled Morphology of Au-Se Deposits on CdSe Nanoparticles, De La Cueva, L., Meyns, M., Bastús, N.G., Rodríguez-Fernández, J., Otero, R., Gallego, J.M., Alonso, C., Klinke, C., Juárez, B.H., *Chemistry of Materials*; **28 (8):** 2704-2714. 2016. IF: 9.407

Size-Controlled Synthesis of Sub-10-nanometer Citrate-Stabilized Gold Nanoparticles and Related Optical Properties, Piella, J., Bastús, N.G., Puntes, V., *Chemistry of Materials*; **28 (4):** 1066-1075, 2016. IF: 9.407

Toxicity of nickel in the marine calanoid copepod *Acartia tonsa*: Nickel chloride versus nanoparticles, Zhou, C., Vitiello, V., Casals, E., Puntes, V., Iamunno, F., Pellegrini, D., Changwen, W., Benvenuto, G., Buttino, I., *Aquatic Toxicology*; **170**, 1-12. 2016. IF: 3.557

Galvanic Replacement onto Complex Metal-Oxide Nanoparticles: Impact of Water or Other Oxidizers in the Formation of either Fully Dense Onion-like or Multicomponent Hollow MnO_x/FeO_x Structures, López-Ortega, A., Roca, A.G., Torruella, P., Petrecca, M., Estradé, S., Peiró, F., Puntes, V., Nogués, J., *Chemistry of Materials*; **28 (21):** 8025-8031. 2016. IF: 9.407

The influence of the MOF shell thickness on the catalytic performance of composites made of inorganic (hollow) nanoparticles encapsulated into MOFs, Yazdi, A., Merkoçi, F., Bastús, N., Imaz, I., Puntes, V., Maspoch, D., *Catalysis Science & Technology*; **6 (24):** 2044-4753. 2016. IF: 5.287

PROJECTS

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 - 10/05/2016, Victor. F. Puntes

Developing New Strategies for the Production of Viable Hybrid Nanocrystals with Applicability in Energy Conversion and (Photo)catalysis, funded by **EC - FP7-PEOPLE-2012-CIG**, 01/12/2012 - 30/11/2016, Neus Gómez Bastús

Diseño de complejos nanocristales inorganicos avanzados para la transformación y el almacenamiento óptimo de energia, funded by **Ministerio de Economía, Industria y Competitividad, Spain**, 01/01/2016 - 31/12/2018, Victor. F. Puntes

High level Integrated SEnsor for NanoToxicity Screening, funded by **EC - H2020-NMP-2015-two-stage**, 01/04/2016 - 31/03/2019, Victor F. Puntes

2014 SGR 612 , funded by **AGAUR**, 01/01/2014 - 30/04/2017, Victor F. Puntes

CONTRIBUTIONS

In Hollow metal nanostructures for enhanced plasmonics, **SPIE BiOS, International Society for Optics and Photonics**, 08/07/1905, Genç, A., Patarroyo, J., Sancho-Parramon, J., Duchamp, M., Gonzalez, E., Bastus, N. G., Houben, L., Dunin-Borkowski, R., Puntes, V. F., Arbiol (oral)

Responsible research and innovation on nanotechnology, **NaNaX 7 Nanoscience with Nanocrystals**, Marburg, Germany, 04/04/2016, Victor Puntes (oral)

A general In Situ Redox Approach for the Synthesis of Metal/CeO_2 Hybrid Nanostructures, **NaNaX 7 Nanoscience with Nanocrystals**, Marburg, Germany, 04/04/2016, Neus G. Bastus (oral)

Morphology-Controlled Synthesis of Colloidal Noble Metal Nanocrystals, **NaNaX 7 Nanoscience with Nanocrystals**, Marburg, Germany, 04/04/2016, Jordi Piella (poster)

New Synthetic Strategies for the Production of Colloidal Pt Hollow Nanocatalysts, **NaNaX 7 Nanoscience with Nanocrystals,** Marburg Germany, 04/04/2016, Florind Merkoçi (poster)

One-pot polyol synthesis of highly monodisperse short green silver nanorods, **NaNaX 7 Nanoscience with Nanocrystals**, Marburg, Germany, 04/04/2016, Javier Patarroyo (poster)

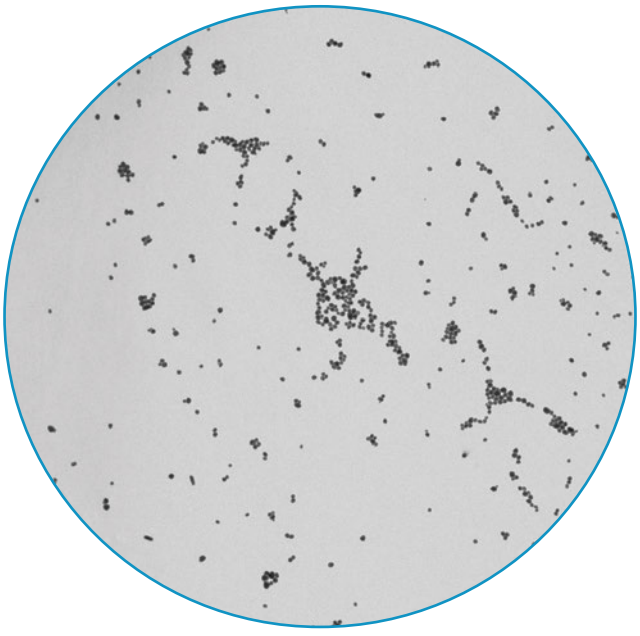
BOOKS

Handbook of Clinical Nanomedicine
- *Gold Nanoparticles against Cancer*, pp 1293-1314, Puntes, V., Ed. Pan Stanford (2016)

THESES

Doctorand: **Tetyana Yudina**
Title: Synthesis, kinetic control and properties engineering of cerium oxide nanoparticles for biomedical applications.
Defence Date: 17/06/2016
Director: Prof. Victor F. Puntes

Doctorand: **Sofia Rubio**
Title: Increasing the resolution at the nanobiointerface with engineering inorganic nanoparticles.
Defence Date: 23/09/2016
Director: Prof. Victor F. Puntes



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

Aranda Ramos, Antonio, Visiting Doctoral Student
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Quintana Puebla, Alberto, Visiting Doctoral Student
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Sort, Jordi, Visiting Researcher
Zhang, Kuan, SO Doctoral Student

GROUP LEADER

ICREA Prof.
Josep Nogués

ICREA Research Professor Josep Nogués earned his degree from the *Universitat Autònoma de Barcelona* (UAB) in 1986. After obtaining his PhD at the *Kungliga Tekniska Högskolan* (Royal Institute of Technology) in Stockholm (Sweden) in 1993, he moved to the University of California San Diego to complete his postdoctoral studies.

NEW PROJECTS & MILESTONES

In 2016 the group has been working on novel nanoparticles and nanostructures for biomedical application in the framework of the THERANANO project to develop multifunctional magnetic and magnetoplasmonic theranostic nanostructures. The aim of this project is to design bottom-up and top-down hybrid magnetic nanostructures for diverse biomedical applications (for instance, hyperthermia or multimode imaging).

It has also continued its research on exchange coupling in core/shell nanoparticles and magnetic nanostructures in the context of the COEFNANO project. New this year is the M-ERA-NET project, PAIRED, which aims to develop magnetically and photochemically active drug carriers for controlled drug delivery.

In 1997 he returned to the UAB. He is currently an ICREA Research Professor and group leader of the ICN2 Magnetic Nanostructures Group.

Prof. Nogués has published 225 articles (including eight reviews), has more than 13,800 citations and an H-index of 51.

He has authored one patent and his work has given rise to over 195 invited talks.

PUBLICATIONS

3D Visualization of the Iron Oxidation State in FeO/Fe_3O_4 Core-Shell Nanocubes from Electron Energy Loss Tomography, Torruella, P., Arenal, R., De La Peña, F., Saghi, Z., Yedra, L., Eljarrat, A., López-Conesa, L., Estrader, M., López-Ortega, A., Salazar-Alvarez, G., Nogués, J., Ducati, C., Midgley, P.A., Peiró, F., Estradé, S., *Nano Letters;* **16 (8):** 5068-5073, 2016. IF: 13.779

Effective ionic-liquid microemulsion based electrodeposition of mesoporous Co-Pt films for methanol oxidation catalysis in alkaline media, Serrà, A., Gómez, E., Golosovsky, I.V., Nogués, J., Vallés, E., *Journal of Materials Chemistry A*; **4 (20):** 7805-7814, 2016. IF: 8.262

Electrochemically synthesized amorphous and crystalline nanowires: Dissimilar nanomechanical behavior in comparison with homologous flat films, Zeeshan, M.A., Esqué-De Los Ojos, D., Castro-Hartmann, P., Guerrero, M., Nogués, J., Suriñach, S., Baró, M.D., Nelson, B.J., Pané, S., Pellicer, E., Sort, J. , *Nanoscale*; **8 (3):** 1344-1351, 2016. IF: 7.76

Highly efficient electrochemical and chemical hydrogenation of 4-nitrophenol using recyclable narrow mesoporous magnetic CoPt nanowires, Serrà, A., Alcobé, X., Sort, J., Nogués, J., Vallés, E., *Journal of Materials Chemistry A*; **4 (40):** 15676-15687, 2016. IF: 8.262

Galvanic Replacement onto Complex Metal-Oxide Nanoparticles: Impact of Water or Other Oxidizers in the Formation of either Fully Dense Onion-like or Multicomponent Hollow MnO_x/FeO_x Structures, López-Ortega, A., Roca, A.G., Torruella, P., Petrecca, M., Estradé, S., Peiró, F., Puntes, V., Nogués, J., *Chemistry of Materials*; **28 (21):** 8025-8031, 2016. IF: 9.407

Modeling the collective magnetic behavior of highly-packed arrays of multi-segmented nanowires, Agramunt-Puig, S., Del-Valle, N., Pellicer, E., Zhang, J., Nogués, J., Navau, C., Sanchez, A., Sort, J., *New Journal of Physics*; **18 (1):** art. no. 013026, 2016. IF: 3.57

Tailoring Staircase-like Hysteresis Loops in Electrodeposited Trisegmented Magnetic Nanowires: A Strategy toward Minimization of Interwire Interactions, Zhang, J., Agramunt-Puig, S., Del-Valle, N., Navau, C., Baró, M.D., Estradé, S., Peiró, F., Pané, S., Nelson, B.J., Sanchez, A., Nogués, J., Pellicer, E., Sort, J., *ACS Applied Materials and Interfaces*; **8 (6):** 4109-4117, 2016. IF: 7.145

Tunable High-Field Magnetization in Strongly Exchange-Coupled Freestanding Co/CoO Core/Shell Coaxial Nanowires, Serrà, A., Alcobé, X., Sort, J., Nogués, J., Vallés, E., *Journal of Materials Chemistry A*; **4 (40):** 15676-15687, 2016. IF: 8.262

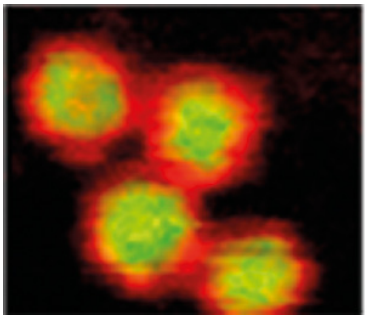
Highly efficient electrochemical and chemical hydrogenation of 4-nitrophenol using recyclable narrow mesoporous magnetic CoPt nanowires, Salazar-Alvarez, G., Geshev, J., Agramunt-Puig, S., Navau, C., Sanchez, A., Sort, J., Nogués, J., *ACS Applied Materials and Interfaces*; **8 (34):** 22477-22483, 2016. IF: 7.145

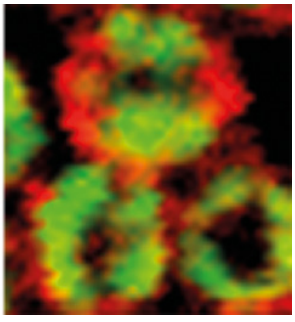
Spontaneous formation of spiral-like patterns with distinct periodic physical properties by confined electrodeposition of Co-In disks, Golvano-Escobal, I., Gonzalez-Rosillo, J.C., Domingo, N., Illa, X., López-Barberá, J.F., Fornell, J., Solsona, P., Aballe, L., Foerster, M., Surinãch, S., Baró, M.D., Puig, T., Pané, S., Nogués, J., Pellicer, E., Sort, J., *Scientific Reports*; **6:** art. no. 30398, 2016. IF: 5.228

PROJECTS

Magnetically and photochemically actuated bioactive nanowires for remotely controlled drug delivery, funded by **MINECO-EU**, 01/05/2016 - 30/04/2019, Josep Nogués

Nanoestructuras magnéticas y magnetoplasmónicas teranósticas, funded by **MINECO**, 01/01/2014 - 31/03/2017, Josep Nogués





CONTRIBUTIONS

New reversal mode in exchange coupled antiferromagnetic/ferromagnetic disks:distorted viscous vortex, **International Conference on Magnetism and Magnetic Materials and - International Magnetism and Magnetic Materials Conference – MMM-INTERMAG**, San Diego, USA, 11-15/1/2016, J. Nogues, D. Gilbert, L. Ye, A. Varea, S. Agramunt-Puig, N. del valle, C. Navau, J.F. Lopez-Barbera, K. Buchanan, A. Hoffmann, A. Sanchez, J. Sort, K. Liu (invited speaker)

Metalenses and nanomotors based on Si nanowires, **Energy Materials Nanotrstuctures Meeting on Nanowires**, Amsterdam, Netherlands, 16-19/5/2016, K. Zhang, M.J. Esplandiu, B. Sepulveda (invited speaker)

Magneto-plasmonic nanostructures for theranostic applications, **Collaborative Conference on 3D & Materials Research**, Incheon, Korea, 20-24/6/2016, A.G. Roca, E. Fantechi, N.G. Bastus, V. Puntes, J. Nogués (invited speaker)

EELS-Tomography: Enabling 4D chemical nd oxidation state characterization of nanostructured materials, **Nanotech Poland International Conference**, Poznan, Poland, 22-25/6/2016, P. Torruella, R. Arenal, Z. Saghi, L. Yedra, A. Eljarrat, J. Rebled, F. de la Peña, M. Estarder, G. Salazar-Alvarez, A. Lóepz-Ortega, J. Nogués, P.A. Midgley, S. Estarde, F. Peiro (invited speaker)

Magneto-plasmonic nanoparticles for enhanced hyperthermia applications, **Brazilian Materials Research Society Meeting**, Campinas, Brazil, 25-29/9/2016, J. Nogués, E. Fantechi, A.G. Roca, Z. li, P. Güell, N.G. Bastus, V. Puntes, B. Sepulveda (invited speaker)

Multi-segmented magnetic nanowires as advanced nanorobotic platforms for biomedical applications, **Conference on Magnetism and Magnetic Materials**, New Orleans, USA, 31/10 - 4/11/2016, J. Sort, J. Zhang, S. Agramunt-Puig, N. del valle, C. Navau, S. Estarde, F. Peiro, S. Pane, A. Sanchez, J. Nogués, E. Pellice (invited)

Incommensurate magnetic order in CoO nanoparticles revealed by neutron diffraction, **International Workshop on Magnetism and Superconductivity and the Nanoscale**, Coma-Ruga, Spain, 4-7/7/2016, I. Golosovsky, M. Estarder, A. Lopez-Ortega, A.G. Roca, J. Nogués (invited speaker)

Multifunctional magnetic and magneto-plasmonic nanoparticles for enhanced hyperthermia applications, **International Conference on Technological Advanced Materials**, Delhi, India, 7-11/11/2016, E. Fantechi, A.G. Roca, P. Güell, Z. Li, N. Bastús, V. Puntes, B. Sepulveda, J. Nogués (invited speaker)

Multifunctional magnetic and magnetoplasmonic nanoparticles for enhanced hyperthermia applications, **International Conference on Magnetism and Magnetic Materials and - International Magnetism and Magnetic Materials Conference – MMM-INTERMAG**, San Diego, USA, 11-15/1/2016, E. Fantechi, A.G. Roca, C. Innocenti, M. Albimno, N. Bastus, V. Puntes. C. Sangregorio, J. Nogués (oral)

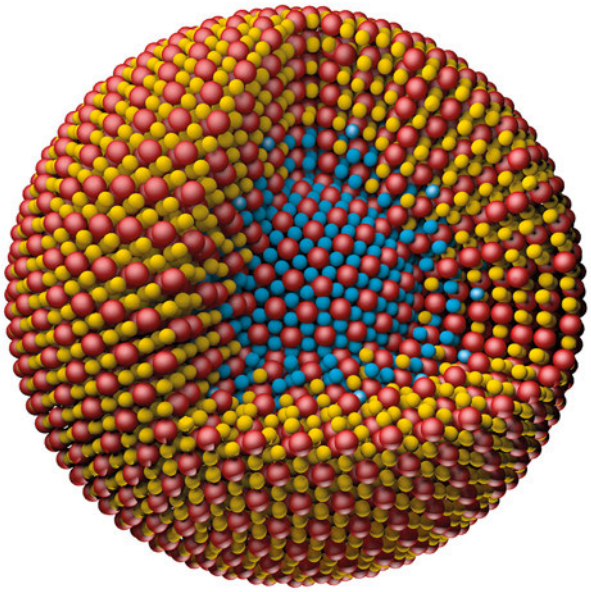
A journey through the secret life of nanoparticles: from 2D high resolution images to 3D oxidation state mapping, **NanoBio & Med Conference**, Barcelona, Spain, 22-24/11/2016, P. Torruella, R. Arenal, Z. Saghi, L. Yedra, A. Eljarrat, J. Rebled, F. de la Peña, M. Estrader, G. Salazar-Alvarez, A. Lopez-Ortega, J. Nogués, P.A. Midgley, S. Estarde, F. Peiro (oral)

Lateral magnetically modlated multrilayers by combining ion implantation and lithography, **Conference on Ion Beam Modification of Materials**, Wellington, New Zealand, 30/10 - 4/11/2016, K. Temst, E. Menendez, J. Nogués, N. Domingo, A. Vantome, C. Van Hasendonck (oral)

Syntesis of highly mesoporous films by means electrodeposition in microemulsions containing ionic liquid, **Formula Conference**, Glasgow, United Kindom, 21-26/8/2016, A. Serra, E. Gomez, I.V. Golosovsky, J. Nogués, E. Valles (poster)

Impact of wáter and oxidation states in the galvanic replacement formation of hollow oxide nanoparticles, **European Microscopy Congress**, Lyon, France, 28/8 - 2/9/2016, P. Torruella, A. Lopez-Ortega, A. Roca, M. Petrecca, S. Estarde, F. peiro, V. Puntes, J. Nogués (poster)

High-temperature magnetic properties of epsilon-Fe_2O_3, **Conference on Magnetism and Magnetic Materials**, New Orleans, USA, 31/10 - 4/11/2016, M. Gich, J. Nogués, A. Roig, F. Fauth, J. Garcia-Muñoz (poster)



NanoBioelectronics and Biosensors Group

Main Research Lines

- **Catalytic/carrier nanomaterials: Nanoparticles as electrocatalysts, nanoparticle as carriers of biomolecules, and nanowires/nanotubes for non-enzymatic/enzyme mimic sensors**
- **Nanomicrofluidics and lab-on-a-chip technologies**
- **Paper or 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

Abdulhadee, Yakoh, Visiting Doctoral Student
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Guardia Giros, Pablo, SO Postdoctoral Researcher
Hassan, Abdel-Rahim, Visiting Postdoctoral Researcher
Khater, Mohga, Visiting Doctoral Student

GROUP LEADER

ICREA Prof.
Arben Merkoçi

ICREA Research Professor and leader of the ICN2 Nanobioelectronics and Biosensors Group, Arben Merkoçi obtained his PhD at the *Universiteti i Tiranës* (Albania) on ion selective electrodes. Since 1992 he has carried out research as postdoctoral fellow and research professor at the Polytechnic University of Budapest (Hungary), University of Loannina (Greece), *Università degli Studi di Padova* (Italy), *Universitat Politècnica de Catalunya*, *Universitat Autònoma de*

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Vila Parrondo, Christian, Visiting Undergraduate Student
Yañez Tienda, Héctor, Visiting Master Student
Zamora Gálvez, Alejandro, Doctoral Student
Zuaznbar Gardona, Julio Cesar, Visiting Doctoral Student

Barcelona and New Mexico State University. His research is focused on the integration of biological molecules and other species with micro- and nanostructures of interest for the design of novel (bio)sensors.

Prof. Merkoçi was awarded the 2011 IAAM Medal and the 2013 Nano Award for outstanding research in the field of nanoscience and nanotechnology by the International Association of Advanced Materials. He has published more than 250 articles and supervised around 25 PhD theses.

NEW PROJECTS & MILESTONES

In 2016 the group became involved in two new projects: INTCATCH to develop nanobiosensors for pollutant monitoring funded under the H2020 programme, and NACANCELL, a EuroNanoMed II project to develop a nanodiagnostic platform for monitoring cancer cell secreted proteins, as project coordinator.

The group continued to make progress in paper- and nanopaper-based platforms, as well as in graphene-based platforms of interest for biosensing and other device fabrication.

Last year one of the group's doctoral students (Luis Pires) defended their PhD thesis.

PUBLICATIONS

Bio(Sensing) devices based on ferrocene–functionalized graphene and carbon nanotubes, Rabti, A., Raouafi, N., Merkoçi, A., *Carbon*; **108:** 481-514, 2016. IF: 6.198

Control of Electron-transfer in Immunonanosensors by Using Polyclonal and Monoclonal Antibodies, Mars, A., Parolo, C., de la Escosura-Muñiz, A., Raouafi, N., Merkoçi, A., *Electroanalysis*; **28 (8):** 1795-1802. 2016. IF: 2.471

Detection of parathyroid hormone-like hormone in cancer cell cultures by gold nanoparticle-based lateral flow immunoassays, Chamorro-Garcia, A., de la Escosura-Muñiz, A., Espinoza-Castañeda, M., Rodriguez-Hernandez, C.J., de Torres, C., Merkoçi, A., *Nanomedicine: Nanotechnology, Biology, and Medicine*; **12 (1):** 53-61. 2016. IF: 5.671

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Graphene-based Janus micromotors for the dynamic removal of pollutants, Orozco J., Mercante L.A., Pol R., Merkoçi A., *Journal of Materials Chemistry A*; **4 (9):** 3371-3378. 2016. IF: 8.262

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Hybrid self-assembled materials constituted by ferromagnetic nanoparticles and tannic acid: A theoretical and experimental investigation, Santos A.F.M., Macedo L.J.A., Chaves M.H., Espinoza-Castañeda M., Merkoçi A., Limac F.D.C.A., Cantanhêde W., *Journal of the Brazilian Chemical Society*; **27 (4):** 727-734. 2016. IF: 1.096

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Modulation of population density and size of silver nanoparticles embedded in bacterial cellulose: Via ammonia exposure: Visual detection of volatile compounds in a piece of plasmonic nanopaper, Heli B., Morales-Narváez E., Golmohammadi H., Ajji A., Merkoçi A., *Nanoscale*; **8 (15):** 7984-7991. 2016. IF: 7.760

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Water activated graphene oxide transfer using wax printed membranes for fast patterning of a touch sensitive device, Baptista-Pires L., Mayorga-Martínez C.C., Medina-Sánchez M., Montón H., Merkoçi A., *ACS Nano*; **10 (1):** 853-860. 2016. IF: 13.334

PROJECTS

Desarrollo de un sistema de detección de endotoxina de alta sensibilidad y libre de interferencias basado en nanomateriales y fenómenos nuevos, funded by **MINECO**, 2014/09/01 - 2016/08/31, Merkoçi, A.

Development and application of novel, integrated tools for monitoring and managing catchments, funded by **CE - H2020-WATER-2015-two-stage**, 01/06/2016 - 31/01/2020, Merkoçi, A.

Development of a Nanodiagnostic platform for monitoring of Cancer cell secreted proteins, funded by **MINECO**, 01/11/2016 - 30/10/2019, Merkoçi, A.

2014 SGR 260, funded by **AGAUR**, 01/01/2014 - 30/04/2017, Merkoçi, A.

Nanobioconjugated paper/plastic platforms for improved diagnostics applications, funded by **MINECO**, 2015-01-01 - 2017-12-31, Merkoçi, A.

Red de sensores y biosensores electroquímicos, funded by **MINECO**, 01/12/2015 - 30/11/2017, Merkoçi, A.

Sensing toxicants in Marine waters makes Sense using biosensors, funded by **CE - FP7-OCEAN-2013-1**, 01/12/2013 - 31/08/2017, Merkoçi, A.

SMART PRINTED PAPER: Printed Electronics para nuevas funcionalidades en papel, funded by **MINECO**, 01/02/2014 - 30/06/2017, Merkoçi, A.

CONTRIBUTIONS

Building simple plastic and paper-based diagnostic devices using graphene and other nanomaterials, **Cambridge Graphene Centre**, Cambridge, UK, Arben Merkoçi (invited speaker)

Paper -based optical biosensors for accurate enough diagnostics. A hot topic of nowadays research and development with interest for technology transfer to the market, **Photonics PPP Annual Meeting 2016**, Brussels, Belgium, Arben Merkoçi (invited speaker)

Nanobiosensors in diagnostics applications, **Tor Vergata University**, Rome, Italy, Arben Merkoçi (invited speaker)

Nanobiosensors-based diagnostics, **4th edition of School of Bioanalytical Chemistry**, Campinas, Brazil, Arben Merkoçi (invited speaker)

Nanobiosensors-based diagnostics, **Institute of Chemistry – UNICAMP**, Campinas, Brazil, Arben Merkoçi (invited speaker)

Nanobiosensors for diagnostics, **Université Tunis El-Manar**, Tunis, Tunisia, Arben Merkoçi (invited speaker)

Nanobiosensors-based diagnostics, **Institute for Materials Science and Max Bergmann Center of Biomaterials**, Dresden, Germany, Arben Merkoçi (invited speaker)

Nanobiosensors-based diagnostics, **PhD School of Chemistry**, Universidad de Alcalá de Henares, Alcalá de Henares, Spain, Arben Merkoçi (invited speaker)

Paper-based sensors for diagnostics, **National Center for NanoSci & Tech**, Beijing, China, Arben Merkoçi (invited speaker)

Paper-based sensors, **Sensors STRATEGIC WORKSHOP**, National Institute of R&D for Technical Physics, Iasi, Romania, Arben Merkoçi (invited speaker)

Graphene-based biosensors, **International Graphene Innovation Conference (GRAPCHINA 2016)**, Gingdao, China, Arben Merkoçi (invited speaker)

Nanomaterial-based biosensors, **FIRST WORKSHOP ON ELECTROCHEMISTRY DEVICES: (Bio)Sensors**, Porto, Portugal, 13/10/2016, Arben Merkoçi (invited speaker)

Paper-based biosensors for diagnostics, **2nd Microfluidics Congress Utilising microfluidic technologies as a tool for progressing medical research and patient care**, London, United Kingdom, 21/10/2016, Arben Merkoçi (invited speaker)

Nanobiosensors for diagnostics applications, **Institute of Aquaculture**, University of Stirling, Stirling, Scotland, UK, 03/11/2016, Arben Merkoçi (invited speaker)

Graphene-based platforms for (bio)sensing applications, **Graphene & 2-D Materials Conference: From Research to Applications**, London, United Kingdom, 16/11/2016, Arben Merkoçi (invited speaker)

Nanobiosensors in Diagnostics, **2nd Annual Bioelectronics & Biosensors Congress**, London, United Kingdom, 17/11/2016, Arben Merkoçi (invited speaker)

Paper-based nanobiosensors in diagnostics: from health, safety and security to environment monitoring, **NanoBiomed Conference**, Barcelona, Spain, 23/11/2016, Arben Merkoçi (invited speaker)

Nanomaterials based nanobiosensors: from health to safety and security applications, **National institute of biology**, Marine biology station Piran, Piran, Slovenia, Arben Merkoçi (invited speaker)

Nanomaterials based nanobiosensors: from health to safety and security applications, **National Institute of Biology (NIB)**, Ljubljana, Slovenia, Arben Merkoçi (invited speaker)

Diagnostic devices using graphene and other nanomaterials, **NanoSpain 2016**, Logroño, Spain, 15-18/3/16, Arben Merkoçi (invited speaker)

Graphene biosensors in diagnostics, **6th edition of Graphene Conference Series, European Event in Graphene and 2D Materials**, Genova, Italy, 19-22/4/16, Arben Merkoçi (invited speaker)

Graphene-based Platforms for Biosensing Applications, **GM-2016 International Conference**, Paestum, Italy, 23-24/5/16, Arben Merkoçi (invited speaker)

From paper to nanopaper-based biosensors. Current challenges and future perspectives, **Biosensors 2016**, Gothenburg, Sweden, 25-27/5/16, Arben Merkoçi (invited speaker)

Nanobiosensors for diagnostic applications, **Conference Advanced Functional & Industrial Printing**, Düsseldorf, Germany, Arben Merkoçi (keynote talk)

Graphene-based platforms for biosensing applications, **2D-Materials Science-Industry-Workshop**, Dübendorf, Switzerland, Arben Merkoçi (keynote talk)

Nanobiosensors for diagnostics applications, **AACC CPOCT International Symposium, The Benefits and Challenges of Point-of-Care Testing Across the Clinical Spectrum**, Copenhaguen, Denmark, Arben Merkoçi (keynote talk)

Paper-based nanobiosensors, **ALBNANO 2016 Workshop on Nanotechnology and Biosensors**, Tirana, Albania, 29-31/05/2016, Arben Merkoçi (keynote talk)

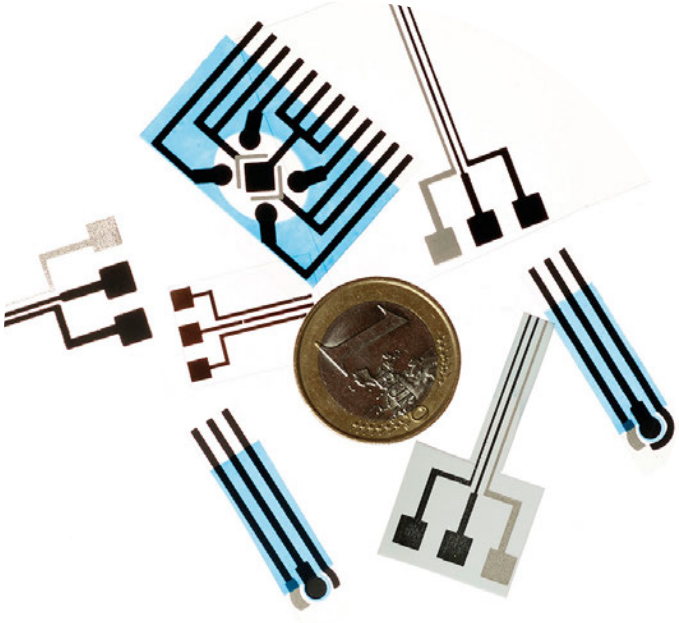
Diagnostics using nanobiosensors, **BioNanoMed 2016 - Nanotechnologyenables Personalized Medicine**, Krems, Austria, 6-8/4/16, Arben Merkoçi (keynote talk)

Development of immunoassay-based method for PBDE determination in seawater, **Application of Analytical Methods to Measure Metabolites in Marine Environment**, Rome, Italy, Andrzej Chalupniak, Arben Merkoçi (oral)

Water Activated Graphene Oxide Transfer Using Wax Printed Membranes for Fast Patterning of a Touch Sensitive Device, **6th edition of Graphene Conference Series, European Event in Graphene and 2D Materials**, Genova, Italy, 19-22/4/16, Luis Miguel Baptista Pires, Arben Merkoçi (oral)

Solid-State nanochannels for electrical detection of cancer biomarkers, A**LBNANO 2016 Workshop on Nanotechnology and Biosensors**, Tirana, Albania, 29-31/05/2016, Alfredo de la Escosura, Arben Merkoçi (oral)

Diagnostics using nanobiosensors, **3rd International Congress on Biosensors**, Ankara, Turkey, 05/10/2016, Arben Merkoçi (plenary lecture)



Paper-based nanobiosensors: simple biosensing platforms compatible with smart phones, **Rapid Methods Europe, The RME Conference Series, 11th Conference Food, Feed, Water Analysis, Animal Human Diagnostics**, Amsterdam, The Netherlands, 08/11/2016, Arben Merkoçi (plenary lecture)

Graphene-based Platforms for Biosensing Applications, **Nanotech France 2016 / European Graphene Forum 2016**, Paris, France, 01-03/06/2016, Arben Merkoçi (plenary lecture)

Nanotechnology and Biosensors: Opportunities in Albania, **ALBNANO 2016 Workshop on Nanotechnology and Biosensors**, Tirana, Albania, 29-31/05/2016, Arben Merkoçi (plenary lecture)

Fe_3O_4 Magnetic Nanoparticles Modified with Molecularly Imprinted Polymers as a Label-Free Sensing Platform, **Biosensors 2016**, Gothenburg, Sweden, 25-27/5/16, Alejandro Zamora, Eden Morales, Arben Merkoçi (poster)

Biosensors for plant pathogen detection, **Biosensors 2016**, Gothenburg, Sweden, 25-27/5/16, Mogha Kahter, Alfredo de la Escosura, Arben Merkoçi (poster)

Molecularly Imprinted Polymer-Decorated Magnetite Nanoparticles for Selective Sulfonamides Detection, **XXI Transfrontier Meeting of Sensors and Biosensors (TMSB-2016)**, Barcelona, Spain, 29-30/09/2016, Alejandro Zamora-Gálvez, Abdellatif Ait-Lahcen, Luiza A. Mercante, Eden Morales-Narváez, Aziz Amine, and Arben Merkoçi (poster)

Signal amplification strategies in lateral flow immunoassays using gold nanoparticles, **XXI Transfrontier Meeting of Sensors and Biosensors (TMSB-2016)**, Barcelona, Spain, 29-30/09/2016, Claudio Parolo, Alfredo de la Escosura-Muñiz, Mariana Medina-Sánchez, Lourdes Rivas, Arben Merkoçi (poster)

Nanochannels-based electrical sensing systems for diagnostics, **XXI Transfrontier Meeting of Sensors and Biosensors (TMSB-2016)**, Barcelona, Spain, 29-30/09/2016, Alfredo de la Escosura-Muñiz, Arben Merkoçi (poster)

Graphene Oxide as an Innovative Pathogen-Revealing Agent, X**XI Transfrontier Meeting of Sensors and Biosensors (TMSB-2016)**, Barcelona, Spain, 29-30/09/2016, Eden Morales-Narváez, Arben Merkoçi (poster)

Plasmonic and Photoluminescent Nanopaper: A novel Sensing Platform, **XXI Transfrontier Meeting of Sensors and Biosensors (TMSB-2016)**, Barcelona, Spain, 29-30/09/2016, Eden Morales-Narváez, Arben Merkoçi (poster)

Graphene sheets wrapped micromotors for remediation of persistent pollutants, **XXI Transfrontier Meeting of Sensors and Biosensors (TMSB-2016)**, Barcelona, Spain, 29-30/09/2016, Jahir Orozco, Luiza A. Mercante, Roberto Pol and Arben Merkoçi (poster)

Water Activated Graphene Oxide Transfer Using Wax Printed Membranes for Fast Patterning of a Touch Sensitive Device, **XXI Transfrontier Meeting of Sensors and Biosensors (TMSB-2016)**, Barcelona, Spain, 29-30/09/2016 (, Poster)

Plant disease monitoring using biosensors, **XXI Transfrontier Meeting of Sensors and Biosensors (TMSB-2016)**, Barcelona, Spain, 29-30/09/2016, Mohga Khater, Alfredo de la Escosura-Muñiz, Arben Merkoçi (poster)

Rapid screening of (poly)phenolic compounds by quantum dot nanosensing probes, **XXI Transfrontier Meeting of Sensors and Biosensors (TMSB-2016)**, Barcelona, Spain, 29-30/09/2016, Ruslan Álvarez-Diduk, Jahir Orozco, Arben Merkoçi (poster)

Solid-State nanochannels for electrical detection of cancer biomarkers, **ALBNANO 2016 Workshop on Nanotechnology and Biosensors**, Tirana, Albania, 29-31/05/2016, Alfredo de la Escosura -Muñiz, Arben Merkoçi (poster)

Lateral Flow Immunoassay designs with improved sensitivities using gold nanoparticles, **ALBNANO 2016 Workshop on Nanotechnology and Biosensors**, Tirana, Albania, 29-31/05/2016, Claudio Parolo, Alfredo de la Escosura-Muñiz, Mariana Medina-Sánchez, Lourdes Rivas, Arben Merkoçi (poster)

A Pathogen-Revealing Agent, **ALBNANO 2016 Workshop on Nanotechnology and Biosensors**, Tirana, Albania, 29-31/05/2016, Eden Morales, Arben Merkoçi (poster)

An Innovative Sensing Platform, **ALBNANO 2016 Workshop on Nanotechnology and Biosensors**, Tirana, Albania, 29-31/05/2016, Eden Morales, Arben Merkoçi (poster)

BOOKS

Comprehensive Analytical Chemistry. Biosensors for Sustainable Food - New Opportunities and Technical Challenges, 1st Edition - Chap. 7, *Emerging nanomaterial for analytical detection*, A. Merkoçi, G. Alarcon-Angeles, G.A. Álvarez-Romero, **74:** 195–246. 2016.

Functional and Physical Properties of Polymer Nanocomposites - Chap. 8, *Bismuth based nanomaterials and platforms for sensing and biosensing applications*, Miquel Cadevall, Josep Ros, Arben Merkoçi, pages 159-174, John Wiley & Sons, Ltd. 2016.

COURSES

Nanotechnology and nanomaterials-based sensors and applications in diagnostics, **Université Tunis El-Manar, Faculté des Sciences de Tunis, Département de Chimie, Campus Universitaire de Tunis El-Manar, Tunis, Tunisia**, 16-19/5/16, Arben Merkoçi.

Nanotechnology master of UAB (6 hours) , **Universitat Autònoma de Barcelona, Barcelona, Spain**, 22/11 - 01/12/2016, Arben Merkoçi.

THESES

Doctorand: **Luis Miguel Pires**
Title: *From nanoparticles to graphene: architecting novel (bio)sensing platforms and devices*
Defence Date: 04/11/2016
Director: Prof Arben Merkoçi

More information:
http://www.nanobiosensors.org/

NanoBiosensors and Bioanalytical Applications Group

Main Research Lines

- **Plasmonics (SPR) and nanoplasmonics (LSPR) for biosensors**
- **Nanophotonic biosensors based on integrated optics technology (MZI and BiMW)**
- **MEMS-based opto-nanomechanical biosensors**
- **Customised polymer microfluidic devices and flow delivery systems**
- **Full integration in lab-on-a-chip and point-of-care biosensor analytical platforms**
- **Universal biofunctionalisation techniques and biochip packaging**
- **Bioanalytical applications in clinical, environmental and molecular biology, providing application-specific functionalities**

GROUP LEADER

CSIC Research Professor
Laura M. Lechuga

Prof. Laura M. Lechuga received her PhD in Chemistry from the *Universidad Complutense de Madrid* in 1992. From 2012 to 2015 she was an adjunct professor at the department of Physics and Technology at the *Arctic University* (Tromsø, Norway). Since 2013 she has been a Distinguished Visiting Professor at the department of Microwaves and Photonics, at the School of Electrical and Computer Sciences of the *Universidade Estadual de Campinas* (Brazil). She has been a fellow of the Optical Society (OSA) since 2014.

Prof. Lechuga is the leader of the ICN2 Nanobiosensors and Bioanalytical Applications Group. The main focus of her research lies in the technological development of photonic (plasmonics and silicon-based) and BioMEMS biosensors, their integration into 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 and delivered more than 300 invited presentations. She also has eight families of

awarded patents at European, US and international level. She was the driving force behind the founding of a spin-off company in 2004 (SENSIA, SL) and the co-founder of another one in 2010 (BIOD, SL).

Prof. Lechuga is an associate editor of the IEEE Photonics and Optics and Laser Technology (Elsevier) Journals, and is on the Editorial Board of the Journal of Sensors. She is a member of the international society for optics and photonics, SPIE, as well as of the European Optical Society (EOS) and the *Real Sociedad Española de la Física* (RSEF). She is a member of permanent steering committees for the Advanced Study Course on Optical Chemical Sensors (ASCOS) and for the Europt(r)ode conference series.

She has often served on the scientific committees of major international conferences and is regularly involved in the organisation of international conferences and workshops. She is a member of the scientific advisory boards of the *Centro Andaluz de Nanomedicina y Biotecnología* (BIONAND), the Biomedical Research Institute (CINBIO) of the *Universidade de Vigo*, the Micro and Nano Research Facility (RMIT, Melbourne, Australia) and the *Centro Investigaciones en Óptica* (CIO, Mexico). She is regularly called upon as an expert evaluator and expert reviewer for the European Commission (FP5, FP6, FP7, H2020), as well as for diverse panel evaluations at the global level.

She has received several prizes and recognitions in 2016, including the Prize for Physics, Innovation and Technology from the *Real Sociedad Española de la Física* (RSEF) and the *Fundación BBVA*.

GROUP MEMBERS

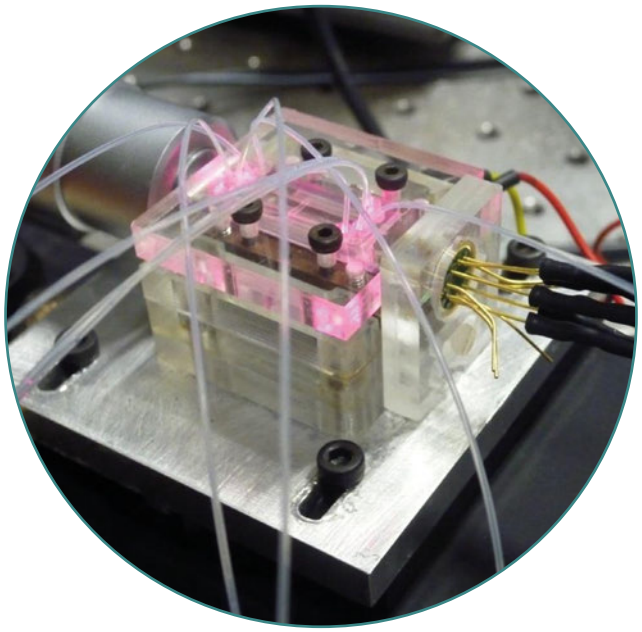
Chocarro Ruiz, Blanca, SO Doctoral Student
Diéguez Gonzalez, Rebeca, Scientific Project Manager
Domínguez Zotes, Santos, CSIC Doctoral Student
Estévez Alberola, María Carmen, Senior Researcher CIBER-BBN
Fabri Faja, Nuria, CSIC Technician
Fariña Santana, David, CSIC Technician
Fernández Gavela, Adrián, CSIC Postdoctoral Researcher
González Guerrero, Ana Belén, CSIC Postdoctoral Researcher
Grajales García, Daniel, Doctoral Fellowship Student
Hernandez, Joel, Doctoral Fellowship Student
Herranz De Andrés, Sonia, CSIC Postdoctoral Researcher
Homs Corbera, Antoni de Padua, SO Senior Researcher
Kurachi, Cristina, Visiting Postdoctoral Researcher
Lechuga Gómez, Laura, CSIC Research Professor and Group Leader
Llop Castelbou, Jessica, Scientific Group Administrator
López Muñoz, Gerardo Arturo, Fellowship Doctoral Student
López Serrano, Albert, Visiting Student
Magro, Remi, Master Fellowship Student
Maldonado Vázquez, Jesús Manuel, Doctoral Fellowship Student
Márquez Villalobos, Salomon Elieser, Doctoral Fellowship Student
Moriones Botero, Oscar, Visiting Master Student
Peláez Gutiérrez, Enelia Cristina, Visiting Doctoral Student
Piqué Reig, Albert, Visiting Undergraduate Student
Ramírez Priego, Patricia, CSIC Technician
Rebull, Jesús, Visiting Undergraduate Student
Recari, Maria, Visiting Undergraduate Student
Ruiz González, Antonio Rafael, Visiting Master Student
Sánchez Huertas, César, Postdoctoral Researcher
Solís Tinoco, Verónica Iraís, Doctoral Fellowship Student
Szydzik, Crispin, Visiting Doctoral Student

NEW PROJECTS & MILESTONES

The activities of the Nanobiosensors and Bionalytical Applications Group are focused on the development of novel nanobiosensor devices based on the principles of plasmonics, nanoplasmonics and silicon-based photonics, including surface biofunctionalisation, microfluidics for automatic fluid delivery and complete lab-on-a-chip integration for point-of-care devices. The application of nanobiosensor devices in real clinical diagnostics and environmental control is one of the group's main objectives. Its research activities range from basic research to the technological operation of working sensing platforms, as well as the transfer of its research outcomes to industry. The group has been at the forefront of developments in photonic biosensors at the international level with such as its bimodal waveguide interferometric device, its optonanomechanical sensor or its magnetoplasmonic biosensor. Since 2016 the group has been associated to the ISCIII Biomedical Research Networking Centre (CIBER), as part of its Centre for Bioengineering, Biomaterials and Nanomedicine (CIBER-BBN).

We have achieved major milestones in several of our research lines, including in integrated silicon nanophotonic biosensors. The ultrasensitive detection limit of this technology at the fM-aM level is far beyond the state-of-the-art and the

group has demonstrated its capabilities in diverse applications. In 2014 a technology transfer agreement was begun with a private company and has been further developed in 2015 and 2016.



In 2016 we have made progress in the development of integrated and multiplexed devices with interferometric nanophotonic and (nano)plasmonic biosensors, with the end goal of achieving sensitive, affordable, handheld and portable point-of-care devices. We have demonstrated their feasibility in several fields of application, including in the research line being developed in cellular pathways. In this regard, we have completed the quantitative evaluation of alternatively-spliced mRNA isoforms with label-free, real-time sensing. We have also successfully demonstrated miRNA detection in biological media at exceptionally low detection limits (aM range). These results have been summarised in three high impact factor publications.

With these results the group has consolidated one of its more fundamental research lines in molecular biology, initiated in 2014. Specifically, we have used our nanobiosensor technologies as alternative analytical techniques for the evaluation of different gene regulating pathways to obtain a more informative and accurate diagnosis and follow-up therapy for cancer. They also allow for a fast, direct and highly-sensitive analysis of these regulating routes without the need for labelling or amplification.

We have also maintained focus on other applications of clinical interest, such as the detection of colorectal cancer biomarkers (i.e. autoantibodies, as part of the RETOS COLONTEST project), the specific detection of infectious diseases such as tuberculosis (European project POCKET and additional collaborations), and the detection of sepsis (European project RAIS). In Environment, we have made progress in the direct detection of marine pollutants in sea water (European project BRAAVOO).

The group has been granted several new projects during 2016. Two of them focus on the development of integrated plasmonic prototypes: URINETEST (RETOS-Colaboración, RTC-2016-5452-1) for the monitoring of a gluten-free diet through the detection of gluten toxic peptides in urine, and PreDICT (RETOS Investigación, TEC2016-78515-R) for the design and fabrication of an advanced multiplexed device for disease detection, progression and therapeutic follow-up in lung cancer. We have also been granted funding for the NANOFOTOSENS project (Domingo Martínez private foundation) for the development of a novel ultrasensitive photonic nanosensor integrating a new class of porous materials (metal-organic frameworks) as specific receptors and nanointerferometers for the fast and specific detection of minute concentrations of gas pollutants for environmental quality control. Two CIBER-BBN intramural projects (PcP-SENS and EYE-POC) have also been granted, devoted to point-of-care device development for the specific detection of *Pneumocystis jirovecii pneumonia* and dry-eye disease, respectively.

PUBLICATIONS

Configurable Quadrant Photodetector: An Improved Position Sensitive Device, Esper-Chaín R., Escuela A.M., Fariña D., Sendra J.R., *IEEE Sensors Journal*; **16 (1, 7234874):** 109-119. 2016. IF: 1.889

Direct and label-free quantification of micro-RNA-181a at attomolar level in complex media using a nanophotonic biosensor, C. S. Huertas, D. Fariña, L.M. Lechuga, *ACS Sensors*; **1 (6):** 748-756. 2016.

Fabrication of well-ordered silicon nanopillars embedded in a microchannel: Via metal-assisted chemical etching: A route towards an opto-mechanical biosensor, Solis-Tinoco V., Marquez S., Sepulveda B., Lechuga L.M., *RSC Advances*; **6 (88):** 85666-85674. 2016. IF: 3.289

Label-free bimodal waveguide immunosensor for rapid diagnosis of bacterial infections in cirrhotic patients, Maldonado J., González-Guerrero A.B., Domínguez C., Lechuga L.M., *Biosensors and Bioelectronics*; **85:** 310-316. 2016. IF: 7.476

Label-free nanoplasmonic sensing of tumor-associate autoantibodies for early diagnosis of colorectal cancer, Soler M., Estevez M.-C., Villar-Vazquez R., Casal J.I., Lechuga L.M., *Analytica Chimica Acta*; **930:** 31-38. 2016. IF: 4.712

Label-free SPR detection of gluten peptides in urine for non-invasive celiac disease follow-up, Soler M., Estevez M.-C., Moreno M.D.L., Cebolla A., Lechuga L.M., *Biosensors and Bioelectronics*; **79:** 158-164. 2016. IF: 7.476

Last advances in silicon-based optical biosensors, Gavela A.F., García D.G., Ramirez J.C., Lechuga L.M., *Sensors (Switzerland)*; **16:** 3-285, 2016. IF: 2.033

On the Spot Diagnosis, L. M. Lechuga, *The Pathologist*, 18, 19-20. 2016.

Out-of-plane single-mode photonic microcantilevers for integrated nanomechanical sensing platform, Fariña Santana D., Álvarez M., Márquez S., Domínguez C., Lechuga L.M., *Sensors and Actuators, B: Chemical*; **232:** 60-67. 2016. IF: 4.758

Prospects of optical biosensors for emerging label-free RNA analysis, Carrascosa L.G., Huertas C.S., Lechuga L.M., *TrAC-Trends in Analytical Chemistry*; **80:** 177-189. 2016. IF: 7.487

Quantitative evaluation of alternatively spliced mRNA isoforms by label-free real-time plasmonic sensing, Huertas C.S., Carrascosa L.G., Bonnal S., Valcárcel J., Lechuga L.M., *Biosensors and Bioelectronics*; **78:** 118-125. 2016. IF: 7.476

Sensitive and label-free detection of miRNA-145 by triplex formation, Aviñó A., Huertas C.S., Lechuga L.M., Eritja R., *Analytical and Bioanalytical Chemistry*; **408 (3):** 885-893. 2016. IF: 3.125

Towards the design of universal immunosurfaces for SPR-based assays: A review, Mauriz E., García-Fernández M.C., Lechuga L.M., *TrAC-Trends in Analytical Chemistry*; **79:** 191-198. 2016. IF: 7.487

Trends in photonic lab-on-chip interferometric biosensors for point-of-care diagnostics, González-Guerrero, A.B., Maldonado, J., Herranz, S., Lechuga, L.M., *Analytical Method*, **8(48):** 8380-8394. 2016. IF: 1.915

PROJECTS

POCKET: Development of a low-cost point-of-care test for Tuberculosis detection, funded by **UE - FP7-ICT-2013-10-610389**, Nov 2013 - Nov 2016, L. M. Lechuga

BRAAVOO: Biosensors, reporters and algal autonomous vessels for ocean operation, funded by **UE - FP7-OCEAN-201-614010**, 01/12/2013 - 01/12/2016, L. M. Lechuga

RAIS: Scalable, point-of-care and label free microarray platform for rapid detection of Sepsis, funded by **UE - H2020-ICT-2014-1-644956**, 01/01/2015 - 01/01/2018, L. M. Lechuga

Recognised as a consolidated research group (SGR 2014-2016) by the Generalitat de Catalunya, funded by **AGAUR**, 2014 - 2017, L. M. Lechuga

COLONTEST: Diseño y puesta a punto de kits para el diagnóstico del cáncer de colon en sangre basados en plataformas multiplex, funded by **Programa RETOS-COLABORACIÓN (MINECO)**, 01/10/2014 - 01/10/2017, L. M. Lechuga

Detección interferométrica en guía de onda bimodal, funded by **Acción Estratégica Economía y Sociedad Digital (AEESD) - Ministerio de Industria, Energía y Turismo (Minetur)** and **PROMAX, S.L.**, 11/2015 - 04/2017, L. M. Lechuga

Implementación de novedosos nanosensores fotónicos para la detección de ínfimas concentraciones de gases contaminantes (NANOFOTOSENS), funded by **Fundación Domingo Martínuez**, 03/2016 - 31/03/2017, L. M. Lechuga

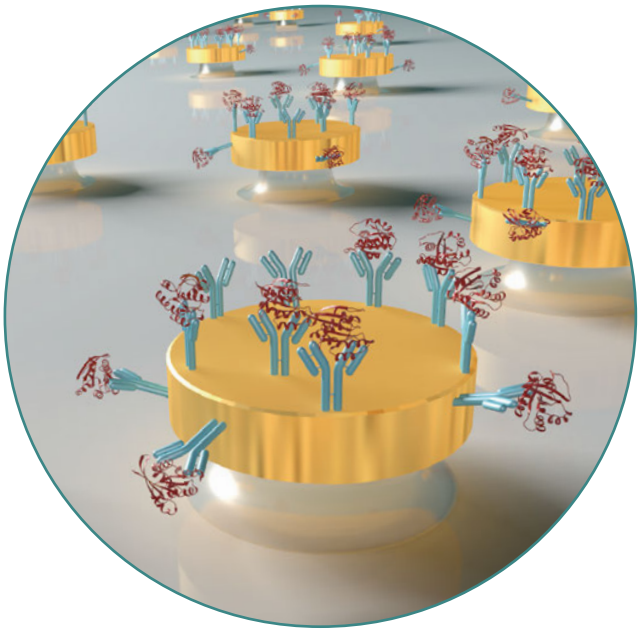
Thematic network of excellence on "Photonic Integrated Circuits for Telecom & Bio Sciences (PIC4TB), fundsed by **Ayudas a la investigación 2016 FDM. Área de Materiales**, 21/03/2016 - 21/03/2017, L. M. Lechuga

URINETEST: Métodos Rápidos de análisis de péptidos inmunogénicos alimenticios en orina, funded by **RETOS/COLABORACIÓN (MINECO)**, 01/01/2016 - 01/01/2018, L. M. Lechuga

PreDICT: Point-of-care nanoplasmonic platforms for novel high-value diagnostics and therapy follow-up, funded by **MINECO**, 30/12/2016 - 29/12/2019, L. M. Lechuga

PcP-Sens: Development of a biosensing diagnostic tool for the fast identification of infection by Pneumocystis, funded by **Proyecto Intramural CIBER-BBN**, 2014 - 2016

EYEPOC: Point of care biosensor devices to detect biomarkers as evaluation end- points for therapeutic clinical trials in ocular surface inflammation, funded by **Proyecto Intramural CIBER-BBN**, 2014 - 2016



CONTRIBUTIONS

Principles and applications of nanoimmunobiosensors, **BRAAVOO Workshop and Creative Design Course**, Lausanne, Switzerland, 31/1/2016 - 6/2/2016, L.M.Lechuga (invited speaker)

Photonic lab-on-chip nanobiosensors as the next diagnostics generation, **8th Workshop of Chemical and Biological Micro Laboratory Technology**, Thuringia, Germany, 23 -25/2/2016, L.M.Lechuga (invited speaker)

Trends and challenges of Nanoplasmonic biosensors for clinical use in Diagnostics, **PITTCON 2016. Session of Frontiers of Plasmonics**, Atlanta, Georgia (USA), 6-10/3/2016, L.M.Lechuga (invited speaker)

Nanophotonic lab-on-chip platforms for ultrasensitive analysis at the point-of-care, **Lab-on-a-Chip Europe 2016 (LAOC)**, Madrid, Spain, 15-16/3/2016, L.M.Lechuga (invited speaker)

REPSOL meeting on Miniaturised Analytical sensors, Madrid, Spain, 25/04/2016, L.M.Lechuga (invited speaker)

Plasmonic and Photonic biosensors, **Meeting on photonic systems for sensing and metrology**, Centre For Doctoral Training In Applied Photonics, University of St Andrews. 25/06 – 01/07/2016, L. M. Lechuga (invited speaker)

Silicon photonic based biosensors and lab-on-a-chip integration, **Summer school on Silicon Photonics**, Ghent University, 29/08 - 2/09/2016, Ghent (Belgium), L. M. Lechuga (invited speaker)

Portable immunonanosensors as the next diagnostics generation for environmental protection, **BRAAVOO Marine Biosensors workshop**, Villars-sur-Ollon, Switzerland, 24-25/11/2016, L.M.Lechuga (invited speaker)

Ultrasensitive bimodal waveguide silicon nitride biosensors for point-of-care diagnosis, **European Optical Society Annual Meeting - Workshop on Sensing Applications Enabled by Silicon Photonics**, Berlin, Germany, 26 -30/9/2016, L.M.Lechuga (invited speaker)

Nanophotonics lab-on-chip biosensors for point of care diagnostics, **Japan-Spain Joint Workshop on Nanomedicine Research**, Madrid, Spain, 1-2/12/2016, L.M.Lechuga (invited speaker)

Nanoplasmonic biosensors for real applications: trends and challenges, **META 2016. The 7th International Conference on Metamaterials, Photonic Crystals and Plasmonics**, Málaga, Spain, 25-28/7/2016, L.M.Lechuga (keynote speaker)

Nanophotonic interferometric immunosensor for label-free and real-time monitoring of Irgarol 1051 in sea water, **BRAAVOO Marine Biosensors workshop**, Villars-sur-Ollon, Switzerland, 14/10/2016, B. Chocarro, S. Herranz, A. Fernández, J. Sanchís, M. Farré, M.P. Marco and L. M. Lechuga (oral)

Integrated Optofluidic system for highly sensitive detection of cancer biomarkers incorporating bimodal waveguide photonic biosensors interfaced to complex, active microfluidics, **SPIE BioPhotonics Australasia**, Adelaide, Australia, 16-19/10/2016, Szydzik, C. et al. (oral)

Development of an immunosensor for the detection of Pseudomonas Aeruginosa in ascitic fluid by bimodal waveguide interferometry, **Europtrode 2016**, Gratz, Austria, 20-23/3/2016, J. Maldonado, A.B. González-Guerrero, J.J. González-López, C. Domínguez and L.M. Lechuga (oral)

Point-of-care photonic tuberculosis sensor (POCKET), **Europtrode 2016**, Gratz, Austria, 20-23/3/2016, D. Martens et al. (oral)

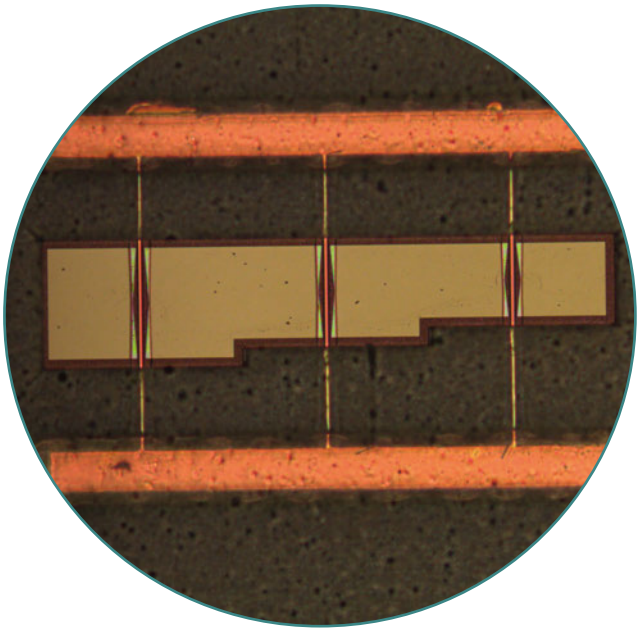
Towards a point-of-care photonic tuberculosis sensor, **SOCS-MINABICT 2016**, Ottranto (Italy), D. Martens et al. (oral)

Sensitive and Label-Free Detection of miRNA-145 by Surface Plasmon Resonance, **RIBORED2016**, Barcelona, Spain, 31/05/2016, A. Aviñó, C. S. Huertas, L. M. Lechuga & R. Eritja (poster)

Decoding the epigenome for cancer diagnosis with advanced label-free nanodevices, **Beyond Cancer Genomes. Barcelona Conference on Epigenetics and Cancer (B-Debate)**, Barcelona, Spain, 13-14/10/2016, C. S. Huertas and L. M. Lechuga (poster)

Direct quantification of exosomes from tumor cell cultures by bimodal waveguide interferometry, **Europtrode 2016**, Gratz, Austria, 20-23/3/2016, A.B. González-Guerrero, P. Ramírez, J. Maldonado and L.M. Lechuga (poster)

LSPR-based immunoassay for the specific detection of HspX protein biomarker related to Tuberculosis disease, **Institut Pasteur International Network Scientific Symposium 2016**, Paris, France, 29/11/2016 - 2/12/2016, E.-C. Peláez, M.-C. Estevez, P. Del Portillo, O. L. Herrera J. Robledo and L. M. Lechuga (poster)



DISSEMINATION CONTRIBUTIONS

Invited Conference, *Point-of-care biosensors for the label-free and fast diagnostics of microorganisms and biomarkers*, **Vall D´Hebrón Hospital**. Barcelona, 28 January 2016, L. M. Lechuga

Invited Conference, *Nanophotonics "Lab-on-a-chip" biosensors for portable diagnostics*, **University of Bielefeld**, Germany, 8 February 2016, L. M. Lechuga

Invited Conference, *Nanophotonics "Lab-on-a-chip" biosensors for mobile diagnostics*, **University of Jena**, Germany, 22 February 2016, L. M. Lechuga

Invited Conference, *Nanophotonics "Lab-on-a-chip" biosensors for portable diagnostics*, **Georgia Tech**, Atlanta (USA), 11 March 2016, L. M. Lechuga

Invited Conference, *Dispositivos nanobiosensores integrados en plataformas lab-on-chip para el diagnóstico descentralizado*, **Universidad de los Andes**. Bogotá, Colombia, 14 October 2016, L. M. Lechuga

Invited Conference, *Nanophotonics biosensors based on Si photonics*, **University of York**, York (UK), 25 October 2016, L. M. Lechuga

BOOKS

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 (2016)

COURSES

Invited Talk : Silicon photonic based biosensors and lab-on-a-chip integration, **Summer school on Silicon Photonics - Ghent University**, Ghent, Belgium, 29/8/16 - 2/9/16, L. M. Lechuga

Plasmonic and Photonic biosensors, Photonic Systems for Sensing and Metrology, **Centre for Doctoral Training in Applied Photonics**, Sant Andrews, Scotland, 25/6/2016 - 1/7/2016, L. M. Lechuga

Invited Conference, **Curso profundización biosensores**, Villavicencio, Colombia, 11-13/10/2016, C. Peláez

AWARDS

Prof. Laura M. Lechuga, **Physics, Innovation and Technology RSEF-FBBVA Award**, organised by *Real Sociedad Española de Física* (RSEF) and *Fundación BBVA*

Prof. Laura M. Lechuga, ***Selección Española de la Ciencia 2016***, gala organised by the Spanish National Research Council (CSIC) and Quo magazine.

PARTICIPATED CONGRESSES

Symposium "Silicon compatible materials and integrated devices for photonics and optical sensing" 2016 E-MRS SPRING MEETING, Lille, France, 2-6/5/2016. L.M. Lechuga - Co-Chair

"(Nano)plasmonics Biosensors". META'16, Málaga, Spain, 25-28/7/2016, L.M. Lechuga - Chair of Special Session

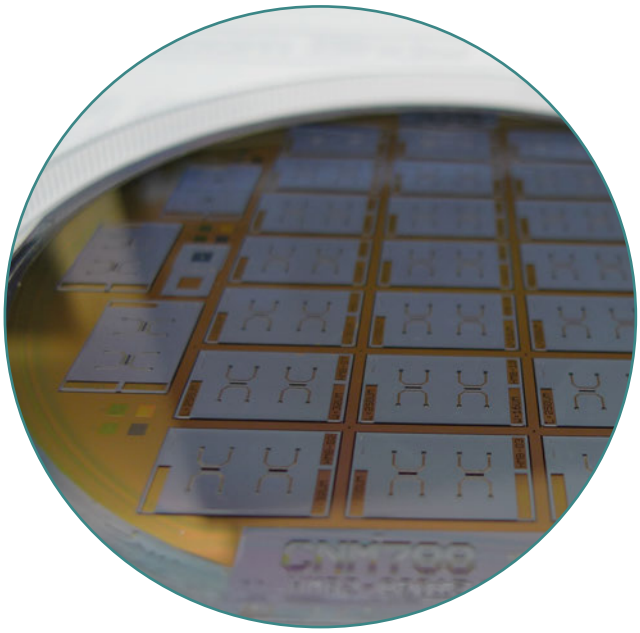
The Latin America Optics and Photonics (LAOP) Conference (OSA Conferences, Biophotonics and Biomedical Applications, Medellín, Colombia, 22-25/8/2016, L.M. Lechuga - Chair of the Symposium

THESES

Doctorand: **Cesar Sanchez Huertas**
Title: Nanophotonic biosensors for deciphering cell regulation pathways.
Defence Date: 04/03/2016
Supervised by Prof. Laura M. Lechuga

Doctorand: **Salomón Márquez Villalobos**
Title: Array of microfluidic beam resonators for mass sensing applications - design, fabrication and testing.
Defence Date: 08/07/2016
Supervised by Prof. Laura M. Lechuga and Dr Mar Álvarez

Doctorand: **Verónica Irais Solís Tinoco**
Title: Development of integrated plasmomechanical sensors in microfluidic devices for live cell analysis.
Defence Date: 18/11/2016
Supervised by Prof. Laura M. Lechuga and Dr Borja Sepúlveda



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

Nanostructured Functional Materials Group

Main Research Lines

- **Bio- and bioinspired nanomaterials:**
  - Drug delivery and imaging nanocarriers
  - Catechol-based biocoatings and bioadhesives
- **Energy-efficient nanomaterials:**
  - Photoactive nanosystems
  - Catalytic nanostructures
- **Hybrid molecular devices:**
  - 2D coordination polymers
  - Active molecular nanostructures on surfaces

GROUP MEMBERS

Albero Blanquer, Laura, Visiting Student
Akhmetzhanova, Dinara, Master's Student
Ayala García, Álex, DI Doctoral Student
Bellacanzone, Christian, SO Doctoral Student
Casagualda Clapés, Carolina, Doctoral student
Contreras Pareda, Noemí, Master's Student
Frias Botella, Carolina, Master's Student
García Martinez, Beatriz, Specilised Technician
Giró Pujols, Roger, Visiting Student
González Monje, Pablo, Specilised Technician
González Ros, Cristina, Visiting Student
Hayati, Payam, Visiting Doctoral student
Julià López, Alejandro Ricar, Doctoral Student
Mancebo Aracil, Juan, Postdoctoral Student
Martínez Pérez, David, Master's Student
Montpeyó García Moreno, David, FI Doctoral Student
Moreira Castro, Sarah, Visiting Student

GROUP LEADER

CSIC Research Scientist
Dr Daniel Ruiz-Molina

Daniel Ruiz-Molina earned his PhD in polyradical dendrimers at the *Institut de Ciència de Materials de Barcelona* (ICMAB-CSIC) under Prof. Jaume Veciana. He then took a postdoctoral position at the University of California San Diego, where he spent three years working on single molecule magnets and molecular switches.

Since 2001 he has held a permanent position at the CSIC and more recently at the ICN2, where he is the leader of the Nanostructured Functional Materials Group. His main research areas are the fabrication of hybrid colloids and surfaces, biomimetic functional nanostructures, and micro- or nanoparticles for smart applications and encapsulation and delivery systems.

Moreno Villaecija, Miguel Ángel, Doctoral Student
Nador, Fabiana Gabriela, Postdoctoral Student
Nayarassery, Adarsh, Postdoctoral Student
Novio Vázquez, Fernando, CSIC Postdoctoral Researcher
Oliveira Marques, Elisabete, Visiting Professor
Otaegui Rabanal, Jaume Ramón, Visiting Student
Rivas Dapena, Antón, Visiting Student
Roscini, Claudio, Senior Postdoctoral Researcher
Ruiz-Molina, Daniel, CSIC Research Scientist and Group Leader
Sedó Vegara, Josep, Senior Postdoctoral Researcher
Segura Lecina, Ona, Visiting Student
Serra Capdevila, Albert, Visiting Student
Solorzano Rodríguez, Rubén, Doctoral Student
Suárez García, Salvio, SO Doctoral Student
Tello Valero, Alexis, Visiting Student
Torres Pierna, Héctor, DI Doctoral student
Verdini, Emanuela, Visiting Master's Student
Wnuk, Karolina, Doctoral student
Xiaoman, Mao, Doctoral Student
Zhang, Fenghua, Visiting 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.
3. Novel bio-inspired catechol-based coatings and adhesives.
4. Development of encapsulation methods for photoactive species and novel photophysical/chemical applications.

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

Biocompatible polydopamine-like particles for the removal of heavy metals at extremely low concentrations, Contreras Rodríguez A.R., Saiz-Poseu J., García-Pardo J., García B., Lorenzo J., Ojea-Jiménez I., Komilis D., Sedó J., Busqué F., Sánchez A., Ruiz-Molina D., Font X., *RSC Advances*; **6 (46):** 40058-40066. 2016. IF: 3.289

Coordination polymers build from 1,4-bis(imidazol-1yl-methyl)benzene: From Crystalline to Amorphous, N. N Adarsh, F. Novio, D. Ruiz-Molina, *Dalton Transactions*; **45 (28):** 11233-11255. 2016. IF: 4.177

High-Throughput Topographic, Mechanical, and Biological Screening of Multilayer Films Containing Mussel-Inspired Biopolymers, A. I. Neto , N. L. Vasconcelos , S. M. Oliveira , D. Ruiz-Molina, J. F. Mano, *Advanced Functional Materials*; **26 (16):** 2745-2755. 2016. IF: 11.382

Nanoscale coordination polymers obtained in ultrasmall liquid droplets on solid surfaces and its comparison to different synthetic volume scales Synthesis of nanoscale coordination polymers confined in femtolitre reactors on surfaces, E. Bellido, P. González-Monje, M. Guardingo, F. Novio, A. Sánchez, M. Montero, G. Molnar, A. Bousseksou, D. Ruiz-Molina, *RSC Advances*; **6:** 76666-76672. 2016. IF: 3.289

Reactions in ultra-small droplets by tip-assisted chemistry, Guardingo M., Busqué F., Ruiz-Molina D., *Chemical Communications*; **52 (78):** 11617-11626. 2016. IF: 6.567

Recent Advances in Porous Nanoparticles for Drug Delivery in Antitumoral Applications: Inorganic Nanoparticles and Nanoscale Metal-Organic Frameworks, A Baeza, M. Vallet-Regí, D. Ruiz-Molina, *Expert Opinion on Drug delivery*; **4 (6):** 783-796. 2016. IF: 5.434

Switchable colloids, thin-films and interphases based on metal complexes with non-innocent ligands: The case of valence tautomerism and their applications, Vázquez-Mera N.A., Novio F., Roscini C., Bellacanzone C., Guardingo M., Hernando J., Ruiz-Molina D., *Journal of Materials Chemistry C*; **4 (25):** 5879-5889. 2016. IF: 5.066

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Temperature-Controlled Switchable Photochromism in Solid Materials, Julià-López A., Hernando J., Ruiz-Molina D., González-Monje P., Sedó J., Roscini C., *Angewandte Chemie-International Edition*; **55 (48):** 15044-15048. 2016. IF: 11.709

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PROJECTS

Materiales Basados en Catecoles para Teranóstica de la Enfermedad de Parkinson, funded by **MINECO**, 01/01/2016 - 31/12/2018, Daniel Ruiz Molina

Materiales nanoestructurados de indice variable de aplicación en la industria óptica oftálmica, funded by **MINECO**, 01/09/2016 - 31/12/2018, Daniel Ruiz Molina

Microcápsulas inteligentes con repelentes de mosquitos y fragancias de aplicación en textiles que eviten la propagación de enfermedades tropicales, funded by **MINECO**, 01/09/2016 - 31/12/2019, Daniel Ruiz Molina

CONTRIBUTIONS

Coordination Polymer Particles (CPPs) as novel nanomaterials for theranostics, **ICMM Workshop Nanoparticles for Biomedical Applications**, Madrid, Spain, 01/06/2016, F. Novio (invited speaker)

Novel (Coordination) Polymer Nanoparticles for Advanced Theranostics, **CIC-Biomagune** , Donosti, Spain, 08/07/2016, D. Ruiz-Molina (invited speaker)

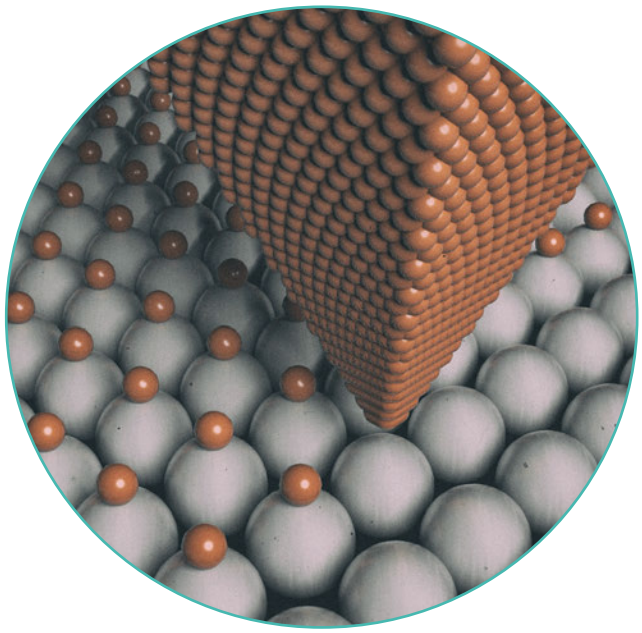
Novel (Coordination) Polymer Nanoparticles for Advanced Theranostics, **Department of Materials Science**, Aveiro University, Aveiro, Portugal, 11/10/2016, D. Ruiz-Molina (invited speaker)

Novel (Coordination) Polymer Nanoparticles for Advanced Theranostics, **2nd International Symposium on Nanoparticles/Nanomaterials and Applications**, 18-21/1/2016, D. Ruiz-Molina (invited speaker)

Spin crossover on exfoliated 2-D coordination polymer sheets, **6th Phase Transition and Dynamical properties of Spin Transition Materials (PDSTM2016)**, Gandia, Spain, 27-30/11/2016, D. Ruiz-Molina (invited speaker)

Switchable optical properties based on phase change materials, **2nd International Caparica Conference on Chromogenic and Emissive Materials (IC3EM)**, Caparica, Portugal, 01/09/2016, C. Roscini (keynote talk)

Switchable optical properties based on phase change materials, **Rational design of hybrid organic-inorganic interfaces: the next step towards advanced functional materials**, 01/10/2016, C. Roscini (keynote talk)



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Controlling the Release in Mesoporous Silica Nanoparticles with Bioinspired Catechol-based Coatings, **HINT Workshop: Nanostructured materials: coatings, surfaces, bioceramics/-composites, membranes**, Vilnius, Lithuania, 14-16/3/2016, M. A, Moreno (oral)

Polymerization of Catechols with Ammonia: A Succesful Approach for Biocompatible Polydopamine-like Coatings and Nanoparticles of Relevance in Health and Environmental Applications, **The 3rd International Conference on Bioinspired and Biobased Chemistry & Materials**, Nice, France, 16-19/10/2016, D. Ruiz-Molina (oral)

New photofunctional materials based on polymeric micro/nanocapsules, **ICREA Conference on Functional Nanocontainers**, Tarragona, Spain, 17-20/10/2016, C. Roscini (oral)

Fast Responsive Photochromic Materials, **Multi-Responsive Photocromes**, Nantes, France, 25-28/4/2016, H. Torres (oral)

Coordination polymer nanoparticles for caner theranostics, **13th European Biological Inorganic Chemistry Conference - EuroBIC**, 28/8 - 1/9/2016, D. Ruiz-Molina (oral)

Pt(IV) Prodrug Cocktailed Coordination Polymer Nanoparticles: Towards Anti-neuroblastoma Drug Delivery, **42nd International Conference on Coordination Chemistry**, Brest, France, 3-8/7/2016, N. Adarsh (oral)

Encapsulation of phase change materials to obtain novel switchable optical properties, **Smart and Green Interfaces Conference 2016**, Athens, Greece, 4-6/5/2016, A.Julià (oral)

Coordination Polymer Particles for Biomedical Applications, **XIII Simposio de Investigadores Jóvenes de la Real Sociedad Española de Química**, Logroño, Spain, 8-11/11/2016, R.Solorzano (oral)

Novel (Coordination) Polymer Nanoparticles for Advanced Theranostics, **Scientific workshop COST Action CM1305 ECOSTBIO**, Krakow, Poland, 8-9/9/2016, R. Solorzano (oral)

Materiales Moleculares Multifuncionales: del Erlenmeyer al nanodispositivo, de la utopía a la aplicación, **Ciclo de Seminarios del Departamento de Física de la Materia Condensada de la Universidad de Zaragoza**, Zaragoza, Spain, 06/05/2016, D. Ruiz-Molina, Plenary Lecture

Novel nanostructured materials based on coordination polymer particles as potential contrast agents, **2nd International Symposium on Nanoparticles/ Nanomaterials and Applications**, Lisbon, Portugal, 18 - 21 /1/2016, Salvio Suárez (poster)

New Single-Antibody, targeted Coordination Polymer Particles for Cancer Treatment, **10th International Summer Schools on N&N, OE & NM (ISSON16)**, Thessaloniki, Greece, 2-9/7/2016, D. Montpeyó (poster)

New lysosomal therapeutic strategies for enzymatic replacement purposes, **MC Meeting of the COST Action "European Network of Multidisciplinary Research and Translation of Autophagy knowledge" (TRANSAUTOPHAGY, CA15138)**, Warsaw, Poland, 6-7/10/2016, F.Novio (poster)

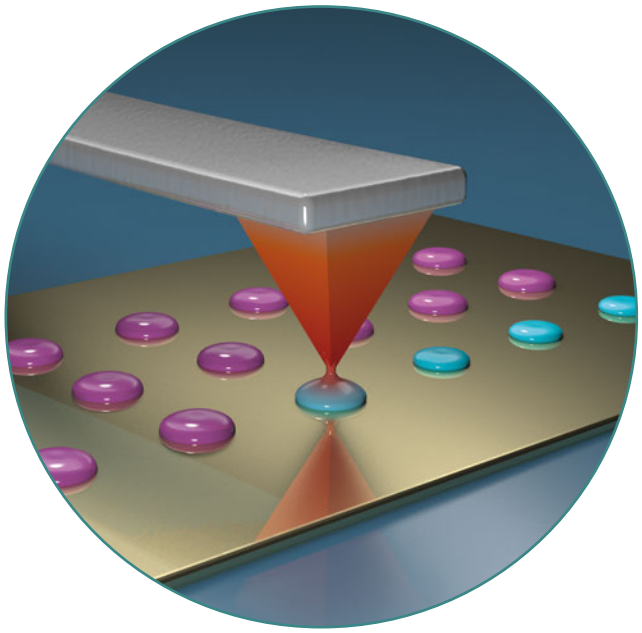
COURSES

Máster Oficial - Nanociencia y Nanotecnologia Avanzadas, **Nanotecnología para Terapia y Remediación, 6h.**, Fac. Ciencies, UAB, Bellaterra, Spain, Feb, 2016, Fernando Novio

Curso de formación en Master *"Industrial chemistry and introduction to chemical research"*, **Micro & nanocapsules for controlled delivery of functional molecules, 3h.**, Fac. Ciencies, UAB, Bellaterra, Spain, Oct. 2016, C. Roscini

AWARDS

Salvio Suarez, **BEST Poster - 2nd International Symposium on Nanoparticles/Nanomaterials and Applications**, Lisbon (Portugal), 18-21 January 2016, "Novel nanostructured materials based on coordination polymer particles as potential contrast agents"



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

Nanostructured Materials for Photovoltaic Energy Group

Main Research Lines

- **Photovoltaics: Next-generation thin film, organic, hybrid, dye-sensitised, halide perovskite and all-oxide solar cells**
- **Synthesis of nanomaterials 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**
- **Semiconductor oxides for energy and ICT applications by solution processing fabrication**
- **Self-driven energy devices.**

GROUP MEMBERS

Álvarez De Lasarte Sagrera, Irene, SO Technician
Balcells, Marc, SO Technician
Billon, Quentin, Master's Fellowship Student
Echeverria Troya, Fernando, Doctoral Fellowship Student
Fonrodona Turon, Marta, Scientific Project Manager
Genç, Rükan, Visiting Researcher
Lira Cantu, Mónica, CSIC Tenured Scientist and Group Leader
Mergny, Loïs, Master's Fellowship Student

GROUP LEADER

CSIC Tenured Scientist
Dr Mónica Lira-Cantú

Mónica Lira-Cantú (Chemistry, 1992) obtained her Master's and PhD degrees in Materials Science at the *Institut de Ciència de Materials de Barcelona* (ICMAB) and the *Universitat Autònoma de Barcelona* in 1995 and 1997, respectively. She then completed her postdoctoral work in the form of a contract between Schneider Electric and ICMAB in 1998. From 1999 to 2001 she worked as permanent senior staff chemist at ExxonMobil Research & Engineering (formerly Mobil Technology Co) in New Jersey (USA), establishing a group on energy-related applications. Besides her role as group leader of the ICN2 Nanostructured Materials for Photovoltaic Energy Group, she is currently a visiting professor at the Laboratory of Photomolecular Science (LSPM) of the *École Polytechnique Fédérale de Lausanne*.

Mingorance Ferrer, Alba, SO Doctoral Student
Morales Melgares, Anna, Internship Student
Perez-Tomas, Amador, Young Investigator Fellow
Reyna Velázquez, Yegraf, Doctoral Fellowship Student
Sánchez Sierras, Óscar, Intership Researcher
Shirley, Ian, Fullbright Doctoral Fellowship Student
Suárez Secilla, Javier, Visiting Undergraduate Student
Tanenbaum, David Michael, Visiting Professor (USA)
Zhang, Jinbao, Visiting Postdoctoral Researcher

Prof. Lira-Cantu has received different awards and fellowships as a visiting scientist at the following laboratories: *Universitetet i Oslo* (Norway) (ESF, 2003), *Risø DTU Nationallaboratoriet* (Denmark) (AGAUR, 2004/05) and the Center for Advanced Science and Innovation (Osaka Univeristy, Japan) (Canon Foundation in Europe, 2006). She obtained a permanent position in 2007 at the *Consejo Superior de Investigaciones Científicas* (CSIC) and established the ICN2 Photovoltaic Energy Group in 2007.

Since then she has directly managed more than 48 researchers, including one visiting professor, five postdoctoral students, eight doctoral students (four in progress), 26 Master's and undergraduate students, two project managers and two technicians. She has been the principal investigator on several national, industrial and European projects, and she is the main coordinator of a COST Action involving more than 470 partners from 35 countries and 22 companies related to the study of the stability of organic and perovskite solar cells.

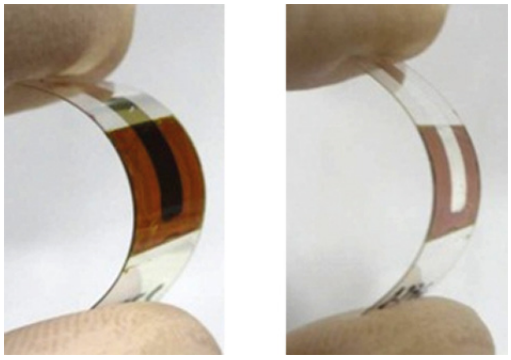
She has coordinated and organised more than 10 scientific conferences and is currently a scientific referee for more than 13 international and European research agencies, and 46 scientific journals, as well as the editor of the Frontiers in Energy and the Energies journals. She is a member of the Advisory Board for the Nanotechnology and Chemical Science and Engineering (INQ) degree of the *Instituto Tecnológico y de Estudios Superiores de Monterrey* (Mexico).

Her research interests lie in the synthesis and application of nanostructured materials for stable next-generation thin-film solar cells: halide-perovskite, dye-sensitised, all-oxide and organic solar cells. Mónica Lira-Cantú has more than 105 publications, among them 87 published papers, 7 patents and 10 book chapters, 1 edited book (in progress) and several technical reports. Her h-index is 32.

NEW PROJECTS & MILESTONES

The Nanostructured Materials for Photovoltaic Energy Group has several key objectives, all of them related to the **development of highly-efficient, highly-stable and low-cost solution processable photovoltaic and optoelectronic devices**.

A major goal is the ***synthesis of nanostructured materials***, especially those involving transition metal oxides (TMOs) and graphene, via the application of low-cost and solution processing methods. TMOs have many possible applications as main active materials or barrier layers, though they also find applications 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. These oxides are being applied in our group as ***nanostructured materials*** (nanorods, nanowires, nanotrees, core-shell, etc.) and dense thin films in the various next-generation solar cells offering excellent performance in term of efficiency and lifetime. The ***functionalisation*** of these oxide surfaces is now carried out in our group by anchoring self-assembled monolayers with selected anchoring groups to interact simultaneously with the oxide and the active light harvesting material.



The ***stability and lifetime*** of optoelectronic devices, especially organic and perovskite solar cells, is a major limitation for these technologies. An important contribution of the group is the study and characterisation of solar cell stability following degradation and characterisation protocols. Prof. Lira-Cantu coordinates a COST Action with a consortium of more than 470 members, among them 60 internationally-recognised research laboratories and 22 companies from 35 countries. **StableNextSol, as the project is known, is related to the stability of organic and perovskite solar cells**. Its goal is to take advantage of the multiple characterisation techniques available through the different partners to elucidate the degradation mechanism of these devices and propose disruptive solutions towards highly stable organic solar cells.

Other interests include the development of self-driven energy devices for ICT and bio-related applications.

PUBLICATIONS

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Above-Bandgap Photovoltages in Antiferroelectrics, Pérez-Tomás A., Lira-Cantú M., Catalan G., *Advanced Materials*; **28 (43):** 9644-9647. 2016. IF: 18.960

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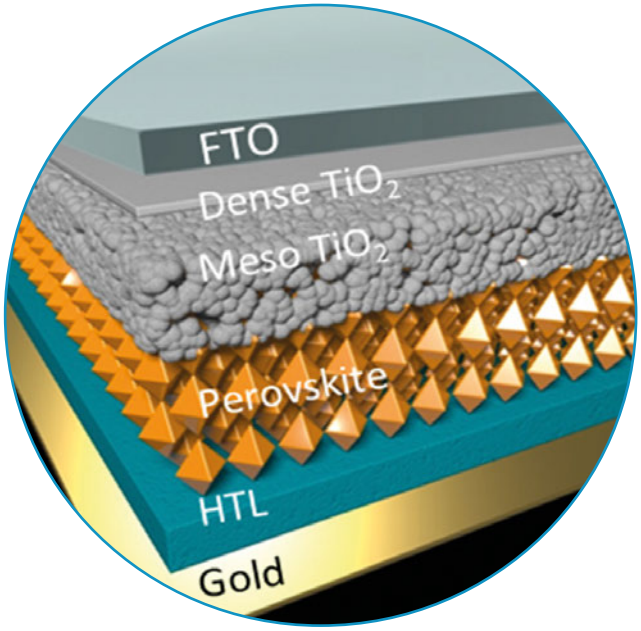
Flexible ITO-free organic solar cells applying aqueous solution-processed V_2O_5 hole transport layer: An outdoor stability study, Lima F.A.S., Beliatis M.J., Roth B., Andersen T.R., Bortoti A., Reyna Y., Castro E., Vasconcelos I.F., Gevorgyan S.A., Krebs F.C., Lira-Cantu M., *APL Materials*; **4** (2, 026104) 2016. IF: 4.323

Improved channel mobility by oxide nitridation for n-channel MOSFET on 3C-SiC(100)/Si, Li F., Sharma Y.K., Jennings M.R., Pérez-Tomás A., Shah V.A., Rong H., Russell S.A.O., Martin D.M., Mawby P.A., *Materials Science Forum*; **858:** 667-670. 2016. IF: 0.399

Performance and stability of mixed $FAPbI_{3(0.85)}MAPbBr_{3(0.15)}$ halide perovskite solar cells under outdoor conditions and the effect of low light irradiation, Reyna Y., Salado M., Kazim S., Pérez-Tomas A., Ahmad S., Lira-Cantu M., *Nano Energy*; **30:** 570-579. 2016. IF: 11.553



PROJECTS

Stable Next-Generation Photovoltaics: Unravelling Degradation Mechanisms of Organic Solar Cells by Complementary Characterization Techniques, StableNextSol. MP1307, funded by **COST Action - EU**, 2014-06-01 / 2018-05-31, Lira-Cantú, M.

Grupo consolidado de la Generalitat de Catalunya, Ref: 2014 SGR 1212, funded by **AGAUR**, 2014 - 2017, Lira-Cantú, M.

Células solares nanoestructuradas fabricadas a partir de disoluciones: nuevos nanomateriales basados en óxidos de metales de transición y grafeno, funded by **MINECO**, Jan-2014 / Dec-2016, Lira-Cantú, M.

CONTRIBUTIONS

Solution Processing Nanostructured Metal Oxides and Graphene for Organic and Perovskite Solar Cells: enhancement of Efficiency and Lifetime, **AIT Austrian Institute of Technology**, Austria, 19/01/2016, Monica Lira-Cantu (invited speaker)

Solution processable metal oxides for organic and solar cells, **International Cooperation for Education on Standarization (ICES2016)**, Kyoto, Japan, 15-16/3/16, Monica Lira-Cantu (invited speaker)

Unravelling the Degradation Mechanisms of Emerging Solar Cell Technologies, **EU COST Action MP1307 – MELECON 2016**, St. Raphael Resort, Limassol, Cyprus, 18-20/4/16, Tom Aernouts, Francesca Brunetti, Jesus de la Fuente, Nieves Espinosa, Marta Fonrodona , Yulia Galagan, Harald Hoppe, Eugene Katz, Monica Lira Cantu, Marta Ramos, Moritz Riede, Antonio Urbina, Koen Vandewal, Sjoerd Venstra, Elizabeth von Hauff. (invited speaker)

1000 h Outdoor Stability of FAPbI3(0.85) MAPbBr3(0.15) Mixed Halide Perovskite Solar Cells Under Outdoor Conditions, **Organic and Perovskite Solar Cell Conference**, Herakion, Greece , 19/20/10/16, Yegraf Reyna, Manuel Salado, Samrana Kazim, Amador Pérez, Shahzada Ahmad, Monica Lira-Cantu (invited speaker)

Solution processable metal oxides for organic and solar cells, **17th SPIE Conference on Organic Photovoltaics, SPIE Optics + Photonics Annual Meeting**, San Diego Convention Center, San Diego, California (USA), 28/8 -1/9/16, Monica Lira-Cantu (invited speaker)

Stability of perovskite solar cells following the ISOS-O-2 protocol: outdoor testing, **Conference Perovskite Thin Film Photovoltaics (ABXPV)**, Barcelona, Spain, 3-4/3/16, Yegraf Reyna, Manuel Salado, SamranaKazim, Amador Pérez, Shahzada Ahmad, Monica Lira-Cantu (invited speaker)

COURSES

Stable Organic and Perovskite Solar Cells Employing Oxide Interlayers. **ISOPHOS, International School on Hybrid and Organic Photovoltaics**, Invited Seminar, Tuscany, Italy, 11-15/9/2016, Monica Lira-Cantu

Next Generation Thin Film Photovoltaics **Master Course. Autonomous University of Barcelona, Industrial Chemistry Master Program**, Barcelona, Spain, Sep 2016, Monica Lira-Cantu

BOOKS

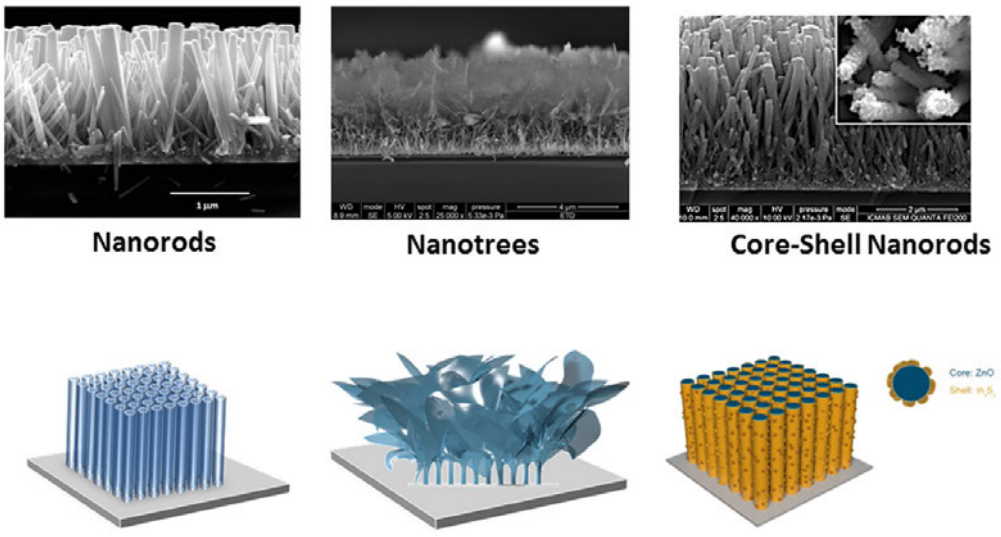
The future of Semiconductor Oxides in Next-Generation Solar Cells, Elsevier Ghenadii Korotcenkov, Series Editor. 2016, *in Preparation.*

BOOKS CHAPTERS

Molecular Devices for Solar Energy Conversion and Storage, *Stability of Molecular Devices: Perovskite Solar Cells in Molecular Devices for Solar Energy Conversion and Storage,* Yegraf Reyna, Amador Pérez-Tomás, Alba Mingorance, Mónica Lira-Cantú. Editors: H. Tian, G. Boschloo and A. Hagfeldt. Ed. Springer. 2016

The future of Semiconductor Oxides in Next-Generation Solar Cells, *Solution processable semiconductor oxides in organic and perovskite solar cells: From binary to complex oxide materials*, Amador Perez Tomas, Alba Mingorance, Yegraf Reyna, Monica Lira-Cantú. Elsevier M. Lira-Cantu Eds. 2016

The future of Semiconductor Oxides in Next-Generation Solar Cells, *Semiconductor oxides for stable organic and perovskite solar cells,* Monica Lira-Cantú. Elsevier M. Lira-Cantu Eds. 2016



Novel Energy-Oriented Materials Group

Main Research Lines

- Hybrid electrode materials for supercapacitors and hybrid energy storage devices
- Graphene batteries. LiFePO4 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, development of secondary products (nanofluids, composites for 3D-printing, inks, etc.) and applications in energy storage

GROUP MEMBERS

Caban Huertas, Zahilia, Visiting Doctoral Student
Cavalcante Huguenin, Fritz, Visiting Postdoctoral Researcher
Chen, Hong, Visiting Student
Dubal, Deepak Prakash, SO CSIC Postdoctoral Researcher
Gibert Roca, Martí, Internship Student
Gómez-Romero, Pedro, CSIC Research Professor and Group Leader
Lian Wang, Jun, Visiting Undergraduate Student
Marchante Fernández, Carlos, Technician
Mohite, Ashwini, Technician
Nagar, Bhawna, SO Doctoral Student

GROUP LEADER

CSIC Research Prof.
Dr Pedro Gómez-Romero

Prof. Pedro Gómez-Romero completed his undergraduate and Master's degrees at the *Universitat de València*, before going on to earn his PhD with Distinction in Chemistry at Georgetown University (USA) in 1987. A CSIC Researcher since 1990, he worked at the *Institut de Ciència de Materials de Barcelona* (ICMAB) from 1990 to 2007. He spent a sabbatical year as a NATO Senior Research Fellow at the National Renewable Energy Laboratory (USA, 1998-99). He

Ribot Sánchez, Sergi, Visiting Undergraduate Student
Rodríguez Laguna, María del Rocío, SO Doctoral Student
Rueda García, Daniel, Doctoral Student
Sánchez Peña, Pilar, Visiting Master's Student
Tajik, Sanaz, Doctoral Fellowship Student

became a CSIC Full Research Professor in 2006 and was group leader of the NEO-Energy laboratory at the former CIN2 (CSIC) from 2007 to 2013, now forming part of the ICN2. He is a fellow of the Royal Society of Chemistry. As group leader of the ICN2 Novel Energy-Oriented Materials Group, he heads projects on hybrid organic-inorganic nanostructures, nanocomposite materials for energy storage and conversion (lithium batteries, supercapacitors, flow cells, solar-thermal energy, nanofluids, graphene). He was vice-director of MATGAS from 2010 to 2014.

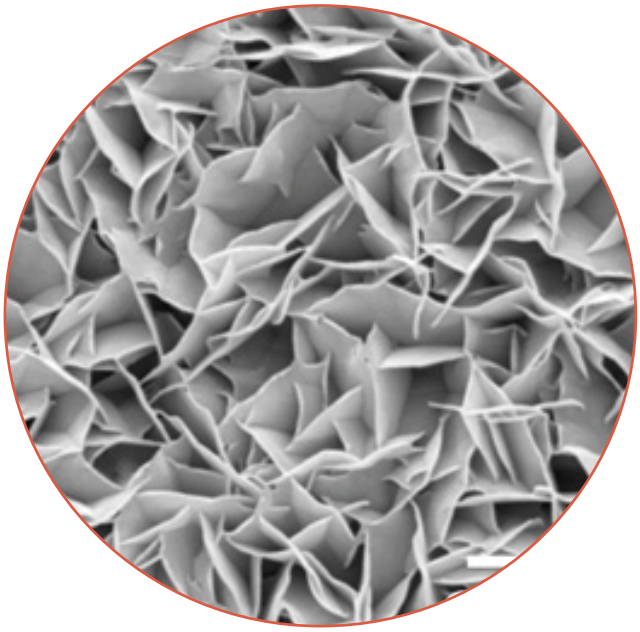
Prof. Pedro Gómez-Romero is the author of more than 200 scientific publications in international refereed journals. He is the scientific editor of the books *Functional Hybrid Materials* (P. Gómez-Romero, C. Sánchez (Eds.) (Wiley-VCH 2004)) and *Metal Oxides in Supercapacitors* (D P. Dubal, P. Gomez-Romero (Eds.) (Elsevier, 2017)). He is also the author of four award-winning popular science books (*Metaevolución. La Tierra en el espejo*, Celeste, 2001; *Un planeta en busca de energía*, Síntesis, 2007; *Creadors de futur*, Bromera, 2016; and *Nanomundo*, Materia/El País, Nov. 2016). http://www.neoenergy.cat

NEW PROJECTS & MILESTONES

Progress along the path towards practical applications of graphene and derived materials has continued steadily in 2016. We have continued work on the industrial fabrication of graphene and graphitene, and consolidated the development of secondary products including nanofluids, both thermal and electroactive, for solar conversion and energy storage, respectively, as well as inks for flexible device printing. But most remarkably, 2016 has been the year of the birth of our first spin-off, EARTHDAS Graphene Powered Mobility, conceived as the vehicle to take all of our fundamental knowledge and use it to demonstrate fast energy storage.

All this said, the work of the department goes beyond graphene, also investigating hybrid nanocomposites for energy storageand a new research line related to cathode materials for Li-sulfur batteries as part of a new NATO project.

Hybrid materials as improved electrodes for electrochemical supercapacitors. The boundaries between batteries and capacitors are now quickly blurring. Nanostructure control is of great importance in the design of high-performance energy storage devices. We are developing materials with high specific surfaces and ultradispersed molecular materials for applications in electrochemical supercapacitors that have a greater power density than batteries. Examples of this type of electrode, prepared for the first time in our laboratory, include activated carbons or



graphene with polyoxometalates or oxide nanoparticles (NANOCARHIBE MAT2012 National Project).

Nanocarbon materials as cathodes for stable and safer Li-S batteries. This is a topic developed as part of an international project funded by NATO's Science for Peace and Security (SPS). Various nanocarbons are tested to determine their capacity to encapsulate sulfur and in this way increase the stability of this very promising system for extra-high energy density batteries.

Eco-friendly high-performance electrodes for rechargeable lithium batteries. This research line includes our work on the optimisation of the 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 (NACARFLOW MAT2015 National Project) 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. This new kid on the nanocarbon block is a 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 many different applications, but our favourite, and the one we are working hard on in our recent spinoff (EARTHDAS), takes the form of fast-charging graphene supercap batteries.

PUBLICATIONS

"Basic idea, advance approach": Efficiency boost by sensitization of blended dye on chemically deposited ZnO films, Baviskar P.K., Dubal D.P., Majumder S., Ennaoui A., Sankapal B.R., *Journal of Photochemistry and Photobiology A: Chemistry*; **318:** 135-141. 2016. IF: 2.477

A symmetric MnO_2/MnO_2 flexible solid state supercapacitor operating at 1.6 v with aqueous gel electrolyte, Chodankar N.R., Dubal D.P., Gund G.S., Lokhande C.D., *Journal of Energy Chemistry*; **25 (3):** 463-471. 2016. IF: 2.322

Ag:$BiVO_4$ dendritic hybrid-architecture for high energy density symmetric supercapacitors, Patil S.S., Dubal D.P., Tamboli M.S., Ambekar J.D., Kolekar S.S., Gomez-Romero P., Kale B.B., Patil D.R., *Journal of Materials Chemistry A*; **4 (20):** 7580-7584. 2016. IF: 8.262

An innovative concept of use of redox-active electrolyte in asymmetric capacitor based on MWCNTs/MnO_2 and Fe_2O_3 thin films, Chodankar, N. R., D. P. Dubal, A. C. Lokhande, A. M. Patil, J. H. Kim and C. D. Lokhande, *Scientific Reports*; **6:** 39205. 2016. IF: 5.228

Aqueous synthesis of $LiFePO_4$ with Fractal Granularity, Cabán-Huertas Z., Ayyad O., Dubal D.P., Gómez-Romero P., *Scientific Reports*; **6** (27024) 2016. IF: 5.228

Asymmetric Supercapacitor Based on Nanostructured Ce-doped NiO (Ce:NiO) as Positive and Reduced Graphene Oxide (rGO) as Negative Electrode, Gawali, S. R., D. P. Dubal, V. G. Deonikar, S. S. Patil, S. D. Patil, P. Gomez-Romero, D. R. Patil and J. Pant, *Chemistryselect*; **1 (13):** 2365-6549. 2016.

Characterization of NiO-Al_2O_3 composite and its conductivity in biogas for solid oxide fuel cell, Patil S.P., Jadhav L.D., Dubal D.P., Puri V.R., *Materials Science- Poland*; **34 (2):** 266-274. 2016. IF: 0.533

Effect of electron beam irradiation on electro synthesized hexagonal $Cd_{0.3}Zn_{0.7}S$ nanosphere with excellent application in solar cell, Dhaygude H.D., Shinde S.K., Dubal D.P., Rath M.C., Fulari V.J., *Applied Surface Science*; **368:** 1-7. 2016. IF: 3.150

Electroactive graphene nanofluids for fast energy storage, Dubal D.P., Gomez-Romero P., *2D Materials*; **3** (3, 031004) 2016. IF: 9.611

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Electrodeposited nanosphere like $Cd_xZn_{1-x}S$ electrodes for photoelectrochemical cell, Dhaygude H.D., Shinde S.K., Takale M.V., Dubal D.P., Lohar G.M., Fulari V.J., *Journal of Materials Science: Materials in Electronics*; **27 (5):** 5145-5152. 2016. IF: 1.798

Fern-like rGO/$BiVO_4$ hybrid nanostructures for high-energy symmetric supercapacitor, Patil S.S., Dubal D.P., Deonikar V.G., Tamboli M.S., Ambekar J.D., Gomez-Romero P., Kolekar S.S., Kale B.B., Patil D.R., *ACS Applied Materials and Interfaces*; **8 (46):** 31602-31610. 2016. IF: 7.145

Growth of polypyrrole nanostructures through reactive templates for energy storage applications, Dubal D.P., Caban-Huertas Z., Holze R., Gomez-Romero P., *Electrochimica Acta*; **191:** 346-354. 2016. IF: 4.803

Hybrid core-shell nanostructured electrodes made of polypyrrole nanotubes coated with $Ni(OH)_2$ nanoflakes for high energy-density supercapacitors, Wolfart F., Dubal D.P., Vidotti M., Gómez-Romero P., *RSC Advances*; **6 (18):** 15062-15070. 2016. IF: 3.289

Morphological tuning of CuO nanostructures by simple preparative parameters in SILAR method and their consequent effect on supercapacitors, Shinde S.K., Dubal D.P., Ghodake G.S., Kim D.Y., Fulari V.J., *Nano-Structures and Nano-Objects*; **6:** 5-13. 2016.

MoS_2 ultrathin nanoflakes for high performance supercapacitors: Room temperature chemical bath deposition (CBD), Karade S.S., Dubal D.P., Sankapal B.R., *RSC Advances*; **6 (45):** 39159-39165. 2016. IF: 3.289

Solution-processed CdS quantum dots on TiO_2: Light-induced electrochemical properties, Sankapal B.R., Salunkhe D.B., Majumder S., Dubal D.P., *RSC Advances*; **6 (86):** 83175-83184. 2016. IF: 3.289

Studies on the $Zn_xCo_{1-x}S$ thin films: A facile synthesis process and characteristic properties, Kamble S.S., Dubal D.P., Tarwal N.L., Sikora A., Jang J.H., Deshmukh L.P., *Journal of Alloys and Compounds*; **656:** 590-597. 2016. IF: 3.014

Synthetic approach from polypyrrole nanotubes to nitrogen doped pyrolyzed carbon nanotubes for asymmetric supercapacitors, Dubal D.P., Chodankar N.R., Caban-Huertas Z., Wolfart F., Vidotti M., Holze R., Lokhande C.D., Gomez-Romero P., *Journal of Power Sources*; **308:** 158-165. 2016. IF: 6.333

The optical and electrical transport studies of $Zn_xCo_{1-x}S$ thin films, Kamble S.S., Sikora A., Deshmukh S.L., Pawar S.T., Chavan G.T., Dubal D.P., Chaure N.B., Maldar N.N., Deshmukh L.P., *Journal of Materials Science: Materials in Electronics*; **27 (12):** 12302-12311. 2016. IF: 1.798

Zinc Oxide Encapsulated Carbon Nanotube Thin Films for Energy Storage Applications, Sankapal B.R., Gajare H.B., Karade S.S., Salunkhe R.R., Dubal D.P., *Electrochimica Acta*; **192:** 377-384. 2016. IF: 4.803

PROJECTS

Development of new cathodes for stable and safer lithium-sulfur batteries, funded by **NATO**, 15/11/2016 - 14/11/2019, Pedro Gómez-Romero

Nanofluidos basados en carbones con microestructura optimizada, funded by **MINECO**, 01/01/2016 - 31/12/2018, Pedro Gómez-Romero

CONTRIBUTIONS

Energy Storage in Graphene: Batteries or Supercapacitors?, **GraphIn Barcelona**, Barcelona, Spain, 13/12/2016, Pedro Gómez-Romero (invited speaker)

Spicing Graphene with electroactive inorganic compounds: Graphene hybrid nanocomposites for energy storage, **NanoSpain 2016**, Logroño, Spain, 15-18/3/2016, Pedro Gómez-Romero, Deepak P. Dubal, Jullieth Suarez-Guevara, Vanesa Ruiz (invited speaker)

Graphene Electroactive Nanofluids for Energy Storage, **Graphene Canada**, Canada, 18-20/10/2016, Pedro Gómez-Romero, Deepak P. Dubal (invited speaker)

Hybrid Graphene Supercapacitors. From solid to liquid electrodes, **GrapChina 2016**, Qingdao, China, 19-21/9/2016, Pedro Gómez-Romero (invited speaker)

What could be better than graphene for energy storage?, **Graphene Malaysia 2016**, Kuala Lumpur, Malaysia, 8-9/11/2016, Pedro Gómez-Romero (invited speaker)

Graphene and Graphene-based Hybrids for Energy Storage, **China-EU Graphene Workshop**, Changzhou, China, 19/05/2016, Pedro Gómez-Romero (keynote talk)

Heat transfer in nanofluids for solar-thermal conversion, **Nanoscale and Microscale Heat Transfer V. Eurotherm Seminar No 108**, Santorini, Grecia, 26-30/9/2016, M. R. Rodríguez-Laguna, M. Sledzinska and C. M. Sotomayor Torres, P. Gómez-Romero (oral)

DISSEMINATION CONTRIBUTIONS

La Ciencia inesperada. Historia de los descubrimientos que nadie buscó, S**emana de la Ciencia y la Tecnología - Ceremonia Clausura - IES Floridablanca**, Murcia, Spain, 12/02/2016, Pedro Gómez-Romero (Invited conference)

Electroactive Nanofluids for Novel Flow Batteries, **BATFLU Meeting at IREC**, Barcelona, Spain, 26/02/2016, Pedro Gómez-Romero (Invited conference)

Polioxometalatos: de clústeres inorgánicos a almacenes de energía, **Nuevos Aspectos en Química Inorgánica**, Dep. Q. Inorgánica, Fac. C. Químicas, UCM, Madrid, Spain, 02/03/2016, Pedro Gómez-Romero (Invited conference)

Energía verde para un planeta azul, **IES Merce Rodoreda**, Barcelona, Spain, 11/03/2016, Pedro Gómez-Romero (Invited conference)

Energy storage: on the road from Nanometers to Terawatts, **ICMAB Seminars**, Bellaterra, Barcelona, Spain, 04/04/2016, Pedro Gómez-Romero (Invited Seminar)

Química: Arquitectura Molecular, **Els Matins de la Ciència - Cosmocaixa**, Barcelona, Spain, 07/04/2016, Pedro Gómez-Romero (Invited conference)

De los Nanometros a los Teravatios. Nanociencia y Nanotecnología al rescate de la energía, **Dilluns de la Ciència - CSIC**, Barcelona, Spain, 11/04/2016, Pedro Gómez-Romero (Invited conference)

Energy Storage at ICN2, **CEA-ICN2 Workshop**, Grenoble, France, 09/06/2016, Pedro Gómez-Romero (Invited conference)

La ciencia inesperada. Historia de los descubrimientos que nadie buscó /Energía verde para un planeta azul, **IES La Garriga - Science Week**, Barcelona, Spain, 14/11/2016, Pedro Gómez-Romero (Invited conference)

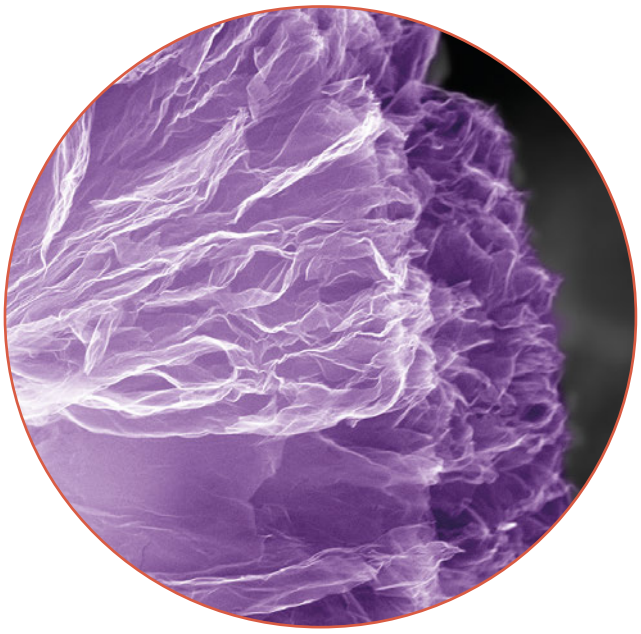
La ciencia inesperada. Historia de los descubrimientos que nadie buscó, **INS Frederic Martí Carreras - Science Week**, Palafrugell, Girona, Spain, 15/11/2016, Pedro Gómez-Romero (Invited conference)

Energía verde para un planeta azul, **INS Terra Alta - Science Week**, Gandesa, Tarragona, Spain, 16/11/2016, Pedro Gómez-Romero (Invited conference)

COURSES

International Summer Course on Nanotechnology at IQS, **Universitat Ramon Llull, Nano and Energy**, Barcelona, Spain, 11/07/2016, Pedro Gómez-Romero (Invited Lecture)

Nanotecnología: luces y sombras del control de la materia a escala atómica, **Universidad Internacional Menéndez Pelayo, UIMP, De los nanometros a los teravatios. Nanociencia y nanotecnología frente al reto energético**, Santander, Spain, 13-14/7/16, Pedro Gómez-Romero (Invited Lecture)



More information:
http://neoenergy.cat

Oxide Nanophysics 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, Senior Researcher
Fina Martinez, Ignasi, Postdoctoral Researcher
Pérez Tomás, Amador, SO Senior Postdoctoral Researcher
Rodríguez Dominguez, Laura, Doctoral Student
Vales Castro, Pablo, Doctoral Student
Vásquez Sancho, Fabián Norberto, Doctoral Student
Zapata Correa, James Arturo, Specialist Technician

GROUP LEADER

ICREA Prof.
Gustau Catalán

Prof. Gustau Catalán earned his degree 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 *Institut Mediterrani d'Estudis Avançats* (2002-2004), the *Rijksuniversiteit Groningen* (University of Groningen, 2004-2005) and the University of Cambridge (2005-2009).

In 2009 he joined the former CIN2 (now the ICN2) as an ICREA Research Professor and leader of the Oxide Nanophysics Group. In 2012 he earned an ERC Starting Grant to set up the world's first laboratory devoted to nanoscale flexoelectricity.

NEW PROJECTS & MILESTONES

Most of this year's milestones have been related to flexoelectricity, since our ERC project on this subject is approaching its end and bearing its fruits.

Umesh Bhaskar delivered the first-ever flexoelectric MEMS actuator, publishing the work in *Nature Nanotechnology*. He followed that work with the first proof of concept of a new type of device, namely a "strain diode", where flexoelectricity and ferroelectricity are combined in order to achieve an asymmetric strain response. This work was published in *Nanoscale*.

Meanwhile, Jackeline Narvaez completed the first PhD thesis to come out of our group. Her thesis won a national prize as the best thesis in experimental condensed matter physics in Spain; congratulations, Jackeline! A highlight of Jackeline's research was the discovery that flexoelectricity is not only a property of dielectric insulators, as previously thought, but also of semiconductors, with the added bonus that, in semiconductors, the effect is much bigger. This result has been published in *Nature*, and we have also patented the concept of transducers based on semiconductor flexoelectricity.

Besides flexoelectricity, we worked on other subjects, such as adsorbates ferroelectrics (a line of research led by Neus Domingo) and antiferroelectric photovoltaics (led by Amador Perez). A notable achievement of this line of work has been the discovery, published in *Advanced Materials*, of above-bandgap photovoltages in antiferroelectrics. The antiferroelectric photovoltaic cells, made in close collaboration with the group of

Monica Lira-Cantu, displayed an eye-catching (and record-breaking) photoelectric field of 6 million volts per centimetre, an order of magnitude bigger than the previous world record. This work has been our first dip in the waters of antiferroelectricity, where we plan to invest more research time in the near future thanks to the funding earned from this year's round of Spanish National Plan grants for a project titled PHABADA (PHase and Antiphase Boundaries And Domains in Antiferroelectrics).

Departures: We wish the best to Umesh Bhaskar (now a postdoc in Purdue), Amir Abdollahi (new teaching assistant at the *Universitat Politécnica de Catalunya*) and Jackeline Narváez (postdoc at the *Universidad de los Andes in Bogotá*).

Arrivals: We welcome Laura Rodríguez, new doctoral student working on phase boundaries, and Pablo Valés, new doctoral student working on electrocaloric effects and antiferroelectricity.

Congratulations: Jackeline Narvaez for her prize, and Neus Domingo and Amador Perez for their respective *"Jovenes Investigadores"* projects.

News and outreach: Most of the above highlights were featured in the press. In addition, Neus Domingo is becoming a bit of a TV star, with polished appearances in TVE and TV Girona. More details can be found on our group website. Other outreach actions include talks by Gustau Catalán at the *Centre de Cultura Contemporània de Barcelona* (CCCB) on the theme of nanotechnology and smart cities, and the annual St. Albert seminar, held in honour of the patron saint of science at the *Universitat Politècnica de Catalunya*. We have also participated in several education programmes for young people, and a high school student (Hachim Bakkali) spent three months in our laboratory developing a mini project on bioflexoelectricity, supervised by Fabian Vasquez.

PUBLICATIONS

3C-SiC Transistor with Ohmic Contacts Defined at Room Temperature, Li F., Sharma Y., Walker D., Hindmarsh S., Jennings M., Martin D., Fisher C., Gammon P., Pérez-Tomás A., Mawby P., *IEEE Electron Device Letters*; **37** (9, 7518645): 1189-1192. 2016. IF: 2.528

A flexoelectric microelectromechanical system on silicon, Bhaskar U.K., Banerjee N., Abdollahi A., Wang Z., Schlom D.G., Rijnders G., Catalan G., *Nature Nanotechnology*; **11 (3):** 263-266. 2016. 10.1038/nnano.2015.260. IF: 35.267

Above-Bandgap Photovoltages in Antiferroelectrics, Pérez-Tomás A., Lira-Cantú M., Catalan G. *Advanced Materials*; **28 (43):** 9644-9647. 2016. IF: 18.960

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Enhanced flexoelectric-like response in oxide semiconductors, Narvaez J., Vasquez-Sancho F., Catalan G., *Nature*; **538 (7624):** 219-221. 2016. IF: 38.138

Ferroelectric Domain Structures in Low-Strain $BaTiO_3$, Everhardt A.S., Matzen S., Domingo N., Catalan G., Noheda B., *Advanced Electronic Materials*; **2** (1, 1500214) 2016.

Flexoelectric MEMS: Towards an electromechanical strain diode, Bhaskar U.K., Banerjee N., Abdollahi A., Solanas E., Rijnders G., Catalan G., *Nanoscale*; **8 (3):** 1293-1298. 2016. IF: 7.760

Freezing the Nonclassical Crystal Growth of a Coordination Polymer Using Controlled Dynamic Gradients, Rubio-Martinez M., Imaz I., Domingo N., Abrishamkar A., Mayor T.S., Rossi R.M., Carbonell C., deMello A.J., Amabilino D.B., Maspoch D., Puigmartí-Luis J., *Advanced Materials*; 8150-8155. 2016. IF: 18.960

Identification of HIV-1–Based Virus-like Particles by Multifrequency Atomic Force Microscopy, González-Domínguez I., Gutiérrez-Granados S., Cervera L., Gòdia F., Domingo N., *Biophysical Journal*; **111 (6):** 1173-1179. 2016. IF: 3.632

Improved channel mobility by oxide nitridation for n-channel MOSFET on 3C-SiC(100)/Si, Li F., Sharma Y.K., Jennings M.R., Pérez-Tomás A., Shah V.A., Rong H., Russell S.A.O., Martin D.M., Mawby P.A., *Materials Science Forum*; **858:** 667-670. 2016. IF: 0.399

Monolithic integration of room-temperature multifunctional $BaTiO_3$ - $CoFe_2O_4$ epitaxial heterostructures on Si(001), Scigaj M., Dix N., Gázquez J., Varela M., Fina I., Domingo N., Herranz G., Skumryev V., Fontcuberta J., Sánchez F., *Scientific Reports*; **6** (31870) 2016. IF: 5.228

Performance and stability of mixed $FAPbI_{3(0.85)}MAPbBr_{3(0.15)}$ halide perovskite solar cells under outdoor conditions and the effect of low light irradiation, Reyna Y., Salado M., Kazim S., Pérez-Tomas A., Ahmad S., Lira-Cantu M., *Nano Energy*; **30:** 570-579. 2016. IF: 11.553

Piezoelectric Templates-New Views on Biomineralization and Biomimetics, Stitz N., Eiben S., Atanasova P., Domingo N., Leineweber A., Burghard Z., Bill J., *Scientific Reports*; **6** (26518) 2016. IF: 5.228

Spontaneous formation of spiral-like patterns with distinct periodic physical properties by confined electrodeposition of Co-In disks, Golvano-Escobal I., Gonzalez-Rosillo J.C., Domingo N., Illa X., López-Barberá J.F., Fornell J., Solsona P., Aballe L., Foerster M., Surinãch S., Baró M.D., Puig T., Pané S., Nogués J., Pellicer E., Sort J., *Scientific Reports*; **6** (30398) 2016. IF: 5.228

Water Affinity and Surface Charging at the z-Cut and y-Cut $LiNbO_3$ Surfaces: An Ambient Pressure X-ray Photoelectron Spectroscopy Study, Cordero-Edwards K., Rodríguez L., Calò A., Esplandiu M.J., Pérez-Dieste V., Escudero C., Domingo N., Verdaguer A., *Journal of Physical Chemistry C*; **120 (42):** 24048-24055. 2016. IF: 4.509

PROJECTS

Electromecánica de Superfícies Avanzada, funded by **MINECO**, 01/12/2016 - 30/11/2019, G. Catalán

Estrestrónica de óxidos, funded by **MINECO**, 01/01/2014 - 30/04/2017, G. Catalán

Flexoelectricity, funded by **CE - ERC-2012-STG**, 01/01/2013 - 31/12/2017, G. Catalán

2014 SGR 1216, funded by **AGAUR**, 01/01/2014 - 30/04/2017 , G. Catalán

CONTRIBUTIONS

Multiferroic domain walls and antiferroelectric photovoltaics, **Royal Society International Meeting on Domain walls as new 2D functional materials**, Buckinghamshire, UK, 22/02/2016, Gustau Catalán (invited speaker)

Giant flexoelectricity in oxide semiconductors, **European Materials Research Society (E-MRS) Fall Meeting**, Warsaw, Poland, 21/09/2016, Gustau Catalán (invited speaker)

Switchable mechanical properties of ferroelectric domains, **International Symposium on Ferroic Domains (ISFD-13)**, Vancouver, Canadá, 05/10/2016, Gustau Catalán (invited speaker)

To flexoelectricity, and beyond, **Cambridge Workshop on Ferroics at the Nanoscale**, Cambridge, UK, 13/12/2016, Gustau Catalán (invited speaker)

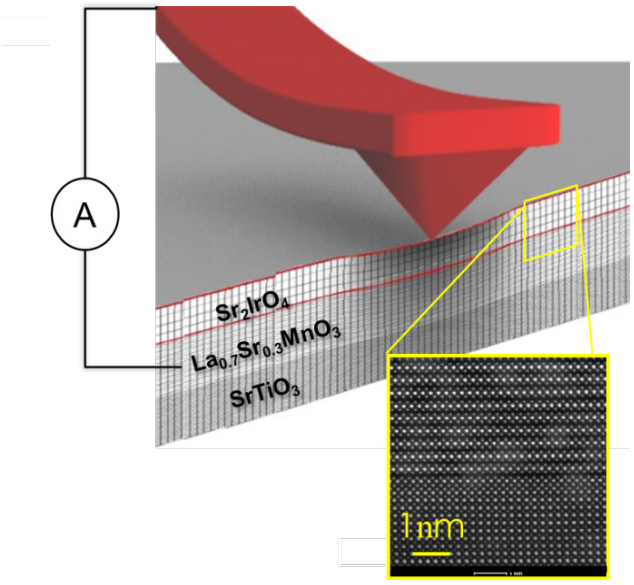
A Christmas list from an oxides guy, **TALEM workshop**, Toulousse, France, 15/12/2016, Gustau Catalán (invited speaker)

Switchable mechanical properties of ferroelectrocs, **Seminar Forum DQMP**, Geneva, Switzerland, 26/04/2016, Kumara Cordero-Edwards, Amir Abdollahi, Neus Domingo, Jordi Sort, and Gustau Catalán (oral)

Flexoelectricity in Bones, **CoMPLEX Annual Conference**, Windsor, London, UK, 3-4/5/2016, Fabián Vásquez (oral)

Flexoelectricity in Bones, **Biomineralization**, Girona, Spain, 14-19/8/2016, Fabián Vásquez (poster)

Flexoelectricity at the nanoscale: Switchable mechanical properties of ferroelectrocs, **Fuerzas y Túneles 2016**, Girona, Spain, 5-7/19/2016, Kumara Cordero-Edwards, Amir Abdollahi, Neus Domingo, Jordi Sort, and Gustau Catalán (poster)



Study of Ferroelectric Transition of $SrTi_{18}O_3$ Single Crystal at low Temperature by PFM, **Fuerzas y Túneles 2016**, Girona, Spain, 5-7/19/2016, James Zapata, Gustau Catalan and Neus Domingo (poster)

Polar ice freezing on ferroelectric $LiNbO_3$ surfaces as measured by low T KPFM and PFM, **Fuerzas y Túneles 2016**, Girona, Spain, 5-7/19/2016, James Zapata, Kumara Cordero, Albert. Verdaguer, Gustau. Catalan and Neus Domingo (poster)

THESES

Doctorand: **Jackeline Narváez**
Title: Flexoelectricity in Single Crystals.
Defence Date: 29/02/2016
Directed by Prof. Gustau Catalán and Dr Neus Domingo

PARTICIPATED CONGRESSES

Fuerzas y Tunel 2016, Girona, Spain, 5-7/9/2016. Neus Domingo - Organising Committee

AWARDS

Dr Jackeline Narváez, **2016 GEFES Prize for the best thesis in Condensed Matter Physics developed in Spain** for her thesis "Flexoelectricity in Single Crystals", directed by Prof. Gustau Catalán and Dr Neus Domingo

Phononic and Photonic Nanostructures Group

Main Research Lines

- Nanophononics and nanophotonics
- Nanoscale thermal transport
- Optomechanics
- Nanofabrication
- Oxide-based Nanostructures

GROUP MEMBERS

Alzina Sureda, Francesc, Senior Researcher
Arregui Bravo, Guillermo, BIST Doctoral Student
Arrighi, Aloïs, SO Doctoral Student
Bericat Vadell, Robert, Visiting Student
Bhansali, Sweta, Doctoral Student
Chatterjee, Arindom, SO Doctoral Student
Chávez Angel, Emigdio, SO Postdoctoral Researcher
Colombano, Martín, SO Doctoral Student
El Sachat, Alexandros, Doctoral Student
Fernández Estévez, Ariadna, Doctoral Student
Francone, Achille Leo, SO Postdoctoral Researcher
García Fernández, P. David, Postdoctoral Fellow (BdP & MC)
Graczykowski, Bartlomiej, Postdoctoral Researcher

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 the University of Manchester (UK). She then held tenured academic appointments at the universities of St. Andrews and Glasgow also in the UK, before becoming a C4 professor at *Universität Wuppertal* (Germany) in 1996. She was a research professor at the Tyndall National Institute, University College Cork (Ireland) from 2004 to 2008. Since May 2007 she has been an ICREA Research Professor based at the ICN2.

She has received awards from the Royal Society of Edinburgh and the Nuffield Foundation, as well as an Amelia Earhart Fellowship from ZONTA International (USA). She is the author of over 470 scientific publications and has edited/co-edited six books (Researcher ID; E-8418-2010, Hirsch index 40, over 6900 citations).

Jaramillo Fernández, Juliana, Visiting Postdoctoral Researcher
Kehagias, Nikolaos, Senior Researcher
Kreuzer, Martin, DFG Postdoctoral Researcher
Morales Cuñado, Cristina, Group Administrator and Project Manager
Navarro Urrios, Daniel, Postdoctoral Fellow (RyC)
Reparaz, Juan Sebastián, Senior Researcher
Rodríguez, Rocío, SO Doctoral Student
Saleta Reig, David, Technician
Sánchez, Miguel Ángel, SO Doctoral Student
Séveno, Lucie, Visiting Student
Sledzinska, Marianna, Research Engineer
Sotomayor Torres, Clivia M., ICREA Research Professor and Group Leader
Wagner, Markus Raphael, Postdoctoral Fellow (MC)
Wang, Mao, Visiting Student

She leads a strong team working on phonon engineering and is actively engaged in European research. She serves in scientific advisory committees on nanoscience and nanotechnology in Grenoble and Paris-Saclay. She is a member of the Board of Stakeholders of Photonic21, represents the ICN2 in the Nanoelectronics ECSEL Joint Undertaking and is a visiting professor at the *Kungliga Tekniska Högskolan* (Royal Institute of Technology, KTH) in Sweden.

During 2016 Prof. Sotomayor has held the following commissions of trust:

- Coordinator of the EU FET Open project, PHENOMEN: All-phononic circuits enabled by opto-mechanics.
- Member of the Expert Committee for the Excellence Strategy of German Universities.
- Member of the International Panel evaluating the last 10 years of research activities carried out at the Centre Nacional de la Recherche Scientifique (CNRS) for the French Ministry of Education.
- Member of the Advisory Group for the European Commission's Future and Emerging Technologies programme.
- ERC panel member.

- Member of Chamber B and Member of the Scientific Community Council of AENEAS, Rome, Italy.
- Research Proposal Evaluator for the Swedish Research Council, Stockholm, Sweden.
- Member of PhD. Examining Committee of Mr. Jin Dai, Royal Institute of Technology KTH, Stockholm, Sweden.

NEW PROJECTS & MILESTONES

In 2016 the group completed two EU FP7 projects: **NANO-RF** (Carbon-based smart systems for wireless applications) and *NANOTHERM* (Innovative nano and micro technologies for advanced thermo and mechanical interfaces), as well as the national CONSOLIDER project **nanoTHERM** (Tailoring electronic and phononic properties of nanomaterials: Towards Ideal Thermoelectricity). All of them were successfully completed. The Marie Slodowska Curie project **Heat ProNano** (Heat propagation and thermal conductivity in nanomaterials for nanoscale energy management) was also successfully completed.

This year also saw the kick-off of the group's coordinated H2020 FET Open project **PHENOMEN** (All-phononics circuits enabled by opto-mechanics), as well as the Spanish National Plan project **PHENTOM** (Phonon engineering for advanced thermal management at the nanoscale and room temperature optomechanics).

A Marie Slodowska Curie Fellowship was awarded to Dr. P.D. García Fernández, for the project COPPOLa (Complex photon phonon coupling).

Two projects were ongoing in 2016, including the EU FP7 project **QUANTIHEAT** (Quantitative scanning probe microscopy techniques for heat transfer management in nanomaterials and nanodevices), together with the H2020 project **NEREID** (NanoElectronics Roadmap for Europe: Identification and Dissemination).

PUBLICATIONS

A hybrid organic-inorganic layered TiO_2 based nanocomposite for sunlight photocatalysis, Benavente E., Maldonado C., Devis S., Diaz L., Lozano H., Sotomayor-Torres C., González G., *RSC Advances*; **6 (22):** 18538-18541. 2016. IF: 3.289

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Titanium particle incorporation in block copolymer templates, Kreuzer M., Simão C., Diaz A., Sotomayor Torres C.M., *Polymer (United Kingdom)*; **105:** 195-202. 2016. IF: 3.586

Two-Dimensional Phononic Crystals: Disorder Matters, Wagner M.R., Graczykowski B., Reparaz J.S., El Sachat A., Sledzinska M., Alzina F., Sotomayor Torres C.M., *Nano Letters*; **16 (9):** 5661-5668. 2016. IF: 13.779

Catalytically Doped Semiconductors for Chemical Gas Sensing: Aerogel-Like Aluminum-Containing Zinc Oxide Materials Prepared in the Gas Phase, Hagedorn K., Li W., Liang Q., Dilger S., Noebels M., Wagner M.R., Reparaz J.S., Dollinger A., Schmedt Auf Der Günne J., Dekorsy T., Schmidt-Mende L., Polarz S., *Advanced Functional Materials*; **26 (20):** 3424-3437. 2016. IF: 11.382

Spatially controlled growth of highly crystalline ZnO nanowires by an inkjet-Printing catalyst-Free method, Güell F., Martínez-Alanis P.R., Khachadorian S., Zamani R.R., Franke A., Hoffmann A., Wagner M.R., Santana G., *Materials Research Express*; **3** (2, 025010) 2016. IF: 0.968

PROJECTS

All-Phononic circuits Enabled by Opto-mechanics, funded by **CE - H2020-FETOPEN-2014-2015-RIA**, 01/09/2016 - 31/08/2019, Clivia M. Sotomayor Torres

Carbon based smart systems for wireless applications, funded by **CE - FP7-ICT-2011-8**, 01/09/2012 - 31/05/2016, Clivia M. Sotomayor Torres

Innovative Nano and Micro Technologies for Advanced Thermo and Mechanical Interfaces, funded by **CE - FP7-ICT-2011-8**, 01/09/2012 - 29/02/2016, Clivia M. Sotomayor Torres

2014 SGR 1238, funded by **AGAUR**, 01/01/2014 - 30/04/2017, Clivia M. Sotomayor Torres

NanoElectronics Roadmap for Europe: Identification & Dissemination, funded by **CE - H2020-ICT-2015**, 16/11/2015 - 15/11/2018, Clivia M. Sotomayor Torres

Phonon engineering for advanced nanoscale thermal management and room temperature optomechanics, funded by **MINECO**, 01/01/2016 - 31/12/2018, Clivia M. Sotomayor Torres

QUANTItative scanning probe microscopy techniques for HEAT transfer management in nanomaterials and nanodevices, funded by **CE - FP7-NMP-2013-LARGE-7**, 01/12/2013 - 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

CONTRIBUTIONS

A Self-Stabilized Coherent Phonon Source Driven by Optical Forces, **Mechanical Systems in the Quantum Regime (Gordon Research Conference). Beyond Standard Optomechanichs: Exploring New Mechanical**, Ventura, California (USA), 06/03/2016, Navarro Urrios, D. (invited speaker)

Silicon-based room temperature cavity optomechanics, **SPIE Photonics Europe**, Brussels, Belgium, 05/04/2016, Navarro Urrios, D. (invited speaker)

Design of the phononic density of states: from confinement to thermoelectricity, **Universidad Catolica del Norte**, Antofagasta, Chile, 28/04/2016, Sotomayor Torres, C.M. (invited speaker)

Strontium titanate thin films and multilayers as thermoelectric material: structural & thermal properties, **CEDENA, Universidad de Chile**, Fac. Science, Dept. Chemistry, Santiago, Chile, 04/05/2016, Sotomayor Torres, C.M. (invited speaker)

Thermal Transport in 2D phononic crystals, **3rd Int Workshop & Conference on Phononics & Thermal Energy Science (PTES2016)**, Xi'an Jiaotong, China, 23/05/2016, Sotomayor Torres, C.M. (invited speaker)

Self-sustained coherent phonon generation in optomechanical crystals, **CEN 2016**, Valencia, Spain, 21/06/2016, Navarro Urrios, D. (invited speaker)

Phonon lasing in optomechanical crystals, **18th International Conference on Transparent Optical Networks ICTON 2016**, Trento, Italy, 12/07/2016, Navarro Urrios, D. (invited speaker)

Disorder to enhance and tailor the light-matter interaction, **META 2016**, Málaga, Spain, 27/07/2016, García, P.D. (invited speaker)

Nanostructured materials for phononic sources, **2016 E-MRS Fall Meeting and Exhibit**, Warsaw, Poland, 19/09/2016, Navarro Urrios, D. (invited speaker)

Thermal transport in silicon phononic crystals, **IIP Workshop thermal and Electronic Transport in Nanostructures**, Natal, Rio Grande du Norte, Brazil, 02/11/2016, Sotomayor Torres, C.M. (invited speaker)

Free-standing Silicon Membranes-based Phononic Crystals, **MRS Fall Meeting 2016**, Boston, USA, 28/11/2016, Sotomayor Torres, C.M. (invited speaker)

Heat propagation in free-standing SOI membranes: a model system, **W Heraeus Workshop on Heat Transfer and Heat Conduction on the Nano scale**, Bad Honnef, Germany, 10-15/4/16, Sotomayor Torres, C.M. (invited speaker)

Thermal transport in 2D membranes and phononic crystals, **30th International Winterschool on the Electronic Properties of Novel Materials IWEPNM 2016**, Kirchberg, Austria, 15-19/2/16, Sotomayor Torres, C.M. (invited speaker)

Phononic and electronic thermal conductivity in the Nano scale, **W Heraeus Workshop on Heat Transfer and Heat Conduction on the Nano scale**, Bad Honnef, Germany, 4-5/4/16, Sotomayor Torres, C.M. (invited speaker)

Phonon dynamics in suspended nanostructures, **Workshop on the frontiers of photonic and light-matter interacting systems "What is bright with light"**, Bariloche, Argentina, 4-9/12/16, Wagner, Markus R. (invited speaker)

T*hermal transport in quasi 2-dimensional materials addressed through two-laser Raman thermometry*, **Workshop on the frontiers of photonic and light-matter interacting systems "What is bright with light"**, Bariloche, Argentina, 4-9/12/16, Reparaz, J.S. (invited speaker)

Silicon-based room temperature cavity optomechanics, **SPIE Photonics Europe**, Brussels, Belgium, 05/04/2016, Navarro Urrios, D. (oral)

Anderson localization to enhance light-matter interaction, **SPIE Photonics Europe**, Brussels, Belgium, 05/04/2016, García P.D (oral)

Optomechanical interaction to characterise thermal properties of Si in the nanoscale, **15th Condensed Matter Days of the French Physical Society. JMC15**, Bordeaux,France, 23/08/2016, Colombano, M.F. (oral)

Thermal and elastic properties of free-standing MoS_2 nanosheets, **Graphene Conference**, Genova, Italy, 19-22/4/16, Sledzinska, M. (oral)

Dynamic surfaces by controlling its wetting states, **15th International Conference on Nanoimprint and Nanoprint Technologies – NNT2016**, Braga, Portugal, 26-28/9/16, Fernández, A. (oral)

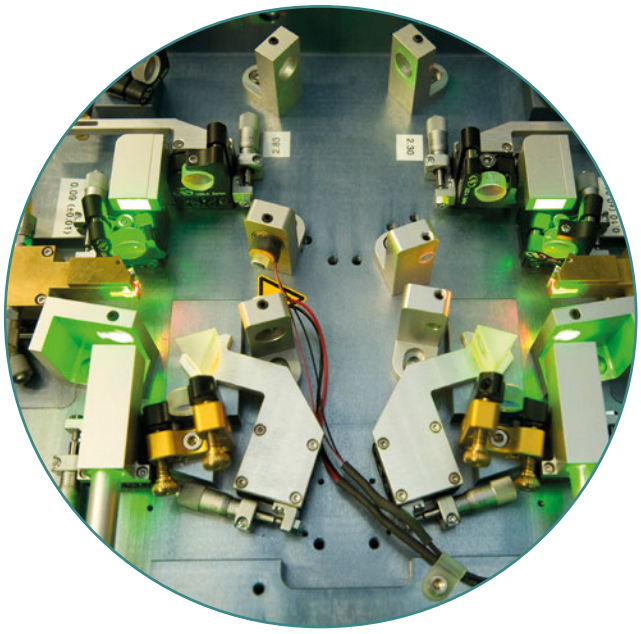
Structural and thermal properties of bare and chromium-covered block copolymer, **Nanoscale and Microscale Heat Transfer V. IEEE Eurotherm Seminar 108**, Santorini, Greece, 26-30/9/16, El Sachat, A. (oral)

Tuning the temperature dependence of the thermal conductivity in silicon membranes by nanopatterning, **Nanoscale and Microscale Heat Transfer V. IEEE Eurotherm Seminar 108**, Santorini, Greece, 26-30/9/16, El Sachat, A. (oral)

$SrTiO_3$ Thin Films as High Efficient Thermoelectric Materials, **Nanoscale and Microscale Heat Transfer V. IEEE Eurotherm Seminar 108**, Santorini, Greece, 26-30/9/16, Sotomayor Torres, C.M. (oral)

Phonons and Fluctuations: a perspective on energy research, **Conferencia Internacional de Nanotecnología. Universidad Andres Bello**, Chile, 14-15/12/16, Sotomayor Torres, C.M. (plenary lecture)

Phonon Engineering: controlling thermal transport in the nanoscale, **Reunión Nacional de Nanociencia y Nanotecnología. Nano2016, Universidad de Buenos Aires**. Buenos Aires (Argentina), 9-13/5/16, Sotomayor Torres, C.M. (plenary lecture)



Phonon Engineering: controlling thermal transport in the nanoscale, **Reunión Nacional de Nanociencia y Nanotecnología. Nano2016. Universidad de Buenos Aires**, Buenos Aires (Argentina), 9-13/5/16, Sotomayor Torres, C.M. (plenary lecture)

A Self-Stabilized Coherent Phonon Source Driven by Optical Forc, **Mecahnical Systems in the Quantum Regime (Gordon Research Conference). Beyond Standard Optomechanichs: Exploring New Mechanical Interactions**, Ventura, California, USA, 06/03/2016, Navarro Urrios, D. (poster)

Structure, composition, and thermal properties of epitaxial $Si_{1-x}Gex$ alloy nanowires studied by scanning thermal microscopy, **Nanoscale and Microscale Heat Transfer V. Eurotherm Seminar**, Santorini, Greece, 26/09/2016, El Sachat, A. (poster)

Thermoelectric performance of p-type misfit layered cobaltites $[Bi_2Sr_2O_4]_q[CoO_2]$ epitaxial thin film, August, 2016, Chatterjee, A. (poster)

THESES

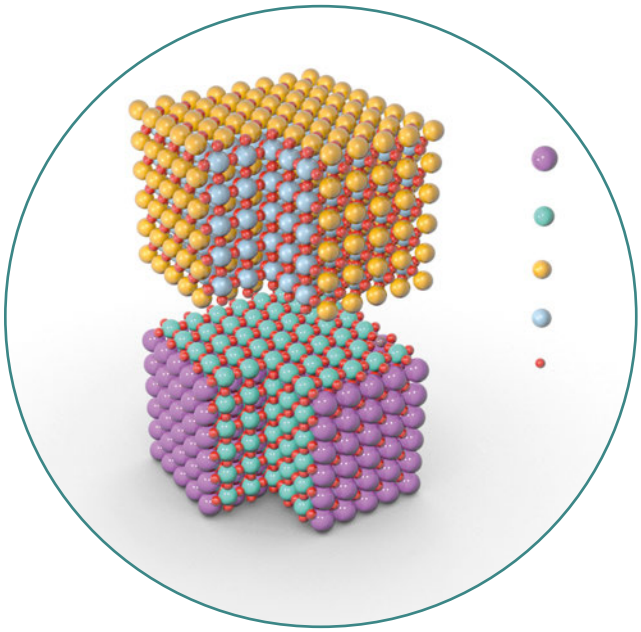
Doctorand: **Ariadna Fernánez Estèvez**
Title: Functional surfaces by means of nanoimprint litography technique
Defence Date: 25/11/2016
Directed by Prof. Clivia M. Sotomayor Torres and Dr Nikolaos Kehagias

PARTICIPATED CONGRESSES

IRT Nanoelectronics CEA-LETI, Grenoble, France, 13/06/2016, Sotomayor Torres, C.M. - Member of the Scientific Committee

Singapore Ministry of Education, Singapore, Singapore, 19/05/2016, Sotomayor Torres, C.M. - Member of Research Proposal Evaluation Panel Physics and Engineering

EU Project NEREID workshop, Grenoble, France, 16/05/2016, Sotomayor Torres, C.M. - Organising Committee



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
Batlle Porro, Sergi, Visiting Student
Benítez Moreno, Luís Antonio, Doctoral Student
Bonell, Frédéric, Postdoctoral Researcher
Costa Cornellà, Aleix, Visiting Student
Costache, Marius Vasile, Senior Researcher
Cuppens, Jo, Postdoctoral Researcher
Gebeyehu, Zewdu Messele, Doctoral Student
Savero Torres, Williams Fernando, Postdoctoral Researcher
Sierra García, Juan Francisco, Postdoctoral Researcher
Urgell Flores, Carles, Visiting Master's Student
Valenzuela, Sergio Osvaldo, ICREA Research Professor and Group Leader

GROUP LEADER

ICREA Prof.
Sergio Valenzuela

Prof. Valenzuela obtained his PhD in Physics in 2001 at the *Universidad de Buenos Aires* (Argentina) and held research positions at Harvard University and the Massachusetts Institute of Technology (MIT). Since July 2008 Prof. Valenzuela has been an ICREA Research Professor and leader of the former ICN (now ICN2) Physics and Engineering of Nanoelectronic Devices Group. His research is focused on the unique properties of materials with nanoscale dimensions, motivated both by their intrinsic scientific interest and their potential for advanced

NEW PROJECTS & MILESTONES

In 2016 the Physics and Engineering of Nanodevices Group joined the work package dedicated to spintronics of the H2020 Graphene Flagship programme in order to develop spintronic applications with graphene and related 2D materials. The group also continued with its progress on its ERC Starting Grant project to investigate the spin properties of materials with large spin-orbit interaction, in particular topological insulators, achieving thin films with arguably the highest quality available worldwide in a dual-chamber molecular beam epitaxial (MBE) system, and developing spin torque measurements in topological insulator/ferromagnet structures. Work as also been carried out on the national MINECO project, Spintronics in 2-Dimensional Dirac Systems (S2DDS), to investigate the spin Hall effect and the charge and spin transport properties of graphene, including the growth of CVD graphene and the electrical injection and detection of hot carriers. The group has also joined the SpinTronicFactory network to coordinate EU spintronics activities, and became a member of FWO network (WOG project) on the functional properties of two-dimensional nanostructured materials.

Senior group member Dr. Marius V. Costache received a *Consejo Superior de Investigaciones Científicas* (CSIC) certificate in recognition of his 2015 IUPAP Young Scientist Medal.

electronic applications. His work encompasses spintronics, quantum computation with superconducting circuits and nanoelectromechanical systems (NEMS) and, together with his collaborators, he has pioneered the use of nonlocal devices to study the spin Hall effect, of thermopiles to isolate the magnon drag in ferromagnetic materials and implemented novel qubit control and spectroscopy methods. Prof. Valenzuela has received the 2001 Giambiagi prize and 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 50 articles (in *Nature*, *Science*, *Reviews of Modern Physics*, *Nature Materials*, *Nature Physics*, *Physical Review Letters*, among others), three patents, and five books or book chapters.

PUBLICATIONS

Determination of the spin-lifetime anisotropy in graphene using oblique spin precession, Raes B., Scheerder J.E., Costache M.V., Bonell F., Sierra J.F., Cuppens J., Van De Vondel J., Valenzuela S.O., *Nature Communications*; **7** (11444) 2016. IF: 11.329

Nanoscale thermal imaging of dissipation in quantum systems, Halbertal D., Cuppens J., Shalom M.B., Embon L., Shadmi N., Anahory Y., Naren H.R., Sarkar J., Uri A., Ronen Y., Myasoedov Y., Levitov L.S., Joselevich E., Geim A.K., Zeldov E., *Nature*; **539 (7629):** 407-410. 2016. IF: 38.138

Spin Hall Effect and Origins of Nonlocal Resistance in Adatom-Decorated Graphene, Van Tuan D., Marmolejo-Tejada J.M., Waintal X., Nikolic B.K., Valenzuela S.O., Roche S., *Physical Review Letters*; **117** (17, 176602) 2016. IF: 7.645

PROJECTS

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

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

Exploring the spin physics at the boundaries of materials with strong spin orbit interaction, funded by **CE - ERC-2012-STG**, 01/02/2013 - 31/01/2018, Valenzuela S.O

2014 SGR 56, Funded by **AGAUR**, 01/01/2014 - 30/04/201, Valenzuela S.O

CONTRIBUTIONS

Spin and heat transport in graphene-based nanodevices, **IMDEA Nanociencia**, Madrid, Spain, 25/11/2016, JF Sierra (invited speaker)

Topological insulators and magnons, **Beyond CMOS Workshop-NanoElectronics Roadmap for Europe: Identification and Dissemination (NEREID)**, Helsinki, Finland, 16-17/5/16, MV Costache and SO Valenzuela (invited speaker)

The Magnetologic gates advances in the US, **Barcelona meeting of GRAPHENE SPINTRONICS WP**, Barcelona, Spain, 24-25/5/16, MV Costache and SO Valenzuela (invited speaker)

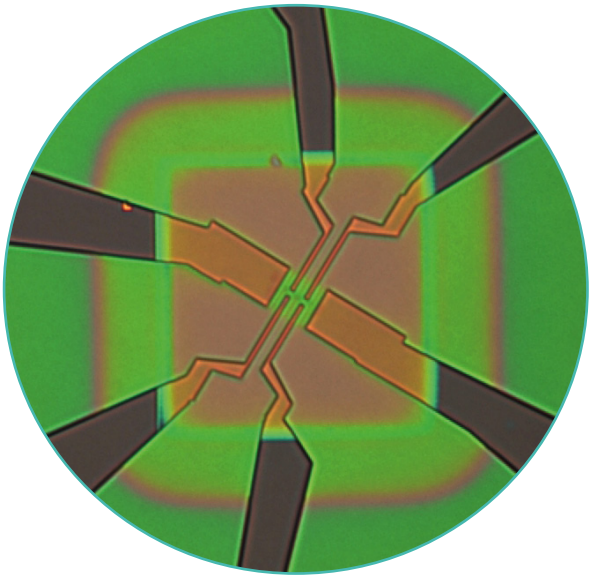
Spin relaxation anisotropy in graphene, **Graphene 2016**, Genova, Italy, April, 2016, B Raes, J E. Scheerder,M V. Costache, F Bonell, J F. Sierra, J Cuppens, J Van de Vondel and S O. Valenzuela (invited speaker)

Spin dynamics in graphene, **ICTP Workshop on Driven Quantum Systems**, Bariloche, Argentina, December, 2016, Sergio Valenzuela (invited speaker)

Spintronics in two-dimensional materials, **Simposio Internacional: Materiales bidimensionales: explorando los límites de la física y la ingeniería**, Madrid, Spain, July, 2016, Sergio Valenzuela (invited speaker)

Spin relaxation anisotropy in graphene, **Energy, Materials and Nanotechnology Meeting**, Dubrovnik, Croacia , May, 2016, B Raes, J E. Scheerder,M V. Costache, F Bonell, J F. Sierra, J Cuppens, J Van de Vondel and S O. Valenzuela (invited speaker)

Determination of the spin relaxation anisotropy in graphene, **Recent Progress in Spintronics of 2D Materials**, Hsinchu, Taiwan, November, 2016, B Raes, J E.



Scheerder,M V. Costache, F Bonell, J F. Sierra, J Cuppens, J Van de Vondel and S O. Valenzuela (invited speaker)

Identifying the spin relaxation mechanism in graphene, **Workshop on Functional Properties of Two-Dimensional Nanostructured Materials**, Leuven, Belgium, October, 2016, Sergio Valenzuela (invited speaker)

Spin relaxation anisotropy in graphene, **New Trends in 2D Materials**, Madrid, Spain, October, 2016, B Raes, J E. Scheerder,M V. Costache, F Bonell, J F. Sierra, J Cuppens, J Van de Vondel and S O. Valenzuela (invited speaker)

Engineering electronic and magnetic properties of metal organic – topological insulator heterostructures, **JPHD 2nd Scientific Meeting of BNC-b Students**, Barcelona, Spain, 29-30/6/16, M. G. Cuxart (oral)

Twin-free Bi_2Te_3 thin films grown by molecular beam epitaxy, **Joint Conference of New Trends in Topological Insulators and 17th International Conference on Narrow Gap Systems**, Würzburg University, Germany, 24-29/7/16, F. Bonell, M. González Cuxart, G. Ceballos, A. Mugarza, S. O. Valenzuela (poster)

Heat transport in two-dimensional heterostructures studied using two-laser Raman thermometry, **Graphene 2016**, Genova, Italy, April, 2016, A. Arrighi, J.S. Reparaz, Z. Messele, J. Cuppens, M.J. Esplandiu, M. Maymó, G. Ceballos, C.M. Sotomayor Torres and S. O. Valenzuela (poster)

Effect of Temperature on the Growth of Single Crystalline Monolayer Graphene by Chemical Vapor Deposition (CVD), **Graphene 2016**, Genova, Italy, April, 2016, ZM.Gebeyehu, J Coppens, MJ. Esplandiu, SO Valenzuela (poster)

COURSES

Topic: Spintronics, **ESONN'16, European School on Nanosciences & Nanotechnologies**, Grenoble, France, September, 2016, Sergio Valenzuela

More information:
http://nanodevices.icn2.cat/

Supramolecular NanoChemistry and Materials Group

Main Research Lines

- **Nanoporous metal-organic frameworks and related nanoparticles**
- **Micro- and nanoencapsulation technologies towards the design of new multifunctional nanocarriers**

GROUP MEMBERS

Albalad Alcalá, Jorge, Doctoral Student
Arenas Jal, Marta, Visiting Doctoral Student
Aríñez Soriano, Javier, Doctoral Student
Avci, Ceren, Doctoral Student
Avci, Civan, Doctoral Student
Ayala Hernández, Abraham, Fellowship Doctoral Student
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Carné Sánchez, Arnau, Postdoctoral Researcher
Espín Marti, Jordi, Doctoral Student
Fernández De Retana Alda, Sofia, Visiting Doctoral Student
García Jimeno, Sonia, Postdoctoral Researcher
Garzón Tovar, Luís Carlos, Doctoral Student
Grzelak, Jan, Visiting Student
Guillerm, Vincent, Postdoctoral Researcher

GROUP LEADER

ICREA Prof. Daniel Maspoch

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* and the *Institut de Ciència de Materials de Barcelona*. He then moved to Northwestern University to work as a postdoctoral fellow in the group led by Prof. Chad A. Mirkin. He moved back to the then ICN, now ICN2, thanks to a *Ramón y Cajal* contract, where he founded the

Hernández López, Laura, Visiting Student
Imaz Gabilondo, Inhar, Senior Researcher
Jarrah, Najmeh, Visiting Doctoral Student
Legrand, Alexandre, Postdoctoral Researcher
Maspoch Comamala, Daniel, ICREA Research Professor and Group Leader
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Murillo Cremaes, Nerea, Specialist Technician
Pérez Carvajal, Javier, Postdoctoral Researcher
Ríos Font, Raquel, Scientific Project Manager
Rodríguez Hermida, Sabina, Postdoctoral Researcher
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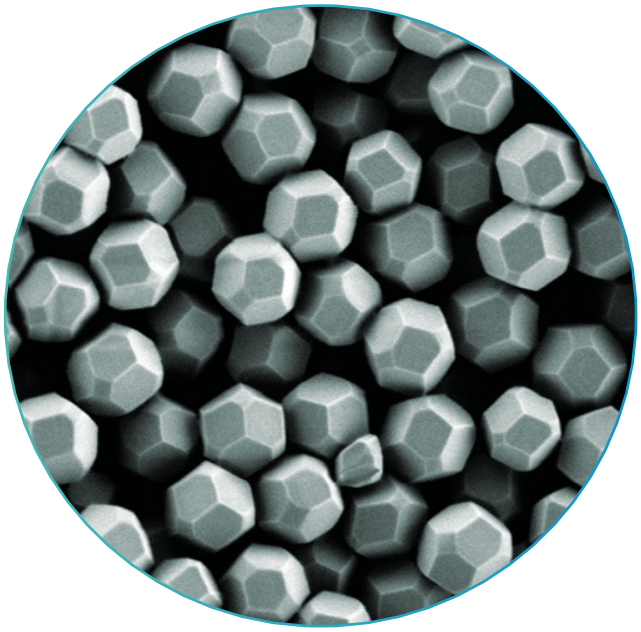
Sanclemente Crespo, Mateo, Visiting Student
Troyano Prieto, Javier, Postdoctoral Researcher
Vignatti Abellán, Claudia, Doctoral Student
Xu, Heng, Doctoral Student
Yazdi, Amirali, SO Doctoral Student

Supramolecular NanoChemistry and Materials Group. He has been an ICREA Research Professor and group leader at the ICN2 since September 2011. In 2014 he was awarded an ERC Consolidator Grant.

Prof. Maspoch has authored 97 scientific publications and five book chapters. He has also filed eight patents and established 14 contracts with private companies, including two patent licence agreements and three successful transfers of in-house technology for immediate application in consumer products.

NEW PROJECTS & MILESTONES

In 2016 the ICN2 Supramolecular NanoChemistry and Materials Group (NANO^{UP}) embarked upon two new projects. The first, with the title Multifunctional MOF-based composites as advanced sorbents for biomedical and energy-related applications (**MOFCAS**), is a three-year project led by Prof. Maspoch, supported by MINECO under the umbrella of the Spanish National Programme for Research Aimed at the Challenges of Society. The second project, with the title Implementation of novel photonic nanosensors for the detection of polluting gases in tiny concentrations (**NANOFOTOSENS**), is a one-year project led by Prof. Laura Lechuga and funded by the private entity *Fundación Domingo Martínez*. The group is currently halfway through **InanoMOF**, the ERC Consolidator Grant project awarded to Prof. Maspoch in 2014), achieving the development of numerous functional nanoMOF@INP composites. It has also reached the end of the first year of the H2020 **ProDIA** project, in which the group is responsible for scaling-up the production of MOFs production for use in industrial adsorption applications, using its spray drying technique.



Moreover, the group has continued to collaborate with companies to develop customised micro- and nanoencapsulation technologies, working in parallel with nine different entities. It has also contributed to the filing of another patent application in the field of MOF development.

PUBLICATIONS

A First Cyclodextrin-Transition Metal Coordination Polymer, Xu H., Rodríguez-Hermida S., Pérez-Carvajal J., Juanhuix J., Imaz I., Maspoch D., *Crystal Growth and Design*; **16 (10):** 5598-5602. 2016. IF: 4.425

A spray-drying continuous-flow method for simultaneous synthesis and shaping of microspherical high nuclearity MOF beads, Garzón-Tovar L., Cano-Sarabia M., Carné-Sánchez A., Carbonell C., Imaz I., Maspoch D., *Reaction Chemistry & Engineering*; **1:** 533-539. 2016.

Application of metal and metal oxide nanoparticles@MOFs, Falcaro P., Ricco R., Yazdi A., Imaz I., Furukawa S., Maspoch D., Ameloot R., Evans J.D., Doonan C.J., *Coordination Chemistry Reviews*; **307:** 237-254. 2016. IF: 12.994

Charge effect of a liposomal delivery system encapsulating simvastatin to treat experimental ischemic stroke in rats, Campos-Martorell M., Cano-Sarabia M., Simats A., Hernández-Guillamon M., Rosell A., Maspoch D., Montaner J., *International Journal of Nanomedicine*; **11:** 3035-3048. 2016. IF: 4.320

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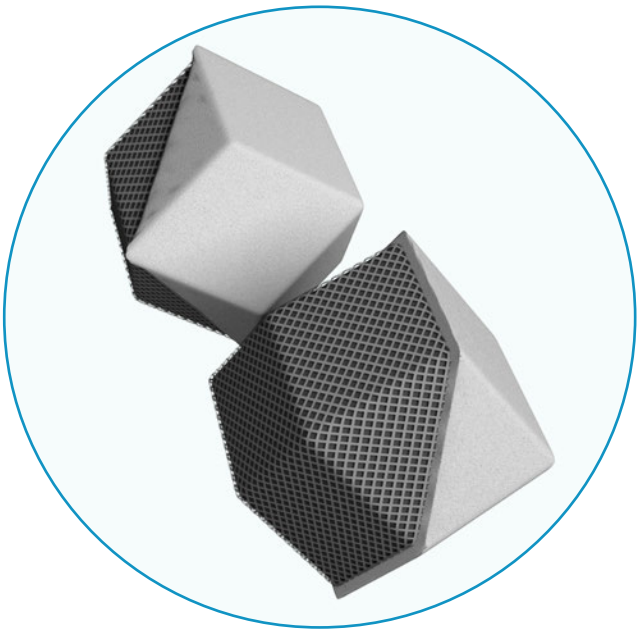

PROJECTS

Composites multifuncionales basados en redes metalorgánicas (MOFs) como sorbentes avanzados para aplicaciones biomédicas y energéticas, funded by **MINECO**, 01/01/2016 - 31/12/2018, Daniel Maspoch, Inhar IMAZ

Del diseño a las aplicaciones de materiales porosos avanzados basados en redes metalorgánicas, funded by **MINECO**, 01/12/2015 - 30/11/2017, Daniel Maspoch

Descubrimiento de nuevos materiales de baja densidad mediante síntesis bajo presión negativa, funded by **MINECO**, 01/09/2015 - 31/08/2016, Daniel Maspoch

Multifunctional micro- and nanostructures assembled from nanoscale metal-organic frameworks and inorganic nanoparticles, funded by **CE - ERC-2013-CoG**, 01/04/2014 - 31/03/2019, Daniel Maspoch

2014 SGR 80, funded by **AGAUR**, 01/01/2014 - 30/04/2017, Daniel Maspoch

Production, control and Demonstration of structured hybrid nanoporous materials for Industrial adsorption Applications, funded by **CE - H2020-NMP-03-2015**, 01/11/2015 - 31/10/2018, Daniel Maspoch

CONTRIBUTIONS

Nanoscale MOFs (from synthesis to applications), Van't Hoff Institute for Molecular Sciences, **University of Amsterdam**, Amsterdam, The Netherlands, 21/04/2016, Daniel Maspoch (invited speaker)

Functional Metal-Organic Frameworks (from bulk to nanoscale): making composites with nanoscale ZIF-8, **ICREA Conference on Functional Nanocontainers**, Tarragona, Spain, 17-20/10/16, Daniel Maspoch (invited speaker)

Multi-shelled MOF-INP Composites synthesizedby a sequential Etching/Re-growth Approach, **IV Meeting of the Italian and Spanish Crystallographic Associations**, Puerto de la Cruz, Tenerife, Spain, 21-25/6/16, Daniel Maspoch (invited speaker)

Novel Carborane-based Metal-Organic Frameworks for Water Stability, **6th EuCheMS Congress**, Sevilla, Spain, 11-15/9/16, M. Y. Tsang, S. Rodríguez-Hermida, C. Vignatti, K. C. Stylianou, V. Guillerm, J. Pérez, F. Teixidor, C. Viñas, D. Choquesillo-Lazarte, C. Verdugo Escamilla, I. Peral, J. Juanhuix, I. Imaz, D. Maspoch, J. Giner Planas (oral)

Multifunctional Metallic Janus MOF Particles Synthesized by the Desymmetrization at Interfaces Approach, **NANOTECH France 2016**, Paris, France, 1-3/6/16, A. Ayala, I. Imaz, D. Maspoch (oral)

Eficacia de la encapsulación de bacteriófagos en fagoterapia oral, **Reunión de la red FAGOMA II**, Oviedo, Spain, 13-14/6/16, P. Cortés, J. Colom, M. Cano-Sarabia, J. Otero, M. Sánchez, D. Maspoch, M. Llagostera (oral)

Liposomes mimicking apoptotic cells: a new strategy to induce tolerogenic dendritic cells, **Workshop on cell-based tolerogenic therapies for early career investigators**, London, United Kingdom, 15-16/03/16, I. Pujol-Autonell, S. Rodríguez-Fernández, M. Cano-Sarabia, R. Ampudia, D. Maspoch, J. Verdaguer, M. Vives-Pi (oral)

Diving into apoptosis: liposome-based platform for autoimmune diseases, **X Congrés de la Societat Catalana d'Immunologia**, Barcelona, Spain, 18-18/11/2016, S. Rodríguez-Fernández; I. Pujol-Autonell, M.J. Mansilla, M. Cano-Sarabia, R.M. Ampudia, J. Navarro-Barriuso, S. García-Jimeno, D. Perna-Barrull, C. Izquierzo, T. Stratmann, E. Martínez-Cáceres, J. Verdaguer, D. Maspoch, M. Vives-Pi (oral)

Synthesis and characterization of rHDL-rApoJ nanoparticles, **X Simposi de Neurobiologia / Societat Catalana de Biologia**, Barcelona, Spain, 6-7/10/16, S. Fernández de-Retana, A. Montañola, J.L. Sánchez-Quesada, D. Maspoch, M. Cano-Sarabia, M. Hernández-Guillamón (oral)

Liposomes mimicking apoptotic ß-cells: a new immunotherapy for type 1 diabetes, **8ª Jornada de recerca de l'Institut Català de la Salut**, Girona, Spain, 03/06/2016, I. Pujol-Autonell, S. Rodríguez-Fernández, E. Aguilera, M. Cano-Sarabia, R. M. Ampudia, F. Vázquez, D. Maspoch, M. Puig-Domingo, J. Verdaguer, M. Vives-Pi (poster)

Liposomes mimicking apoptotic ß-cells: a new immunotherapy for type 1 diabetes, **CIBERDEM Annual Meeting**, Bellaterra, Barcelona, Spain, 11-13/5/16, I. Pujol-Autonell, S. Rodríguez-Fernández, E. Aguilera, M. Cano-Sarabia, R. M. Ampudia, F. Vázquez, D. Maspoch, M. Puig-Domingo, J. Verdaguer, M. Vives-Pi (poster)

Metal-Organic Polymers Made of Cyclodextrins, **Jornades Doctorals UAB**, Bellaterra, Barcelona, Spain, 1-3/6/16, H. Xu, I. Imaz, D. Maspoch (poster)

Design and synthesis of new photo-responsive coordination polymers, **Jornades Doctorals UAB**, Bellaterra, Barcelona, Spain, 1-3/6/16, J. Espín, C. Vignatti, J. Albalad, I. Imaz, D. Maspoch (poster)

Synthesis and characterization of rHDL-rApoJ nanoparticles, **5th International Cerebral Amyloid Angiopathy Conference**, Boston, USA, 8-10/9/16, S. Fernández de-Retana, A. Montañola, J.L. Sánchez-Quesada, D. Maspoch, M. Cano-Sarabia, M. Hernández-Guillamón (poster)

THESES

Doctorand: **Javier Aríñez**
Title: Design and Synthesis of Submicron Diagnostic Systems Based on Coordination Polymers
Date: 03/11/2016
Directors: Prof. Daniel Maspoch Comamala and Dr Inhar Imaz

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 2-dimensional materials**
- **Predictive modelling and multiscale numerical simulation of complex nanomaterials and quantum nanodevices**

GROUP MEMBERS

Barrios Vargas, José Eduard, Visiting Postdoctoral Researcher

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Power, Stephen, Postdoctoral Researcher

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Settnes, Mikkel, Visiting Postdoctoral Researcher

Song, Kenan, SO Doctoral Student

Soriano Hernández, David, Senior Postdoctoral Researcher

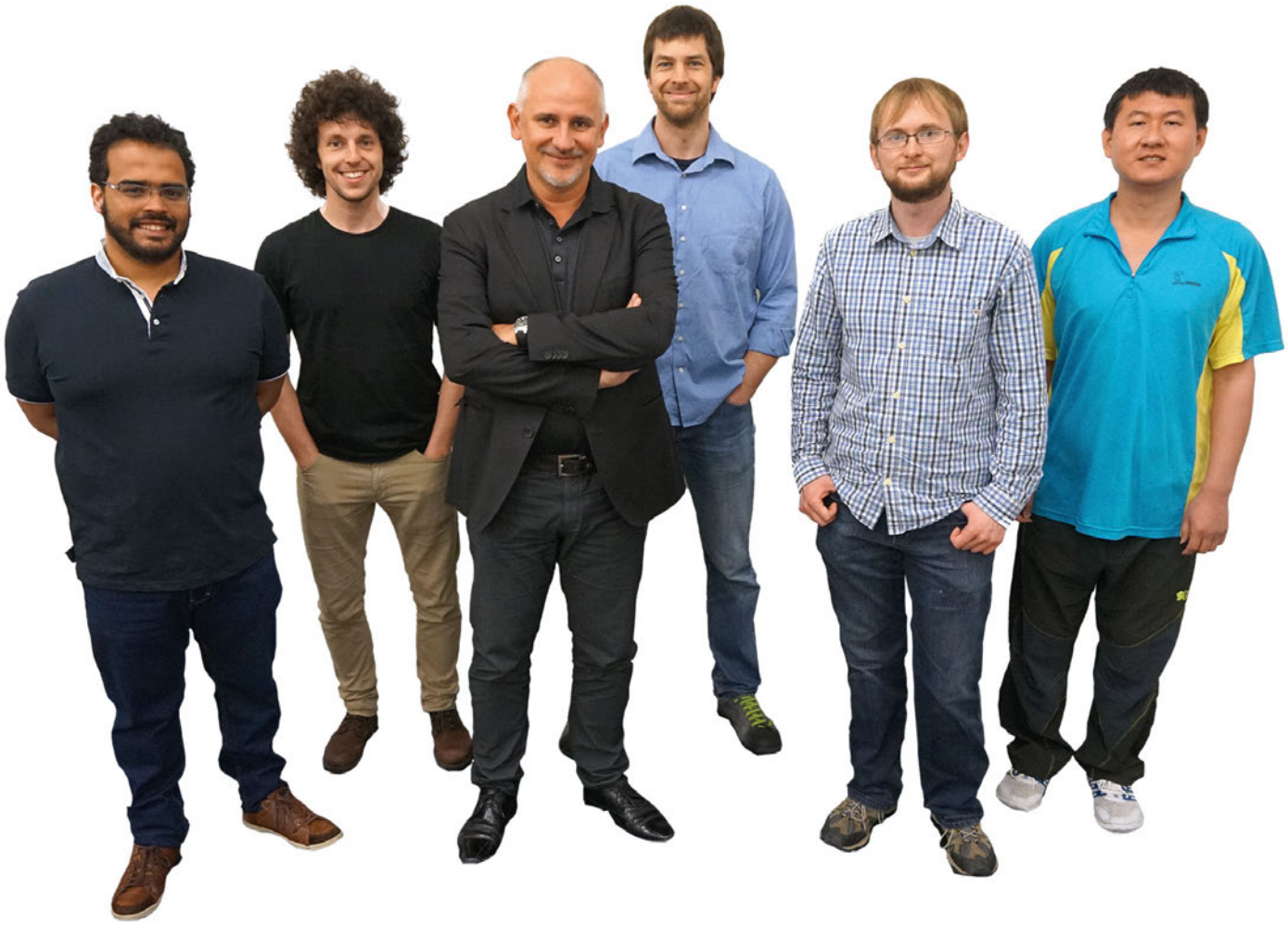
Vila Tusell, Marc, Doctoral Student

GROUP LEADER

ICREA Prof. Stephan Roche

Prof. Stephan Roche is a theoretician with more than 20 years' experience in the study of transport theory in 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 Letters* and *Physical Review Letters* (40 papers) and he is the



NEW PROJECTS & MILESTONES

1) Spin Manipulation in Graphene by Chemically-Induced Sublattice Pseudospin Polarization

Spin manipulation is one of the most critical challenges to realising spin-based logic devices and spintronic circuits.

Graphene has been heralded as an ideal material to achieve spin manipulation, but so far new paradigms and demonstrators are limited. We have shown that certain impurities such as fluorine ad-atoms, which locally break sublattice symmetry without the formation of strong magnetic

co-author of the recently-published *Introduction to Graphene-Based Nanomaterials: From Electronic Structure to Quantum Transport* (Cambridge University Press, 2014). He received authorisation to supervise PhD students from the *Université Joseph Fourier* (Grenoble, France) in 2004, since which time he has supervised seven PhD students and some 20 postdoctoral researchers in France, Germany and Spain. In 2009 Prof. Roche was awarded the prestigious Friedrich Wilhelm Bessel Research Award by the Alexander Von-Humboldt Foundation (Germany) and, last but not least, since 2011 he has been actively involved in the European Graphene Flagship project, as part of which he currently co-leads the spintronics work package.

moments, could result in a remarkable variability of spin transport characteristics.

In 2014 our group discovered a novel spin relaxation mechanism in non-magnetic graphene samples connected to the unique spin-pseudospin entanglement occurring near the Dirac point. Such a finding has inspired new directions towards the control of the spin degree of freedom modifying the pseudospin or vice versa. In 2016 we have shown how a chemical functionalisation of graphene with certain types of ad-atoms such as fluorine, by breaking the sublattice symmetry and by inducing a SOC without the formation of strong magnetic moment, could provide an innovative technique to monitor spin transport properties for spintronic applications. Our theory also allows current experimental controversies to be revisited and brings an enabling building block for graphene spintronics.

2) Spin Hall effect in decorated graphene

Although graphene has attractive properties in spintronics, such as long room temperature spin diffusion length, it is inactive for the spin Hall effect (SHE), a spin transport phenomenon mediated by strong spin-orbit coupling in which opposite spins are deviated in contrary directions while propagating inside a channel. Several experiments reporting an unexpectedly large SHE in graphene decorated with ad-atoms, locally enhancing the spin-orbit coupling effects in graphene, have raised fierce controversy. Indeed to date, measured values for the spin Hall angle range from 0.0001 in semiconductors to 0.3 in some metals, which are finding important applications in the magnetic memory market. The measurements on decorated graphene indicate a spin Hall angle of about 0.2, which would make modified graphene technologically relevant.

We developed a fully quantum simulation of this phenomenon to analyse such intriguing experimental results and found that multiple background contributions to non-local resistance, which was argued to be the smoking gun of SHE, could resolve these controversies. A novel device geometry to suppress these contributions and quantify the upper limit for the SHE in 2-dimensional materials has been also proposed. Such results are opening new directions for experiments in this field and give some hope for the efficient engineering of the spin Hall effect in graphene-based materials.

3) Simulation CVD graphene devices

Major roadblocks towards high-performance graphene devices are the nanoscale variations of graphene polycrystalline morphologies (grain boundaries, grain sizes), which strongly impact on all macroscopic physical properties (mechanical, electrical and thermal). The requirements in terms of device quality and uniformity are very demanding, and major roadblocks to the high-performance of many graphene devices stem from the complex structural morphologies of large-scale graphene (CVD, reduced graphene oxides, etc.), which are detrimental to their optimal macroscopic properties.

We have clarified the impact of edges and grain boundaries on a large spectrum of properties, including charge mobility, Seebeck coefficient thermal conductivity and the thermoelectric figure of merit of CVD graphene. In particular we have reported on the scaling properties of polycrystalline graphene and hybrid graphene/hBN heterostructures, providing guidance for the optimisation of materials for a desired application.

4) Spin lifetime in ultraclean graphene devices

We have clarified theoretically the fundamental properties of spin dynamics in ultraclean spin-orbit-coupled materials. By considering the quasiballistic limit, and introducing small broadening of electronic states due to thermal effects or electrical bias.

Indeed in the ballistic limit, the spin lifetime was demonstrated to be dictated by the dephasing effects arising from energy broadening plus a non-uniform spin precession, which is very unique to Dirac materials such as graphene and topological insulators. For the case of clean graphene, we find a strong anisotropy with spin lifetimes that can be short even for modest energy scales, on the order of a few nanoseconds. These results offer deeper insight into the nature of spin dynamics in graphene, and are also applicable to the investigation of other systems where spin-orbit coupling plays an important role.

We have clarified theoretically the fundamental properties of spin dynamics in ultraclean spin-orbit-coupled materials, by considering the quasiballistic limit, and introducing small broadening of electronic states due to thermal effects or electrical bias. In the ballistic limit, the spin lifetime was demonstrated to be dictated by dephasing effects arising from energy broadening plus a non-uniform spin precession, which is very unique to Dirac materials such as graphene and topological insulators. For the case of clean graphene, we find a strong anisotropy with spin lifetimes that can be short even for modest energy scales, in the order of a few nanoseconds. These results offer deeper insight into the nature of spin dynamics in graphene and are also applicable to the investigation of other systems where spin-orbit coupling plays an important role.

PUBLICATIONS

Anomalous ballistic transport in disordered bilayer graphene: A Dirac semimetal induced by dimer vacancies, Van Tuan D., Roche S., *Physical Review B - Condensed Matter and Materials Physics*; **93** (4, 041403) 2016. IF: 3.718

Charge, spin and valley Hall effects in disordered grapheme, Cresti A., Nikolíc B.K., Garcia J.H., Roche S., *Rivista del Nuovo Cimento*; **39 (12):** 587-667. 2016. IF: 1.250

Effects of Dephasing on Spin Lifetime in Ballistic Spin-Orbit Materials, Cummings A.W., Roche S., *Physical Review Letters*; **116** (8, 086602) 2016. IF: 7.645

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How disorder affects topological surface states in the limit of ultrathin Bi_2Se_3 films, Song K., Soriano D., Robles R., Ordejon P., Roche S., *2D Materials*; **3** (4, 045007) 2016. IF: 9.611

Localized electronic states at grain boundaries on the surface of graphene and graphite, Luican-Mayer A., Barrios-Vargas J.E., Falkenberg J.T., Autès G., Cummings A.W., Soriano D., Li G., Brandbyge M., Yazyev O.V., Roche S., Yandrei E., *2D Materials*; **3** (3, 031005) 2016. IF: 9.611

Near-field photocurrent nanoscopy on bare and encapsulated graphene, Woessner A., Alonso-González P., Lundeberg M.B., Gao Y., Barrios-Vargas J.E., Navickaite G., Ma Q., Janner D., Watanabe K., Cummings A.W., Taniguchi T., Pruneri V., Roche S., Jarillo-Herrero P., Hone J., Hillenbrand R., Koppens F.H.L., *Nature Communications*; **7** (10783) 2016. IF: 11.329

Quantum transport in graphene in presence of strain-induced pseudo-Landau levels, Settnes M., Leconte N., Barrios-Vargas J.E., Jauho A.-P., Roche S., *2D Materials*; **3** (3, 034005) 2016. IF: 9.611

Spin dynamics and relaxation in graphene dictated by electron-hole puddles, Van Tuan D., Ortmann F., Cummings A.W., Soriano D., Roche S., *Scientific Reports*; **6** (21046) 2016. IF: 5.228

Spin dynamics in bilayer graphene: Role of electron-hole puddles and Dyakonov-Perel mechanism, Van Tuan D., Adam S., Roche S., *Physical Review B-Condensed Matter and Materials Physics*; **94** (4, 041405) 2016. IF: 3.718

Spin Hall Effect and Origins of Nonlocal Resistance in Adatom-Decorated Graphene, Van Tuan D., Marmolejo-Tejada J.M., Waintal X., Nikolic B.K., Valenzuela S.O., Roche S., *Physical Review Letters*; **117** (17, 176602) 2016. IF: 7.645

Spin Manipulation in Graphene by Chemically Induced Pseudospin Polarization, Van Tuan D., Roche S., *Physical Review Letters*; **116** (10, 106601) 2016. IF: 7.645

Thermal conductivity of MoS_2 polycrystalline nanomembranes, Sledzinska M., Graczykowski B., Placidi M., Reig D.S., El Sachat A., Reparaz J.S., Alzina F., Mortazavi B., Quey R., Colombo L., Roche S., Torres C.M.S., *2D Materials*; **3** (3, 035016) 2016. IF: 9.611

Unconventional features in the quantum Hall regime of disordered graphene: Percolating impurity states and Hall conductance quantization, Leconte N., Ortmann F., Cresti A., Roche S., *Physical Review B-Condensed Matter and Materials Physics*; **93** (11, 115404) 2016. IF: 3.718

PROJECTS

Graphene-based disruptive technologies, funded by **CE - H2020-Adhoc-2014-20**, 01/04/2016 - 31/03/2018, Stephan Roche

Graphene-Based Revolutions in ICT And Beyond, funded by **CE - FP7-ICT-2013-FET-F**, 01/10/2013 - 31/03/2016, Stephan Roche

2014 SGR 58, funded by **AGAUR**, 01/01/2014 - 30/04/2017, Stephan Roche

Spin Manipulation in Dirac Matter, funded by **MINECO**, 01/01/2016 - 31/12/2018, Stephan Roche and Aron Cummings

CONTRIBUTIONS

Revisiting Spin dynamics and Spin Hall Effect in Graphene, **Spinograph Workshop 2016**, Madrid, Spain, 24/02/2016, Stephan Roche (invited speaker)

Spin Transport in Graphene: from fundamental relaxation mechanism to Spin Hall Effect, **Symposium Z: Two-dimensional crystals and van der Waals heterostructures for nanoelectronics**, Strasbourg, France, 04/05/2016, Stephan Roche (invited speaker)

Spintronics with 2D Materials, **Colloquium Spintronics with 2D Materials**, University of Konstanz, Germany, 10/05/2016, Stephan Roche (invited speaker)

Real space computational approaches for exploring charge/spin/thermal transport in materials with billions of atoms, **Towards reality in modelling of molecular electronics**, San Sebastián, Spain, 13/06/2016, Stephan Roche (invited speaker)

Spin Transport Phenomena in Graphene and Two-dimensional Materials : Current challenges & opportunities, **AIST**, Tokyo, japan, 20/07/2016, Stephan Roche (invited speaker)

The future of Graphene Spintronics, **GRAPHCHINA2016**, Qingdao, China, 22/09/2016, Stephan Roche (invited speaker)

Controlling Spin Dynamics in Graphene, Graphene EU-US Workshop on 2D Materials, **Heterostructures and Devices**, Manchester, UK, 10/10/2016, Stephan Roche (invited speaker)

Why 2D Materials could revolutionize Spintronics, **GRAPHENE CANADA 2016**, Montreal, Canada, 17/10/2016, Stephan Roche (invited speaker)

COURSES

Undergraduate - "Try the impossible to achieve the unusual" : About creativity in Science and Technology, **Barcelona International Youth Science Challenge**, Barcelona, Spain, 13/07/2016, Stephan Roche

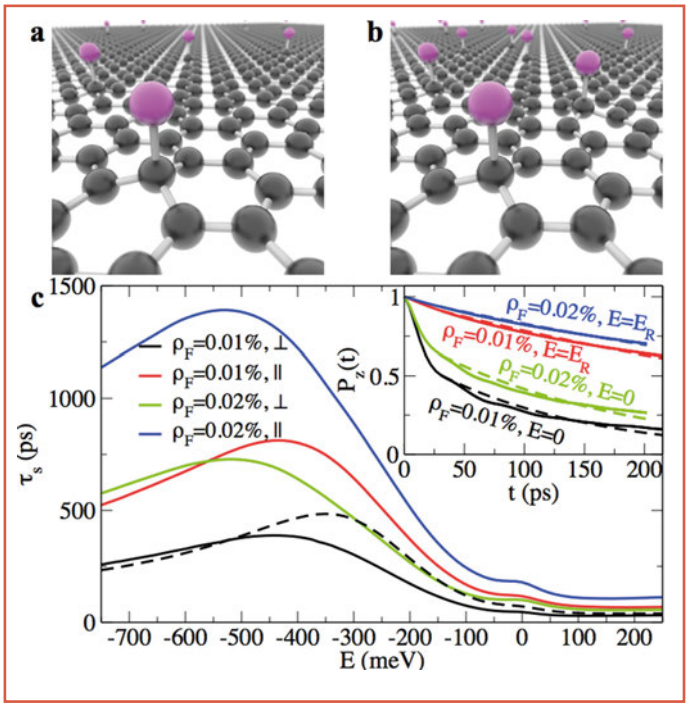
Fundamentals of Electronic Excitations and Spin Dynamics in Dirac Matter, **Open Knowledge-ICN2**, Barcelona, Spain, 14/05/2016, Stephan Roche

Quantum simulation for Nanoscience, **University of Denmark**, DTU - Denmark, 11/03/2016, Stephan Roche

Quantum Transport in Mesoscopic Physics, **Master of Nanoscience UAB**, Barcelona, Spain, 28/01/2016, Stephan Roche

BOOKS

Simulation of Transport in Nanodevices
- Chap. 5, *Introduction to quantum transport*, Triozon F, Roche S, Niquet, Ed. John Wiley & Sons, 2016



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 and TRANSIESTA**
- **First-principles simulations at the nanoscale**
- **Novel physical properties in 2D materials**

GROUP MEMBERS

Alonso Pruneda, José Miguel, CSIC Tenured Scientist
Bernd, Ensing, Visiting Researcher
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Ordejón Rontomé, Pablo, CSIC Research Professor, Group Leader and ICN2 Director
Papior, Nick Rubner, Postdoctoral Researcher
Robles Rodríguez, Roberto, SO Senior Postdoctoral Researcher

GROUP LEADER

CSIC Research Prof. Pablo Ordejón

Prof. Ordejón earned his degree in Physics (1987) and PhD in Science (1992) at the *Universidad Autónoma de Madrid*. 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 to the former CIN2 (now ICN2) as the leader of the Theory and Simulation Group, where he is currently a CSIC Research Professor. Since July 2012 he has served as Director of the ICN2.

He has published nearly 200 scientific articles, which have received over 22,000 citations (h-index of 53). 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 oversaw the Condensed Matter Physics subject area of the Physics Panel of the Spanish National Evaluation and Foresight Agency (ANEP) from 2003 to 2006, and was 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 electronic transport in nanoscale devices and electronic processes at surfaces and 2D materials, among many others. He maintains frequent collaborations with industrial laboratories on the simulation of material processes at the atomic level. He is a co-founder of the spinoff company SIMUNE.

NEW PROJECTS & MILESTONES

Most of the research carried out by the group in 2016 has gravitated around the MaX Centre (www.max-centre.eu), one of the eight European Centres of Excellence in HPC Applications supported by the EU under its 2105 H2020 e-infrastructure funding programme.

MaX supports developers and end users of advanced applications for materials simulations, design and discovery, and works at the frontiers of current and future high performance computing (HPC) technologies. It brings together leading developers and users of materials applications, together with top experts in HPC. It is based on the collaboration of 13 teams, including five research groups, like the ICN2 Theory and Simulation Group, which will focus on enhancing the capabilities of the SIESTA package and develop new methodologies for industrial applications of simulation tools in materials science.

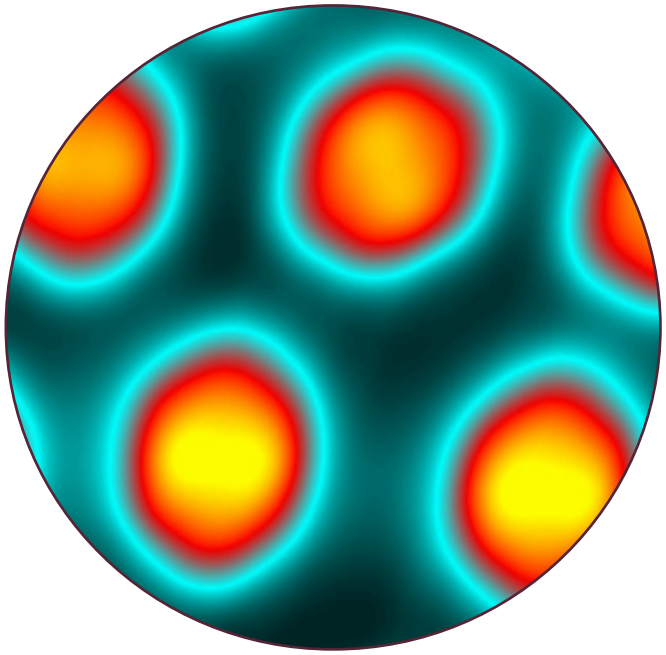
Considerable effort has been devoted to improve the modularity and efficiency of the SIESTA and TRANSIESTA codes. The first release of the SIESTA code under a GPL license at the beginning of the year was an important milestone in 2016, as was the TranSiesta/TBTrans School organised at the ICN2, which was a great opportunity to present some major recent developments in the tools developed by the group. The release of the spin-orbit implementation and a first operative version of the Density Functional Perturbation Theory within the code are also among the group's achievements in 2016.

The group has continued its participation in NFFAEurope (www.nffa.eu), a project funded under the H2020-INFRAIA-2014-2015 call "Integrating and opening existing national and regional research infrastructures of Europeaninterest". The 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" offering access to computational support for experimental user projects.

On the science side of things, in 2016 we made progress along two new important research lines:

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, developing new tools and methodologies. In particular, we are exploring the thermal transport properties of 2D materials, which have revealed unusual behaviours (as compared to bulk systems), leading to unexpected intriguing features with significant potential for various front-edge and emerging nanotechnologies (e.g. heat management in nanodevices, thermoelectric energy conversion or the manipulation of lattice heat to engineer phononic devices). Within the MaX Centre, and in the context of an industrial collaboration, we have also focused on techniques to study thermal properties in nanofluids, which potential impact on energy storage.

Magnetic properties at the nanoscale, with new developments in SIESTA that make the study of systems with strong spin-orbit effects (including topological insulators) possible, as well as the study of magnetic anisotropies in thin films and other nanostructured materials. We have used the working versions in our study of hybrid organic-inorganic perovskites, layered graphene-based magnetic nanostructures and topological insulators. These materials are very promising in the development of spin-based applications, wich are of great interest at the ICN2 as a whole.



With respect to the existing research lines, we have made strong advances on:

Understanding the properties of 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 all examples of our activities in 2D materials during 2016.

Understanding nanostructured oxides: In collaboration with experimental colleagues in Argentina, we studied the mechanisms contributing to oxygen reduction reactions in manganites ($La_{(1-x)}Sr_xMnO_3$), identifying an increased oxygen vacancy concentration close to the surfaces that causes significant ionic conduction and enables the use of these nanostructured materials in solid oxide fuel cells in the "intermediate" temperature range. In addition to this collaboration, and motivated by the MaX Centre, we have established a new research collaboration with industry to advance oxygen diffusion in materials for sensor applications, which will run over the coming years.

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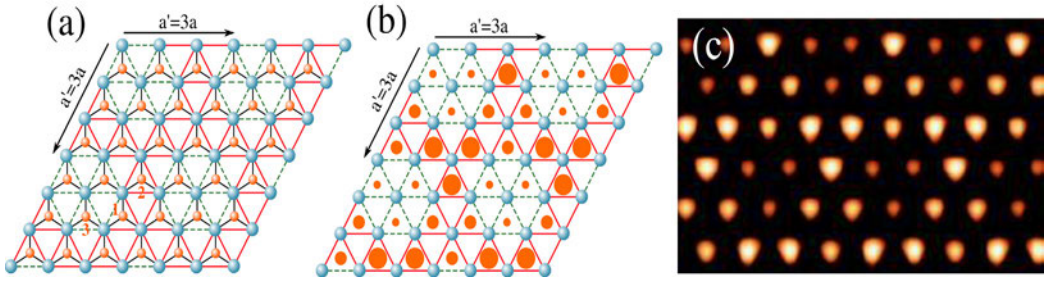


PROJECTS

SIESTA and the Theory of Instabilities and Transport in Functional and Low-Dimensional Materials, funded by **MINECO**, 01/01/2016 - 31/12/2018, Miguel Pruneda and Pablo Ordejón

Materials Design at the eXascale, funded by **CE - H2020-EINFRA-2015-1**, 01/09/2015 - 28/02/2018, Pablo Ordejón

Nanoscience foundries and fine analysis-Europe, funded by **CE - H2020-INFRAIA-2014-2015**, 01/09/2015 - 31/08/2019, Pablo Ordejón

CONTRIBUTIONS

Layered and 2D materials: electronic properties and structural instabilities from first Principles, **30th Meeting of the European Crystallographic Association**, Basel, Switzerland, August, 2016, Pablo Ordejon (invited speaker)

MaX Center of Excellence: Materials at the Exascale, **E-CAM Industry Meeting**, Mainz, germany, August, 2016, Pablo Ordejon (invited speaker)

Layered and 2D materials: electronic properties and structural instabilities from first Principles, **2016 International Graphene Innovation Conference**, Qingdao, China, September, 2016, Pablo Ordejon (invited speaker)

Surprises at the interfaces of 2D materials, **Thomas Young Centre, Imperial College**, London, United Kingdom, September, 2016, Miguel A. Pruneda (invited speaker)

Charge-density-wave state manipulation in $TiSe_2$ single-layers, **32nd Annual Meeting of Reference Network of R+D+I on Theorical and Computational Chemistry (XRQTC)**, Autonomous University of Barcelona (UAB), Bellaterra, Barcelona, Spain, 22/06-24/06, 2016, Bogdan Guster, Enric Canadell, Miguel Pruneda, Pablo Ordejon (oral)

Origin and Manipulation of the Charge-Density-Wave in the 2D $TiSe_2$, **CECAM - Workshop "Tailor-made 2D-materials and functional devices"**, University of Bremen, Bremen, Germany, 4-5/07, 2016, Bogdan Guster, Enric Canadell, Miguel Pruneda, Pablo Ordejon (poster)

First-principles calculations of electronic band structure of graphene adsorbed on multilayered WS_2, **Spinograph Workshop 2016**, Madrid, Spain, 22-26 Feb 2016, Francisco Hidalgo, José Silva, Miguel Pruneda and Pablo Ordejón (poster)

Spin texture in graphene induced by proximity to Bi_2Se_3, **New Trends in Topological Insulators 2016 (NTTI2016)**, Würzburg (Germany), July 24-29, 2016, K. Song, D. Soriano, R. Robles, A. W. Cummings, S. Roche (poster)

MARVEL/MaX/Psi-K tutorial on high-throughput computations: general methods and applications using AiiDA, **Swiss Federal Institute of Technology in Lausanne (EPFL)**, Lausanne, Switzerland, 22/06-24/07, 2016, Bogdan Guster, Desanka Boskovic, Enric Canadell, Miguel Pruneda, Pablo Ordejon (poster)

Magnetic impurities on heavy metal surface alloys, **Fuerzas y Túnel 2016**, Girona, Spain, 5-7 September, 2016, S. Schirone, M.A. Valbuena, R. Robles, N. Lorente, P.Gargiani, M. Valvidares, C. Nistor, L. Persichetti, P. Gambardella, A. Barla, A. Mugarza (poster)

Influence of chemical doping and molecular organization on the electronic properties of 2D organic thin films, **Fuerzas y Túnel 2016**, Girona, Spain, 5-7 September, 2016, J. Hieulle, R. Robles, J. Cruz, I. Imaz, D. Maspoch, C. Moreno, A. Mugarza (poster)

Technical Development and Support

The research support divisions and core facilities led by Dr Gustavo Ceballos constitute a centralised support infrastructure that affords research scientists shared access to sophisticated equipment and specialised services. It aims to offer both ICN2 research groups and neighbouring centres a repository of expertise and know-how for the development of new methods, materials, instruments and techniques, as well as fostering interdisciplinary collaborations. A highly-qualified multidisciplinary team of experts is on hand to provide expertise that may be lacking in the research laboratories.

RESEARCH SUPPORT DIVISIONS

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

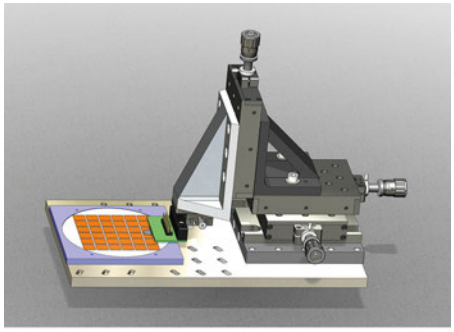
RESEARCH SUPPORT FACILITIES

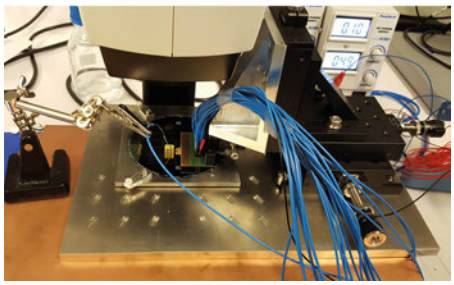
Nanoscience Instrument Development Division

Main Research Lines

- Design, development and improvement of advanced precision instrumentation
- Modification of commercial instrumentation to match particular experimental requirements
- Scientific computing
- Data acquisition
- 3D-CAD design of precision devices
- Vacuum technology (HV, UHV)
- Cryogenics

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 earned his degree in Chemistry at the *Universidad Central de 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* to complete his postdoctoral studies, and from 2001 to 2002 he worked at the Low-Temperature Scanning Tunnelling Microscopy Group

Dr Gustavo Ceballos

DIVISION MEMBERS

Ceballos, Gustavo, Head of Scientific Technical Research Support

Maymó, Marc, Research Engineer

NEW PROJECTS & MILESTONES

The division provides scientific and technical assistance in applied physics, precision instrumentation, microengineering, nanotechnology, scientific computing, and the 3D-design of precision devices. Its goal is to help address challenging instrumentation requirements in both basic and applied research. In recent years the division has also offered support for dissemination activities, specifically where the design and construction of prototypes and technology demonstrators are required.

at the *Fritz-Haber-Institut der Max- Planck-Gesellschaft*, also in Berlin. From 2002 to 2006 he was a research scientist at the XSTM and Low-Temperature STM of Nanostructures Division at the *Laboratorio Nazionale TASC-INFM*, (Trieste, Italy). In 2006 he joined the then ICN as a senior scientist and eventually created the Nanoscience Instrument Development Division. He actively participates in the research led by the ICN2 Atomic Manipulation and Spectroscopy Group.

Throughout his career Dr Ceballos has made modifications to existing instruments or experimental setups, or developed news ones, to meet the needs of the new experiments he has devised.

Electron Microscopy Division

Main Research Lines

- Use of electron microscopy techniques for nanoscience and nanotechnology research and applications
- Scientific-technical support for both internal ICN2 research groups and external scientists and companies
- Study of the structure and chemistry of functional carbon nanotubes
- Exploration of 2D layered inorganic nanotube systems
- Electron microscopy studies on graphene

DIVISION MEMBERS

Ballesteros Pérez, Belén, Division Leader
Belarre Triviño, Francisco Javier, CSIC Technician
Pach, Elzbieta, Visiting Doctoral Student
Rosado Iglesias, Marcos, Specialist Technician
Peña, Jose Antonio, Visiting Student (UAB)

DIVISION LEADER

Dr Belén Ballesteros

Dr Belén Ballesteros earned her degree in Chemistry with Honours at the *Universitat Autònoma de Barcelona* (UAB) in 2001, going on to obtain 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 the *Universiteit Twente* (Netherlands), *Universitetet i Oslo* (Norway),

NEW PROJECTS & MILESTONES

During 2016 the Electron Microscopy Division consolidated its range of scientific-technical support activities, providing support not only to internal users, but to an increasing number of external users. The division also hosted a visiting internship student from the *Universitat Autònoma de Barcelona* (Jose Antonio Peña).

We actively participated in the outreach activities organised at the ICN2, such as the *Escolab* and *Professors i Ciència*

University of St 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 the nanoanalysis of carbon nanotubes, inorganic nanotubes and related materials. She has been the head of the Electron Microscopy Division at the ICN2 since April 2009.

Dr Ballesteros has authored 58 peer-reviewed articles and around 900 citations.

programmes, and the Nanoinnovation course (Introduction to Innovation & Entrepreneurship –Nanotechnology Innovation). Notably, division member Marcos Rosado was one of the monthly prize winners of the FEI Image Contest.

Research-wise, the Electron Microscopy Division has continued devoting efforts to the electron microscopy study of functional carbon nanomaterials for biomedical applications. For instance, we studied filled and functionalised carbon nanotube constructs with applications as targeted anticancer therapy systems or as cellular X-ray fluorescence contrast agents. We also worked on the thorough characterisation of functionalized graphene samples.

PUBLICATIONS

Carbon nanotubes allow capture of krypton, barium and lead for multichannel biological X-ray fluorescence imaging, Serpell C.J., Rutte R.N., Geraki K., Pach E., Martincic M., Kierkowicz M., De Munari S., Wals K., Raj R., Ballesteros B., Tobias G., Anthony D.C., Davis B.G., *Nature Communications*; **7** (13118) 2016. IF: 11.329

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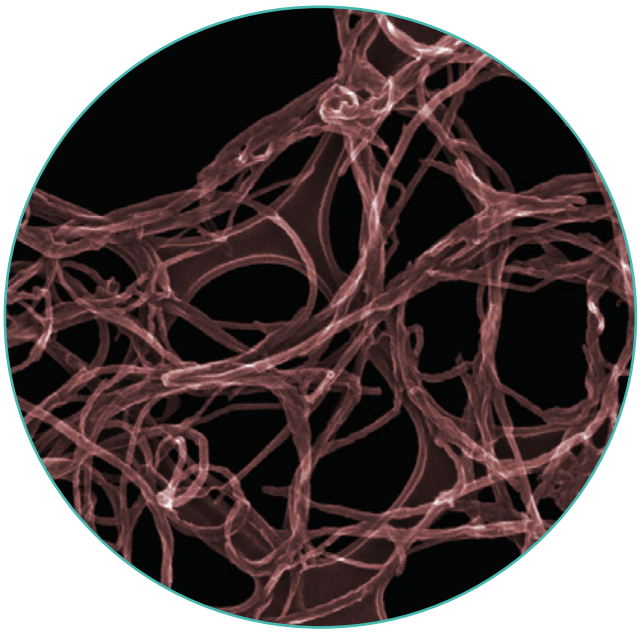

Nanomaterials Growth Division

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. Particular emphasis is given to the advanced TEM characterisation of defects at the nanoscale, such as misfit dislocations at the interface and their role in generating new functionalities.**
- **Current research is mainly devoted to the thin epitaxial growth of mixed ionic-electronic conducting oxides and multilayers by PLD, their structural 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.**
- **MOCVD growth of 2D layers of transition metal dichalcogenides**

DIVISION LEADER

CSIC Tenured Scientist
Dr José Santiso

Dr José Santiso earned his degree in Physics at the *Universitat Autònoma de Barcelona* (UAB) in 1988, later obtaining his PhD from the *Universitat de Barcelona* (UB) in 1993.

After his doctoral studies, he worked as a visiting scientist at Cambridge University (UK) from 1994 to 1996. He then joined the *Institut de Ciència de Materials de Barcelona* (ICMAB) as a research associate and became a CSIC tenured scientist in 2002. In 2007 he moved to the ICN2 as the leader of the Pulsed Laser Deposition and Nanoionics Group, which recently become the ICN2 Nanomaterials Growth Division. In 2012 he

DIVISION MEMBERS

Bagués Salguero, Núria, CSIC Doctoral Student
Caicedo Roque, José Manuel, Research Engineer
Chatterjee, Arindom, SO Doctoral Student
Magrasó Solà, Anna, Postdoctoral Researcher
Rodríguez Domínguez, Laura , SO Doctoral Student
Santiso López, José, CSIC Tenured Scientist and Division Leader

received the Sômiya Award from the International Union of Materials Research Society (IUMRS) for his contributions to solid state ionics. More recently in 2014 he obtained a grant from the Japan Society for the Promotion of Science to join the International Institute for Carbon-Neutral Research (I²CNER, Kyushu University) for a three-month research visit.

In 2015 Dr José Santiso spent three months at the Massachusetts Institute of Technology (USA). The aim of this visit was to consolidate the collaboration between groups working in the field of oxide thin films for energy applications.

Dr Santiso has authored more than 120 articles, and has around 1200 citations and an h-index of 20.

NEW PROJECTS & MILESTONES

In 2016 the Nanomaterials Growth Division continued working on the following closely-related main research objectives:

Thin-film deposition of epitaxial oxide materials by means of a pulsed laser deposition technique. Our division produces films for and in close collaboration with a large number of the ICN2 research groups. In some cases the thin-film deposition requires the use of reflection high-energy electron diffraction (RHEED). Our division carries out the preliminary structure characterisation, for the most part by X-ray diffraction. (Some of the ICN2 group leaders 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. This involves the development of novel methods for the X-ray diffraction and diffuse scattering characterisation of microstructure features in epitaxial thin films. These include in-plane diffraction, GISAXS analysis, as well as 3D reciprocal space mapping, the latter of which requires the use of synchrotron radiation source (i.e. 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 research is completed via 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 combining 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 University and MIT).

This year we built a new thin film MOCVD reactor for the growth of high quality ultrathin transition metal dichalcogenides, starting with MoS_2, in collaboration with the ICN2 group led by Prof. José Antonio Garrido. We are currently working on a further scaling-up of this reactor to deposit films in 2" wafers.

PUBLICATIONS

Comparison of the local and the average crystal structure of proton conducting lanthanum tungstate and the influence of molybdenum substitution, Magrasó A., Frontera C., *Dalton Transactions*; **45 (9):** 3791-3797. 2016. IF: 4.177

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The Band Gap of $BaPrO_3$ Studied by Optical and Electrical Methods, Schrade M., Magrasó A., Galeckas A., Finstad T.G., Norby T., *Journal of the American Ceramic Society*; **99 (2):** 492-498. 2016. IF: 2.787

Thermodynamic conditions during growth determine the magnetic anisotropy in epitaxial thin-films of $La_{0.7}Sr_{0.3}MnO_3$, Vila-Fungueiriño J.M., Bui C.T., Rivas-Murias B., Winkler E., Milano J., Santiso J., Rivadulla F., *Journal of Physics D: Applied Physics*; **49** (31, 315001) 2016. IF: 2.772

Tunneling anisotropic magnetoresistance in $La_{2/3}Sr_{1/3}MnO_3/LaAlO_3$/Pt tunnel junctions, Galceran R., Balcells L., Pomar A., Konstantinovic Z., Bagués N., Sandiumenge F., Martínez B., *AIP Advances*; **6** (4, 045305) 2016. IF: 1.444

CONTRIBUTIONS

Modulation of surface strain and currents by misfit relieving defects in epitaxial complex oxide, **2nd Functional Oxide Thin Films for Advanced Energy and Information Technology Conference**, Cancun, méxico, 5-8/3/16, N. Bagués, J. Santiso, M. Paradinas, Z. Konstantinovic, A. Pomar, Ll. Balcells, C. Ocal, M. -J. Casanove, B. Martínez, and F. Sandiumenge (invited speaker)

Misfit dislocation structure and guided topographic and conduction patterning in complex oxide epitaxial thin films, **CMD26, Condensed Matter in Groningen**, Groningen,The Netherlands, 4-9/9/16, N. Bagués, J. Santiso, M. Paradinas, Z. Konstantinovic, A. Pomar, Ll. Balcells, C. Ocal, B. Esser., D. McComb., B. Martínez., F. Sandiumenge (oral)

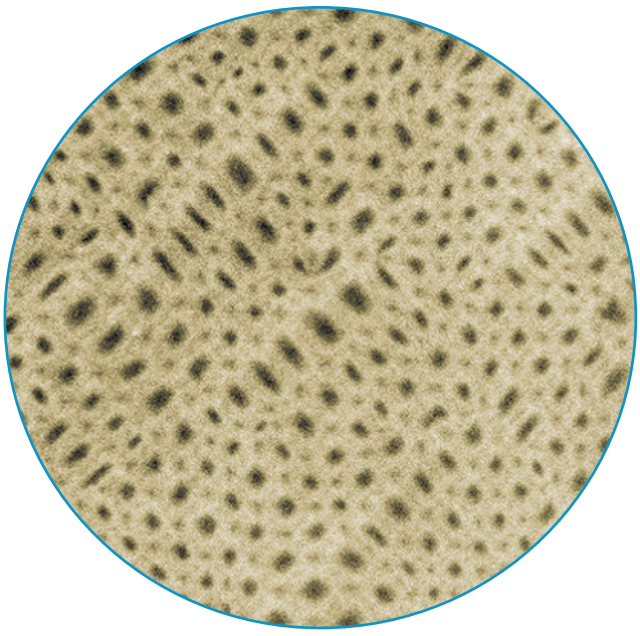
Strain engineered ferromagnetism in $LaMnO_3$ thin films, **GEFES 2016, IX Reunión del Grupo Especializado de Física del Estado Sólido**, Cuenca, Spain, 13-15/1/16, A. Pomar, J. Roqueta, J. Santiso, C. Frontera, Ll. Balcells, B. Bozzo, Z. Konstantinovic, S. Valencia, R. Abrudan, and B. Martinez (poster)

COURSES

Practical session on X-ray diffraction of thin films, **Nanotechnology master of UAB (8 hours)**, UAB, Bellaterra, Spain, nov-2016, José Santiso

THESES

Doctorand: **James Zapata**
Title: Epitaxial Thin Film Growth and Study of Charge and Mass Transport Properties of Mixed Ionic Electronic Conducting $GdBaCo_2O_{5+\delta}$ (GBCO).
Defence Date: 08/02/2016
Directed by Dr José Santiso



Nanofabrication Facility

The Nanofabrication Facility focuses on the design and development of nanofabrication methods and techniques for basic and applied research in nanoscience and nanotechnology. It provides researchers and students an extensive range of processing services to help them carry out their research activities. It also offers support, assistance and training to allow the researchers and other users to safely and efficiently operate the equipment available.

The facility is designed to support the fabrication and characterisation of nanoscale materials and structures, and the integration of devices at all length scales.

The facility's mission is to provide high quality services to both internal and external users.

FACILITY MEMBERS

Xavier Borrisé, Research Engineer

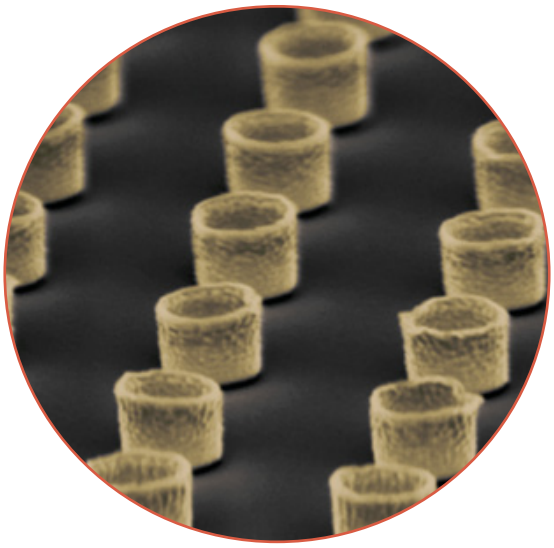
Raúl Perez, Research Engineer

AVAILABLE TECHNIQUES

- Electron-beam lithography (EBL)
- Focused ion beam (FIB)
- Thermal and UV-nanoimprint lithography (NIL)
- Atomic force microscopy (AFM)
- E-beam evaporation
- Sputter coating
- Plasma cleaning
- Wedge bonding
- Spin coating
- Optical Microscopy
- 3D Optical Profiler
- Stylus Profilometer

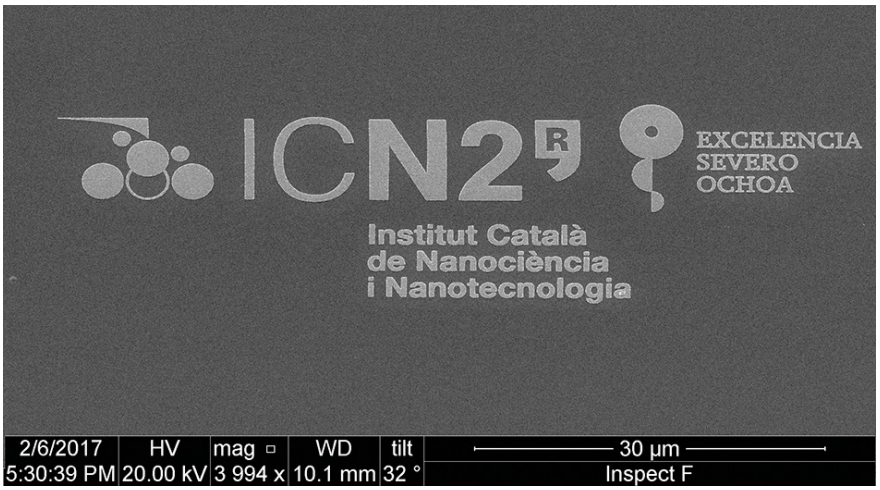
NEW PROJECTS & MILESTONES

In 2016 the Nanofabrication Facility has been working on the project to construct and equip a new environmentally-controlled area within the ICN2 building. This new area, with controlled particulate concentration, temperature, humidity and light, will be distributed across three main technical areas: lithography, etching, and deposition and characterisation. It will have a total surface area of approximately 100m^2. This new facility, together with the equipment yet to be acquired, will allow researchers to develop and fabricate fully-functioning micro- and nanodevices and prototypes with high levels of accuracy and reliability in a wide range of materials.



PUBLICATIONS

Gold interdigitated nanoelectrodes as a sensitive analytical tool for selective detection of electroactive species via redox cycling, Alayo N., Fernández-Sánchez C., Baldi A., Esquivel J.P., Borrisé X., Pérez-Murano F., *Microchimica Acta*, **183 (5)**, 1633-1639. 2016. IF: 4.831



Instrumental Core Research Facilities

The Instrumental Core Research Facilities provide all ICN2 researchers with an array of specialised equipment, technologies and services efficiently operated by highly-qualified staff. This enables them to achieve ambitious research goals cost-effectively. From essential routine support through to more advanced technical and consulting services, these core facilities enable and enhance the important research carried out at the institute on a daily basis.

FACILITY MEMBERS

Jessica Padilla, Research Technician at the X-ray Diffraction Facility

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

AWARDS

Dr Javier Saiz Poseu, **UAB Doctoral Thesis Extraordinari Award** for his doctoral thesis entitled "*Multifunctional molecular systems derived from catechols: synthesis, characterization and integration*", directed by Prof. Daniel Ruiz-Molina and Prof. Félix Busqué Sánche

Technical Facilities Mechanical Workshop

The Mechanical Workshop facility was created with the aim of offering high-precision machining services. In 2016 a new tungsten inert gas (TIG) welding machine was acquired to endow the facility with the basic welding capabilities for different metals. This year the facility ran at full capacity, offering a broad range of custom machining services for the design, fabrication and assembling of devices and components for ICN2 researchers.

FACILITY MEMBERS

Rafael León, SO Mechanical Workshop Technician

AVAILABLE TECHNIQUES

- Precision milling, turning, grinding
- Close tolerance machining
- Mechanical assembly
- CAD (computer-aided design)
- CAM (computer-aided machining)
- CNC (computer numerical control)
- TIG welding

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 (BCP) self-assembly/graphoepitaxy
- Step-and-repeat nanoimprint lithography
- Hierarchical micro/nano patterning
- Flexible processing: In-line and off-line dimensional nanometrology

PLATFORM MEMBERS

Francone, Achille Leo, SO Postdoctoral Researcher
Kehagias, Nikolaos, Senior Researcher

PLATFORM LEADER

Dr Nikolaos Kehagias

Dr Kehagias has led the ICN2 Nanoimprint Lithography Platform since 2010. He obtained his PhD in 2007 from the National University of Ireland, Cork, where he continued to work as a postdoctoral fellow until May 2008. He then joined the ICN2 Phononic and Photonic Nanostructures Group.

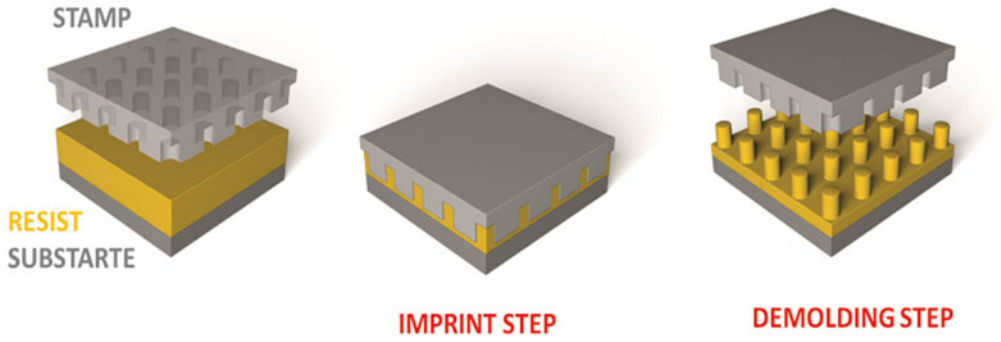
NEW PROJECTS & MILESTONES

The Nanoimprint Lithography Platform is constantly developing novel approaches and methods for nanoscale device-related research. This flexible fabrication laboratory has pioneered research in nanofabrication (nanoimprint lithography, incl. NIL and roll-to-roll, nano-injection moulding, self-assembly and others) with the aim of demonstrating the feasibility of 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 thick wafers onto various materials and substrates. We combine imprint-based lithography techniques to achieve large area micro/nano structured functional surfaces.

Our advanced manufacturing technology has been developed to the point where 3D and sub 50 nm patterning is feasible, with high throughput capabilities.

The added functionality allowed by introducing micro/nano structures onto surfaces will have a big impact on various industrial sectors. Sustainable production and products can be expected from our novel manufacturing approach, enhancing the performance of targeted products by improving their functionality and keeping production costs down.

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 effects depending on their distinctive mechanical behaviours.



Schematic illustration of the NIL process

His research work focuses on the study and development of novel nanomanufacturing methods based on imprint lithography. In recent years, his research efforts have been focused on developing nano-enabled plastic components and devices with bio-mimetic 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.

CONTRIBUTIONS

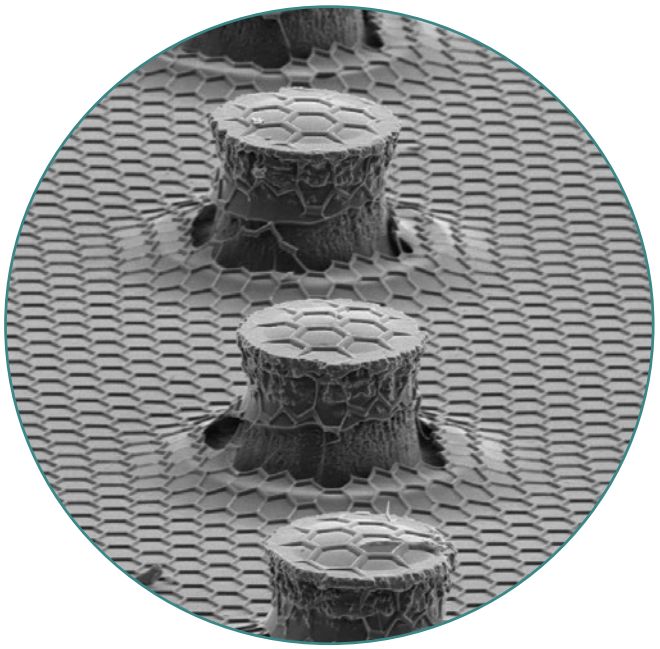
Advanced production technologies for multi-functional nano-structured plastic components, **US-Singapore Bilateral Workshop on Nanomanufacturing**, Singapore, Singapore, 26/02/2016, N. Kehagias (invited speaker)

ICN2 Nanoimprint Lithography Platform, **EPIC Annual General Meeting**, Zurich, Switzerland , 22/04/2016, N. Kehagias (invited speaker)

Hybrid manufacturing technologies: utilizing nanoimprint lithography for high rate/volume production of nano-enabled plastic components, **2016 MRS fall meeting**, Boston, USA, 28/11/2016, N. Kehagias (invited speaker)

PROJECTS

Project PLAST-4-FUTURE (www.plast4future.eu) funded by **FP7-2012-NMP-ICT-FoF**.



Management and Services

The 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 seven departments, reporting to the General Manager: namely, **Competitive Funding, Finance, Human Resources, Information Technologies, Knowledge and Technology Transfer, Maintenance and Safety** and **Marketing and Communication**. Additionally, the **Strategy Development Department**, a young and evolving structure, reports directly to the Director. Each department has been designed and scaled to provide services to the whole of the ICN2 community, including its 17 research groups and 6 technical support divisions and facilities.

COMPETITIVE FUNDING

The Competitive Funding Department is devoted to supporting the researchers in managing competitive funding bids and projects in compliance with the terms and requirements of the various funding agencies throughout the life of each funded project. This includes providing comprehensive support for the preparation and submission of proposals and, upon grant acceptance, fulfilling all administrative and reporting requirements for active grants, as well as budget management.

The philosophy of the department is based on establishing a fluid dialogue with the researcher in which the assigned project manager becomes the go-to contact for all the steps related to project management. In this way, researchers can devote their time almost exclusively to the technical development of their project, minimising their involvement in financial control and deadlines.

FINANCE

The Finance Department is split into two areas: administration and accounting. The administration team oversees all of the centre's administrative functions. Each research group, division, facility and department has a contact person responsible for administrative tasks in order to ensure fluid communication with the Finance Department and to adapt the service to the specific needs of the unit in question. Sales and billing management is also carried out by this team, providing support to the Knowledge and Technology Transfer Department and the research support divisions.

Meanwhile the accounting team is responsible for overall financial reporting and control. Reporting is carried out both internally and externally, in fulfilment of the Institute's legal obligations as set out by the Spanish tax office and other public bodies, patrons, dashboards and internal economic reports. Among its responsibilities are financial analysis, budget monitoring, treasury and public tenders.

HUMAN RESOURCES & EDUCATION

The Human Resources Department focuses on the people of the ICN2, providing effective talent attraction, selection, development and assessment processes, as well as a set of user-friendly guidelines and tools. Its mission is to support growth and career development through the cultivation, together with all ICN2 members, of an attractive institutional environment.

The department policies contribute to making the ICN2 a workplace people enjoy working at, where they can share their experiences and exchange new ideas. The Institute was awarded the HR Excellence in Research Badge by the European Commission, in recognition of its a commitment to career development, equal opportunities, transparency and favourable working conditions.

INFORMATION TECHNOLOGIES

In 2016, the IT department continued the implementation of the infrastructure for the ICN2's headquarters (network, IP communications, firewalls, etc.). The Department provides support to all of the ICN2.

KNOWLEDGE AND TECHNOLOGY TRANSFER

The ICN2 Knowledge Technology Transfer Department offers a specialised service to evaluate, protect and transfer the research outcomes developed at the ICN2 to industry and society in general.

Among the major goals achieved by the department in 2016 are four European patent (EP) applications, two Spanish patent (ES) applications, two United Stated patent (US) applications, five PCT extensions filed, three granted patents, three patent licensing agreements and the creation of three new spinoff companies.

MAINTENANCE AND SAFETY

The Maintenance and Safety Department has been working with the ICN2 workforce since 2007. It manages all building facilities and plays a key role in the configuration of new spaces. Its members work to keep over 40 laboratories in optimal condition.

The department also oversees management of external service providers (cleaning, gardening, reception, security guard, courier, post, etc.).

Another of the department's main roles is to coordinate the Risk Prevention Plan, supervising and editing all safety procedures. Additionally, it organises the annual routine medical check-ups offered to all ICN2 members and liaises with health and safety-related companies.

MARKETING AND COMMUNICATION

The Marketing and Communication Department offers a range services to enable and encourage the dissemination of the knowledge generated at the ICN2, thereby maximising its impact across all stakeholder groups.

Among its responsibilities is the management of the ICN2 website, social networks and institutional image. It offers the ICN2 community specialist illustration and graphic design services to ensure that the quality of visual support material is on a par with the science being developed. Specifically this service is used to produce visuals for papers published in major journals, as well as for internal and institutional communications. The department also supports and leads the organisation of high-impact events in the field of nano research. Another key task is the management of public and media relations.

This department also leads a series of outreach projects to support the dissemination of the research conducted at the ICN2 and raise its public profile. In 2016 the department made contributions to a successful FECYT proposal, as well as two H2020 project proposals. Such projects enable the development of nano-related classroom resources and training sessions for school teachers.

STRATEGY

The ICN2 Strategy Department, in cooperation with four of the research centres associated to the Barcelona Institute of Science and Technology (BIST), led the coordination of two successful H2020 Marie Skłodowska Curie COFUND proposals. These two projects are international, multidisciplinary and intersectorial academic programmes that will train 24 predoctoral and 61 postdoctoral fellows over the next five years. These ambitious programmes bring together research centres, universities, hospitals and private companies and are expected to deliver excellent quality and high-impact research and innovation outcomes.

Scientific Output

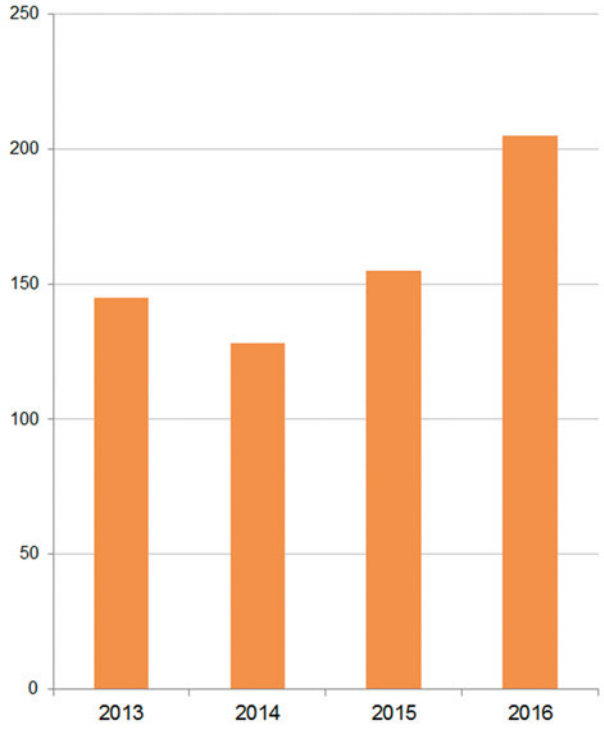
PUBLICATIONS

The scientific production of the ICN2 has grown considerably over 2016: total number of indexed publications rose to 206 (from 155 in 2015), while average impact factor also increased to 6.75 (from 6.58 in 2015).

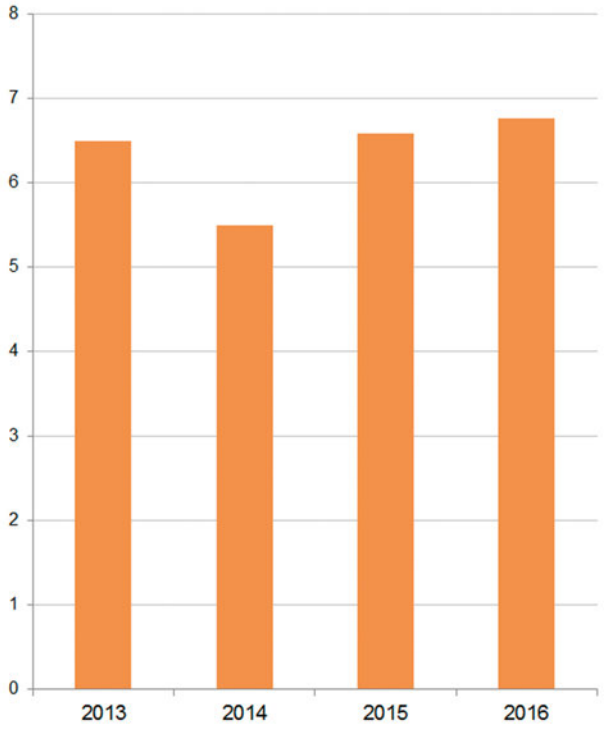
TOP 10 journals

Journal	IF	articles
Nature	38.138	2
Nature Nanotechnology	35.267	1
Advanced Materials	18.96	2
Advanced Energy Materials	15.23	1
Nano Letters	13.779	12
ACS Nano	13.334	2
Journal of the American Chemical Society	13.038	3
Coordination Chemistry Reviews	12.994	1
Angewandte Chemie - International Edition	11.709	2
Nano Energy	11.553	3

Evolution of number of indexed publications at ICN2



Evolution of average impact factor at ICN2



ICN2 EVENTS

ICN2 researchers, with the support and collaboration of the administrative departments, have forged a role at the forefront of European nanoscience and nanotechnology, including the organisation of international events that attract scientists to Barcelona from around the globe.

Among the outstanding examples of events organised by the ICN2 are:

Festival Diez a la Menos 9
April 2016, UAB Campus

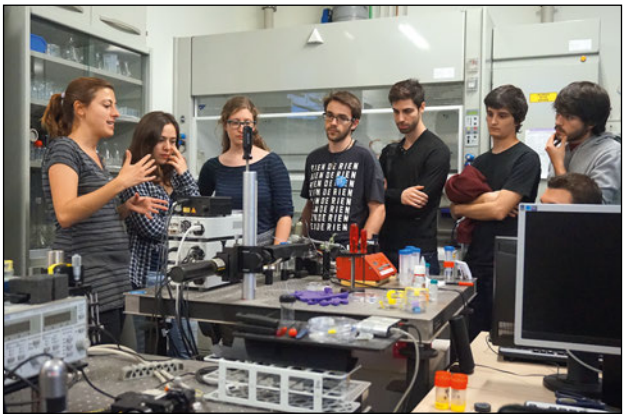
- A dissemination event organised in collaboration with the *Universitat de Barcelona* (UB), *Universitat Autònoma de Barcelona* (UAB), *Instituto de Nanociencia de Aragón* and nanoGUNE, to bring nanoscience closer to society.
- The ICN2 coordinated the events developed at UAB Campus.

NanoEduca
April 2016, Barcelona - CCCB

- The closing event of the NanoEduca pilot programme brought together over 200 secondary school students at Centre de Cultura Contemporània de Barcelona (CCCB).
- The project is developed in collaboration with the UB, UAB and CESIRE.

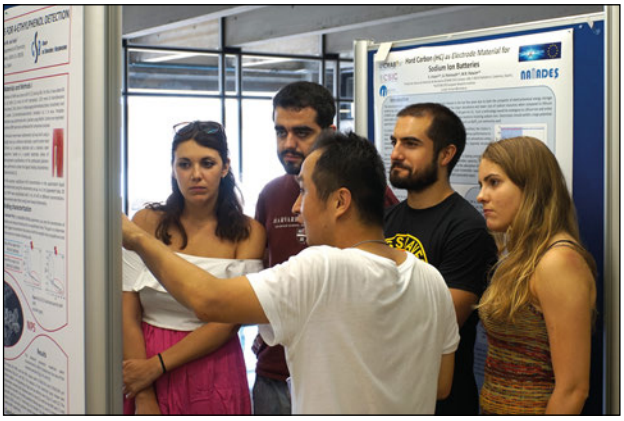
ICN2 Careers Day
May 2016, ICN2

- The ICN2 opened its doors to students in the final year of their undergraduate or Master's degree.



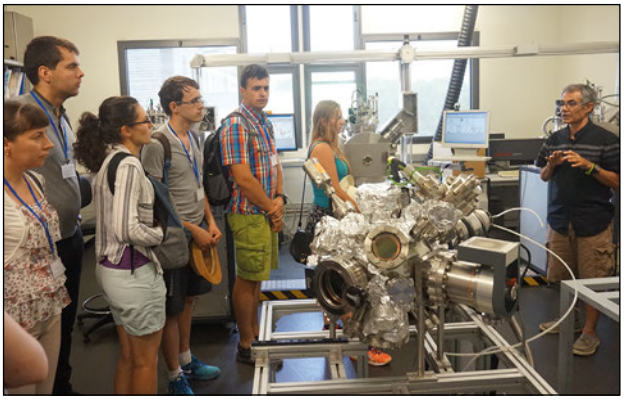
2nd Scientific Meeting of BNC-b Students
29 June, 2016

- Over a hundred students participated in this meeting and had the opportunity to share experiences and research from different areas of nanoscience.
- The PhD Movie 2 was shown, followed by a debate on the first stages of a career in science career.



1st NFFA-Europe Summer School Nanoscience Foundries and Fine Analysis (NFFA), available instruments and techniques
Barcelona (Spain), 18-22 July, 2016

- The school is one of the training activities organised by NFFA-Europe, a research and innovation action (RIA) under the H2020 research funding programme.



ICN2 Summer School
Summer 2016, ICN2

- The ICN2 opened its doors to students in the final stages of their university education.
- Over 600 candidates applied to the 1st ICN2 Summer Fellowship Programme.

Fuerzas y Túnel 2016
5-7 September 2016, Girona

- A 2-day biennial conference to brings together the Spanish community working on scanning probe techniques organised by the ICN2 and supported by the ICN2 Severo Ochoa Award.
- This year some 100 participants came to share the experience.
- It included dissemination activities to showcase the research conducted at the ICN2 at the nanoscale.

UAB Workshop: "Excellence 2016. Strategies towards achieving a top level of scientific excellence at the UAB Campus"
October 2016, Campus UAB - CRAG Auditorium

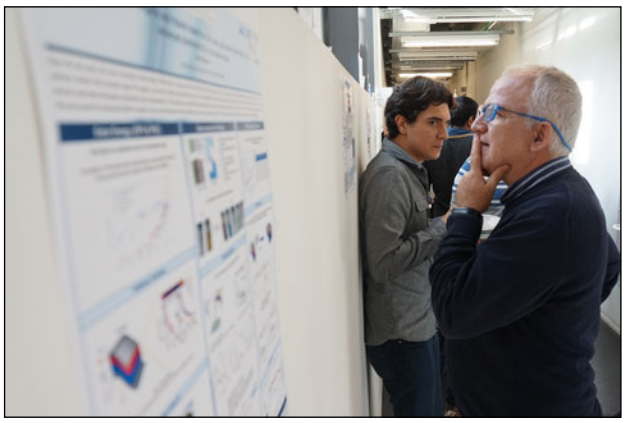
- Five Severo Ochoa Centres of Excellence and two María de Maeztu Units of Excellence are based at the UAB Campus in an unprecedented concentration of research excellence.
- The event offered the opportunity to compare and discuss the policies and strategies pursued to achieve excellence at the participating centres.

BIST Postdoc Day
21 November, Barcelona

- An event to establish links among the six institutes forming BIST.

ICN2 Severo Ochoa Workshop
7-8 November, Campus UAB

- An event to offer an overview of the achievements made possible through the ICN2 Severo Ochoa Programme.

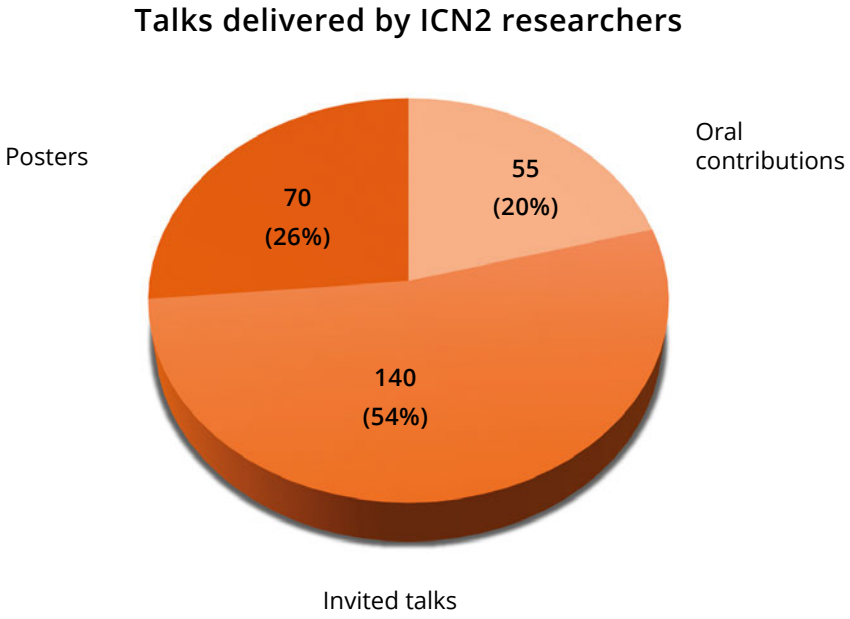


X Aplicaciones Industriales de la Nanotecnología (AIN)
November 2016, Zaragoza

- A yearly event co-organised with the Instituto de Nanociencia de Aragón (INA). With the support of LEITAT and the Chamber of Commerce, INA brings together innovation, discussion and interaction in a unique event.
- Over 15 speakers
- More than 100 participants

EVENTS IN WHICH ICN2 RESEARCHERS PARTICIPATED

In 2016 ICN2 researchers made 265 contributions to conferences related to nanoscience and nanotechnology. A breakdown of their contributions is shown in the following graph:



ICN2 BOOTH IN TRADE SHOWS AND FAIRS

The Knowledge and Technology Transfer, and Marketing and Communication departments promote the active participation of the Institute in major international events on nanoscience and nanotechnology. The institutional booth travels with ICN2 representatives to events such as:

Mobile World Congress
February 2016, Barcelona – Fira Gran Via

- The ICN2 was one of the institutions selected to showcase graphene-based devices at the Graphene Flagship's Graphene Experience Zone.
- Brain-computer interfaces and flexible printed electronics were presented at the ICN2 booth.

NanoSpain
March, Logroño – RiojaForum

- Since 2004 this event has been a highlight in the Spanish nanoscience and nanotechnology calendar, serving as a link between industry and researchers.

Graphene 2016
April, Genova – Porto Antico di Genova Centro Congressi

- This year was the 6th edition of the Graphene Conference series, the largest event in Europe on graphene and 2D materials
- In addition to its institutional booth, the ICN2 was very involved in the event organisation.

IDTechEx Show! Europe 2016
April, Berlin - Estrel Berlin Hotel and Convention Center

- Since 1999 IDTechEx has provided independent market research, business intelligence and events on emerging technology to clients in over 80 countries.
- The ICN2 graphene-based printed and flexible electronics were showcased at this year's event.

GraphChina 2016
September 2016, Qingdao

- The central theme for this year's the event was "New power, new trend and new development", bringing together over 2000 attendees.
- It was organised by the China Innovation Alliance of the Graphene Industry (CGIA).
- Several ICN2 representatives offered an overview of ICN2 graphene-based technologies.

Naturejobs Career Expo 2016
September 2016, London – Business Design Centre

- More than 50 exhibitors from all over the world took part in this careers event.
- Together with fellow BIST members, the ICN2 HR department travelled to London to promote the ICN2 brand and job offers.

GraphIn
December 2016, Barcelona – Parc Científic de Barcelona

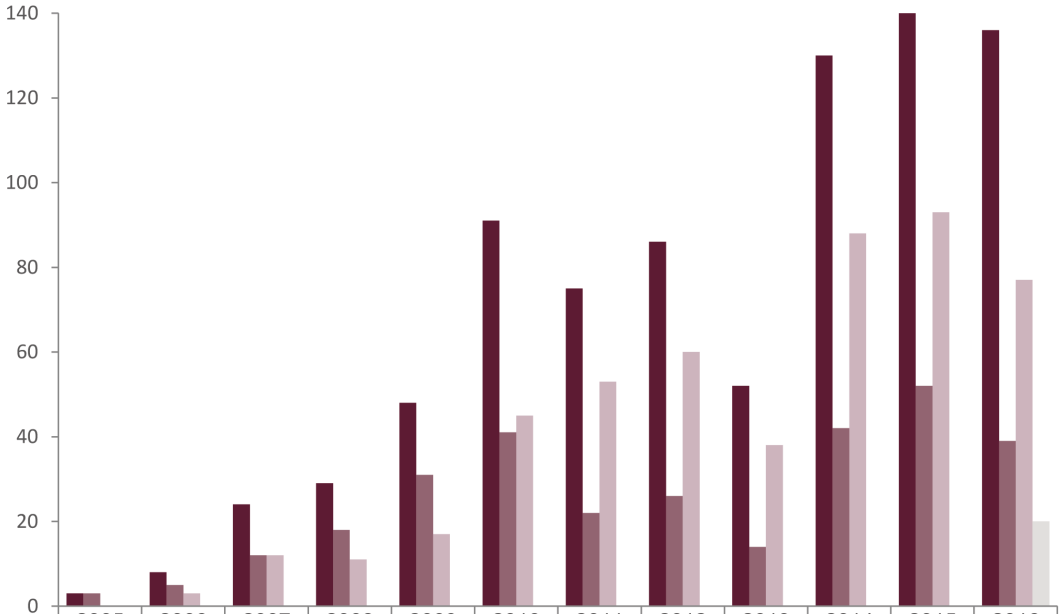
- This one-day workshop aims to present the current state-of-the-art and the opportunities afforded by graphene-based materials and devices, as well as the related industrial challenges.

Projects

In 2016 a total of 136 proposals were submitted by the ICN2 community. We are still awaiting the outcome of some of these submitted proposals, but so far the amount granted to the ICN2 from different sources of competitive funding consolidates a growing trend.

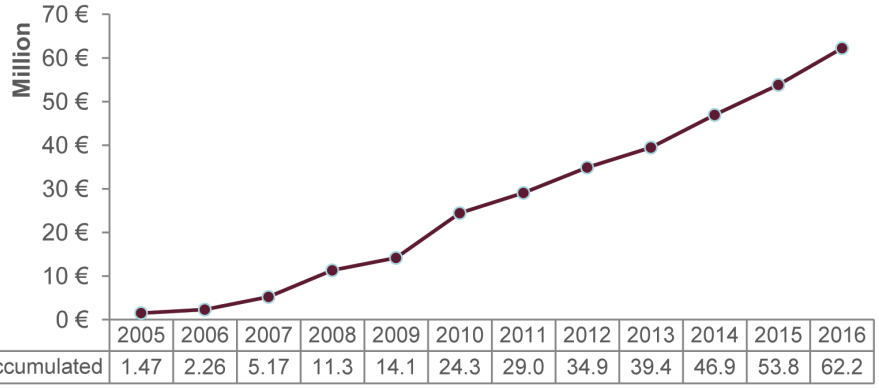
The breakdown of competitive funding at the ICN2 for 2016 is illustrated in the following charts:

Proposals submitted by year (results as of 30/04/2017)



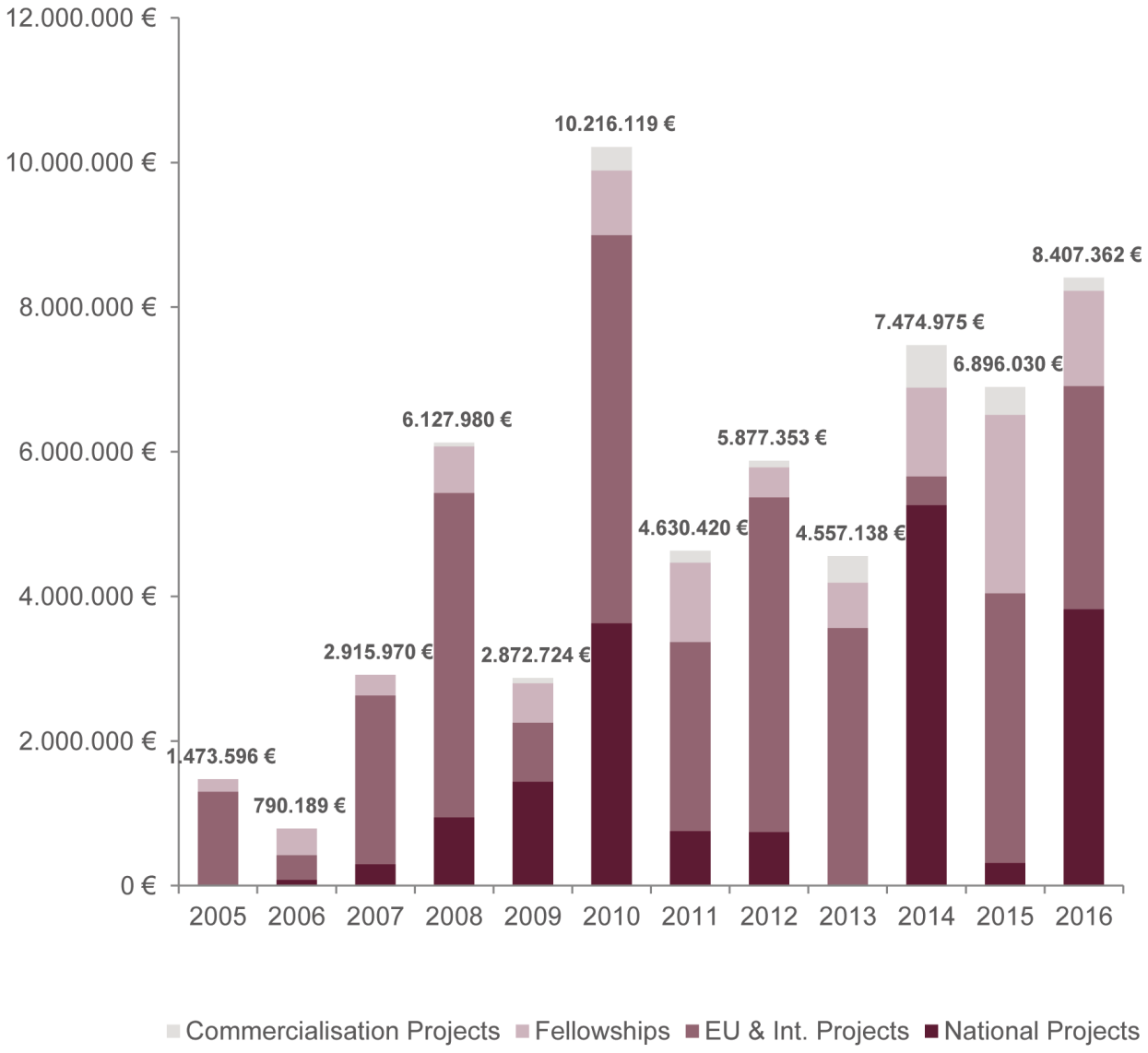
	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Requested	3	8	24	29	48	91	75	86	52	130	145	136
Approved	3	5	12	18	31	41	22	26	14	42	52	39
Rejected	0	3	12	11	17	45	53	60	38	88	93	77
Pending	0	0	0	0	0	0	0	0	0	0	0	20

Proposals approved by year (independently of the year of application)



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Accumulated	1.47	2.26	5.17	11.3	14.1	24.3	29.0	34.9	39.4	46.9	53.8	62.2

Proposals approved by year
(independently of the year of application)



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Commercialisation Projects	-	-	-	53,709	74,580	325,964	161,570	91,475	365,236	586,121	385,816	180,094
Fellowships	175,400	367,600	284,935	642,237	544,832	892,343	1,100,560	416,372	627,672	1,228,292	2,466,735	1,320,638
EU & Int. Projects	1,298,196	341,415	2,333,548	4,486,646	817,276	5,368,981	2,615,393	4,627,620	3,564,229	400,143	3,729,431	3,085,566
National Projects	-	81,174	297,485	945,388	1,436,035	3,628,829	752,897	741,886	-	5,260,418	314,048	3,821,062

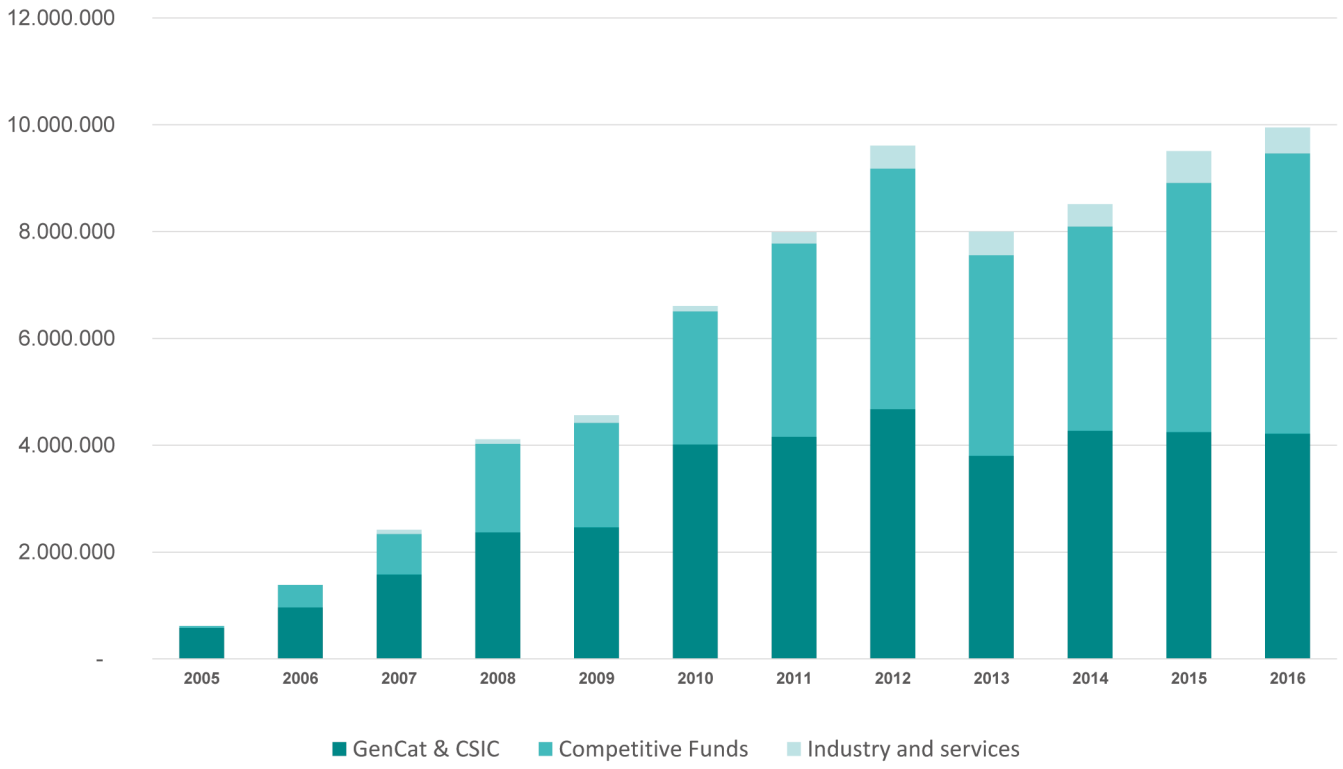
Finances

FINANCIAL ACCOUNTS 2016

In 2016 the Finance Department has continued to implement the SAP B1 system, developing the web area where budget managers can monitor performance.

This year we have worked towards two goals: the first to improve communication and tailor the service to the needs of the different groups and departments, and the second to begin to offer financial information to all users.

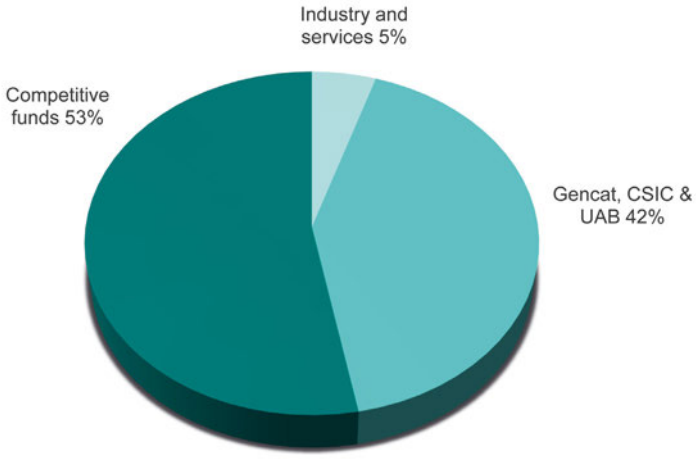
Evolution of ICN2 operational funds



	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Industry and Services	-	436	77,817	84,780	141,657	97,601	210,633	430,032	441,151	417,634	593,302	485,478
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	5,250,045
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	4,214,581

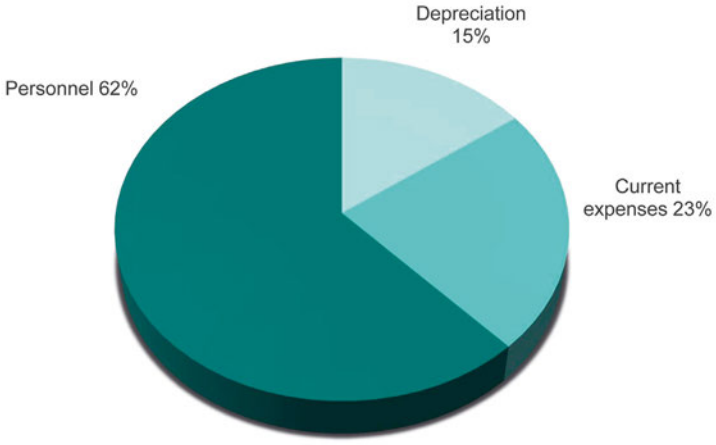
INCOME

The ICN2's total operating funds in 2016 stood at €9,950,104, of which 42% were obtained from Gencat and CSIC, 53% were from competitive funding calls, and 5% came from industry and services.



EXPENSES

Total expenditure in 2016 came to €9,935,523, including current expenses, personnel costs and depreciation.



Facilities and Equipment

In 2016 the ICN2's total accumulated investment, including scientific equipment, common services and general infrastructure, was €19,757,140. Investment in 2016 stood at €1,034,413.

The main scientific, technical and IT equipment acquired in 2016 are as follows:

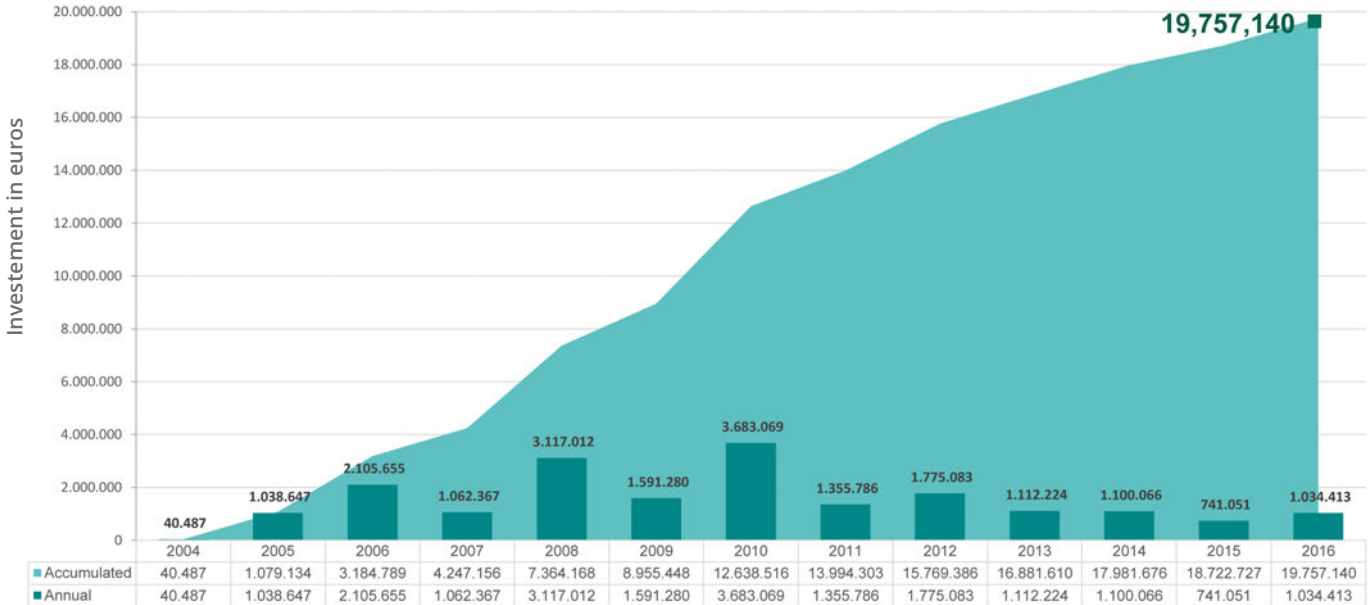
- Surface profilometer with nanoscale measurement resolution
- High-voltage generator for X'pert PRO MRD system
- Glove box for UNIVEX 350G
- Test bench
- Vacuum heater
- Tunable laser (high voltage)
- Molecular beam epitaxy
- Thermogravimetric analyser
- Cobolt solid state laser

Equipment funded using FEDER funds:

- RAMAN microscope system
- Chemical vapour deposition (CVD) for graphene synthesis
- Profilometer
- Small nanofabrication lab

Unió Europea
Fons europeu de desenvolupament regional
Una manera de fer Europa

Evolution of ICN2 total investments, 2004-2016



	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016
Accumulated	40.487	1.079.134	3.184.789	4.247.156	7.364.168	8.955.448	12.638.516	13.994.303	15.769.386	16.881.610	17.981.676	18.722.727	19.757.140
Annual	40.487	1.038.647	2.105.655	1.062.367	3.117.012	1.591.280	3.683.069	1.355.786	1.775.083	1.112.224	1.100.066	741.051	1.034.413

Technology Transfer

In 2016 the Knowledge and Technology Transfer Department furthered its efforts to protect and commercialise ICN2 research results, establishing new R&D and licensing contracts with industry, new collaborations with the private and public sectors, new spinoffs and new networking channels.

INTELLECTUAL PROPERTY AND SPINOFFS

Four new European patent (EP) applications:

- *Synthesis of UiO-66 by Spray Drying combined with continuous flow*. Supramolecular Nanochemistry and Materials Group. Daniel Maspoch, Inhar Imaz and Luis C.Garzón.
- *Ceria nanoparticles for use in the treatment of hepatocellular carcinoma*. Inorganic Nanoparticles Group. Víctor Puntes.
- *A hybrid hyperthermia device, and methods using the same*. Magnetic Nanostructures Group. Josep Nogués, Borja Sepúlveda, Alejandro Gómez and José Luis Elvira.
- *A process for the post-synthetic modification of metal organic frameworks*. Supramolecular Nanochemistry and Materials Group. Daniel Maspoch, Inhar Imaz Sabina Rodríguez and Luis C. Garzón.

Two Spanish patent (ES) applications:

- *Catechol-based molecules for functional coating applications*. Nanostructured Functional Materials Group. Daniel Ruiz-Molina, Josep Sedó and Juan Mancebo.
- *Película de material polimérico con propiedades termo-fotocrómicas para regulación del color de superficies acristaladas y materiales plásticos*. Nanostructured Functional Materials Group. Daniel Ruiz-Molina, Claudio Roscini and Alex Julià.

Two US patent (US) applications:

- *Method to treat antimicrobial resistant infections by electric current*. Inorganic Nanoparticles Group. Víctor Puntes.
- *Thermotherapy method to treat antimicrobial resistant infections*. Inorganic Nanoparticles Group. Víctor Puntes.

Three granted patents:

- Patent ref. ICN PAT 01/08 *Conjugates comprising nanoparticles coated with Platinum containing compounds*, granted in Canada on 11 April 2016.
- Patent ref. ICN PAT 01/11 *Method for the preparation of metal organic frameworks*, granted in the United States on 2 February 2016.
- Patent ref. ICN PAT 07/09 *Biogas Production*, granted in Canada on 4 May 2016.

Five international PCT extensions filed:

- *Graphene-based electroactive nanofluids as liquid electrodes in flow cells.*
- *Flexoelectric device.*
- *Electrode material comprising silicon nanowires covered by mesoporous oxide nanostructured coating and ionic liquid electrolytes for energy storage applications.*
- *Method for monitoring radius and shape variations of atomic force microscope cantilever tips and device thereof.*
- *Nanoemulsion optical materials.*

Three patent licensing agreements:

- For the patent *Synthesis of UiO-66 by Spray Drying combined with continuous flow*, signed with a European company. The license agreement includes an ongoing collaboration project with said company. It is the second ICN2 patent licensed to this company.
- For the patent *Nanoemulsion optical materials*, signed with the ICN2 spinoff company FUTURECHROMES, S.L.
- For the patent *Graphene-based electroactive nanofluids as liquid electrodes in flow cells*, signed with the ICN2/CSIC spinoff company EARTHDAS, S.L.

Three new spinoff companies:

- PaperDrop Diagnostics, S.L.
- Earthdas Graphene Powered Mobility, S.L.
- Graphenicalab, S.L.

OTHER HIGHLIGHTS

Other technology transfer activities include new contacts and meetings with more than 118 companies, 38 signed NDAs, seven patent license discussions, eight signed R&D contracts, 34 R&D services, 13 technology assessments, two in-house IP training sessions, two industrial doctorates with local industries and the evaluation of 9nine spinoff companies.

The department has participated in the following relevant trade fairs: Mobile World Congress, Transfiere, Nanospain, Grahene Connect and the 10th Aplicaciones Industriales de la Nanotecnología (AIN), among many others.

An additional industrial secret related to edible micro-nanoestructures has been filed.

Public Outreach

Beyond the ICN2's principal mission to be a leading international centre for cutting-edge research in nanoscience and nanotechnology, the Institute also has a social responsibility in the area of science communication and education. As a publicly-funded research institute, the 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 the ICN2's future success in the research arena. Furthermore, providing content created specifically for the general public is essential to ensuring that they understand the implications of the Institute's research and its applications.

La dimensió nano

Diagnóstico veterinario con nanopartículas de oro

El futur del grafè en medicina: implants al cervell i l'ull

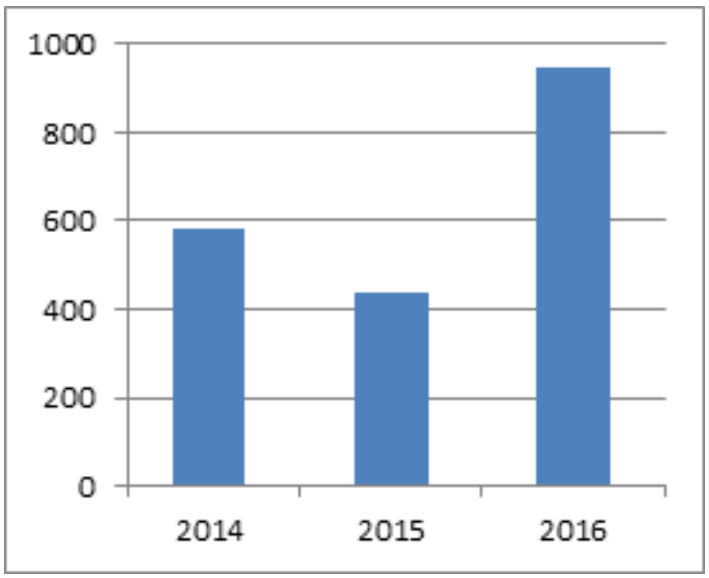
Sensores y biomedicina, la apuesta catalana por el grafeno

Microencapsulación para suavizantes con olor más duradero

Media relations: In 2016 the ICN2 redoubled its efforts to reach the general public through the media. Close working relationships with journalists and eight press releases resulted in 16 newspaper articles that mention the ICN2, five radio interviews, three TV appearances, including an extensive presentation of the Institute at TVE's Lab24, and the publication of two magazine feature stories on the ICN2.

The following chart shows the number of online impacts identified on journalistic websites over the past three years.

Number of online journalistic impacts per year
Source: Meltwater news



NanoEduca Kits: Scientists, teachers and communicators work together in an ICN2 co-funded initiative involving the UB, UAB and CESIRE to design a programme to bring nanoscience into the classroom. NanoEduca includes the production of an educational kit of nano-related experiments. The kits are intended to offer teachers a set of interactive experiences involving nanoscience that can be linked to subjects such as Chemistry, Physics, Mathematics and even Philosophy. In 2016 NanoEduca organised the first edition of its science posters contest for secondary school students, which brought together over 200 students at the *Centre de Cultura Contemporània de Barcelona* (CCCB).

In 2015 the *Fundación Española para la Ciencia y la Tecnología - Ministerio de Economía, Industria y Competitividad* (FECYT-MINECO) granted funding for a project that allowed the NanoEduca team to produce 100 kits for distribution to schools throughout Catalonia through the Catalan Ministry of Education. We are currently making new contacts to widen the distribution of the NanoKits to other Spanish autonomous communities and beyond, and collaboration with European educational initiatives have already started. The ICN2 Severo Ochoa programme and the *Fundació Catalana per a la Recerca i la Innovació* (FCRi) also lent their support to the initiative.

Mad for Physics (*Bojos per la Física*): The *Fundació Catalunya / La Pedrera* has developed a programme to open the doors of the region's top research institutes to outstanding secondary school students. The ICN2 and IFAE are the coordinators of this programme.

Now in its second year, this initiative will allow 25 students to come into contact with researchers from the ICN2, IFAE, UAB, ICMAB and ICFO in a series of 16 work sessions. The idea is to design an experimental experience for these students, as well as conveying a sense as to what it's like to be a physics researcher.

Young Ones and Science (*Joves i Ciència*): The *Fundació Catalunya / La Pedrera* offers the most promising secondary school students the opportunity to enjoy a short stay at selected research centres. Traditionally the ICN2 research groups have participated in this initiative to give budding future researchers their first taste of research. The students visit the ICN2 for one to two weeks (30-40 hours), where they are given an overview of what research in a nanoscience lab looks like, followed by a more in-depth experience in a selected area.

ESCOLAB. These lab tours offer young students the opportunity to enter a research facility and interact with real scientists. These activities are short-term actions which, when combined with follow-up activities, form a real bond with budding young students and cause engagement with science in general and nanoscience in particular to soar.

ESCOLAB is an initiative led by Barcelona City Council in which the ICN2 has been present since the outset.

Nano2All: The ICN2 joined the European Nano2All project, an ambitious initiative funded under Horizon 2020 which aims to contribute to an emerging Responsible Research and Innovation (RRI) policy and governance in the area of nanotechnologies. The project promotes the transparent co-production of knowledge driven by the needs of society, and engagement with all relevant stakeholders via the inclusive and participatory activities organised by a dedicated Mobilisation and Mutual Learning Action. In 2017 the ICN2 will organise two debates in Barcelona on the applications and related ethical concerns of brain-computer interfaces based on new materials and nanotechnology.

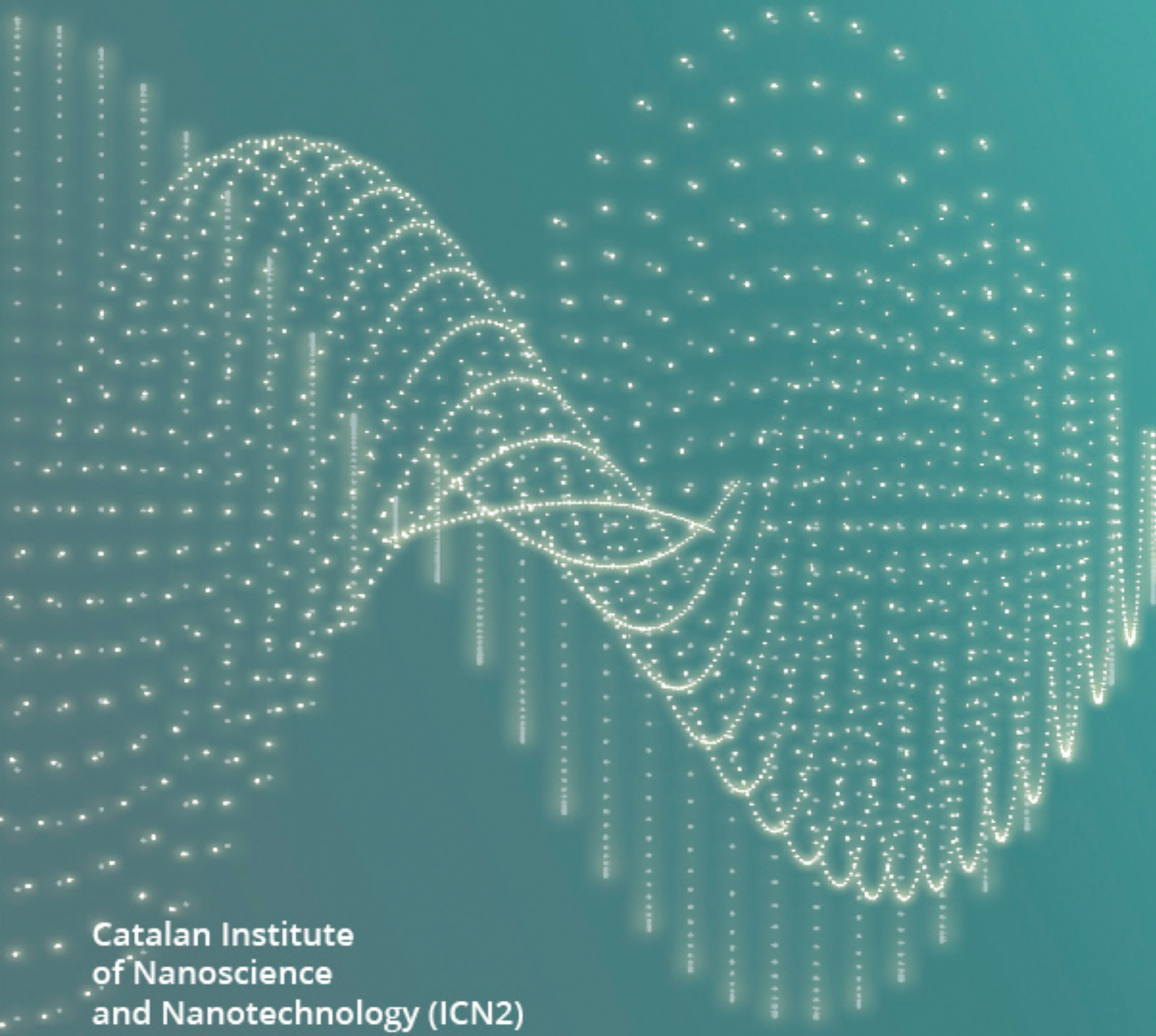
Annual Report 2016

Marketing and Communication Department
June 2017

ICN2

Institut Català de Nanociència i Nanotecnologia

EXCELENCIA SEVERO OCHOA



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