ANNUAL REPORT
2018
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Welcome to the ICMAB Annual Report 2018!

This annual report corresponds to that of the third year of our Severo Ochoa “Center of Excellence” called “Smart FUNctional MATerials for social grand challenges” (FUNMAT). The Research Program includes several scientific and technological actions addressing three very timely social grand challenges: Clean and Secure Energy, Sustainable and low cost electronics and Smart Nanomedicine. The R&D activities are organized following 5 different Research Lines (RLs): RL1: Sustainable energy conversion and storage systems; RL2: Superconductors for power applications; RL3: Oxide electronics; RL4: Molecular electronics; RL5: Multifunctional nanostructured biomaterials. I’m sure you will enjoy reading the provided summaries of our research and the different activities providing evidence of the ICMAB enthusiasm and effectiveness in advancing knowledge and address the critical goals of these challenges.

One of the priorities of our FUNMAT project was the attraction of new talent. The success in this issue has been overwhelming as demonstrated by a huge increase of the total personnel at ICMAB: 80 more people since starting FUNMAT, i.e. 65% increase of non-permanent people, reaching a total of 340 people. We had in 2018 a total of 113 PhD fellows (47% of them from abroad, from 24 different countries), 58 postdoctoral researchers, 34 undergraduate and master students and we also assured 3 new permanent scientists reaching a total of 61. The availability of new spaces in the neighboring MATGAS building has been essential to properly accommodate this outstanding staff growth.

The R&D activities and projects where our researchers have been engaged are neatly deeply diversified. For instance, we have been awarded up to 2018 with a total of 9 ERC Grants (2 more will start soon), additionally, we were also awarded with several new outstanding European research projects. Overall, during 2018 a total of 35 European or international projects were alive which have provided to ICMAB a total budget of 22.2 M€. The total budget for 2018 is similar to 2017 (14.7 M€) and consolidates a 54% growth since starting FUNMAT thanks to a competitive funding of 64%. The success in attracting and managing competitive funds strongly relies on the international leadership of our researchers and also on the support of the Strategic Project Managing Unit build up in the scope of FUNMAT and the general administration and maintenance staff. It is also worth to mention that FUNMAT has strongly promoted the internal synergy among research groups, for instance through the allocation of 24 Frontier Interdisciplinary Projects (FIP).

The scientific production of ICMAB researchers continues to be outstanding and of high quality, a total of 226 articles were published, reaching an average impact factor of the journals of 6.30 in 2018. As an indicator of our outstanding impact we should also mention that ICMAB reached the highest CSIC Nature Index per researcher and the second position in absolute values. We continue also to increase the total number of citations (> 145.000 at the end of 2018 from 5,223 publications). Our researchers are widely selected to lecture in international conferences as reference speakers and they receive awards and recognitions.

“ICMAB has been a very active and enthusiastic research center in advanced materials during our already long history, more than three decades”
The scientific highlights that we selected for this report correspond to outstanding publications of the different Research Lines. I’m sure you will enjoy reading those presentations about the diverse topics investigated at ICMAB. They cover contributions at the frontiers of materials research. You will see how we envisage novel research opportunities to make synthesis and processing of materials, how we use or develop new advanced tools to characterize or simulate properties of materials and also how these materials are integrated into devices or adapted for competitive practical applications, bringing appealing opportunities for technological innovation. You will see how we tune optical properties of sustainable colloids through plasmonics, of low cost photovoltaic cells or inorganic nanotube heterostructures, you will further understand how complex in the chemistry of batteries and supercapacitors and how we can make them more competitive. Multifunctionality of complex oxides remains a topic where ICMAB is extremely active: new magnetic, ferroelectric or superconducting epitaxial thin films with controlled nanostructures and defects show a plethora of attractive properties useful for information technologies or power applications. Understanding and controlling the electronic properties of molecular materials at the nanoscale is shown to be a very rich source of appealing properties which the ICMABers know how to design and use in electronic devices. Finally, remarkable and very promising advances on materials for nanomedicine are demonstrated, materials for a clean and secure energy, materials for low-cost electronics, and materials for nanomedicine.

In conclusion, we are sure that this report will help to spread the vitality of ICMABers, to widely transmit the many new ideas and achievements we have made and our passion for progressing towards a better future. For more information about the ICMAB activities you can access the website version of our report (https://resources.icmab.es/annualreport2018/).

Enjoy the tour!

Xavier Obradors
ICMAB Director
CENTER OF EXCELLENCE

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This group is addressed to explore, understand and develop new strongly correlated materials of interest in fundamental condensed matter research and as novel materials for the Information technologies. The activities of the group are based on the application of chemical and magnetic crystallography methods to the investigation of emergent functional oxides. Combining an intensive use of Large Scale Facilities (such as neutron and synchrotron sources) with symmetry analysis methodologies, we investigate the symmetry-properties relationship associated to structural, magnetic or electronic orders in functional oxides.

departments.icmab.es/cmeos

Crystallography of Magnetic and Electronic Oxides and Surfaces (CMEOS)

Prof. José Luis García-Muñoz

He has a wide expertise on strongly correlated functional oxides, their preparation, fabrication and advanced characterization with emphasis on the application of scattering methods. Group leader of CMEOS, its current scientific interests include spin-charge-orbital order phenomena and instabilities in frustrated magnetic and electronic materials, the study at atomic-scale of physico-chemical mechanisms in materials for oxide electronics, and the symmetry phenomena in commensurate and incommensurate novel magnetoelectric multiferroics with strong coupling of the ferroic orders.

Dr. Xavier Torrelles

He is graduated in Physics with a PhD in Physical Sciences. His scientific interest are focused on the design of switchable ferroelectric buffer films as support of TiO₂ catalysts for water splitting and gas-liquid-solid-molecular interfaces with oxide-metal crystals to deepen in the knowledge of fundamental surface interactions.
Crystallography Group

The aim of the group is to explore, understand and develop new strongly correlated materials of interest in fundamental science, such as studies of intermolecular interactions, and in the improvement of methods for crystal structure determination from electron diffraction data. The group has developed the new through-the-substrate (tts) X-ray microdiffraction technique, integrated now at ALBA Synchrotron, and has a great expertise in nanocomposite porous materials, applied to different catalysis reactions.

departments.icmab.es/crystallography

Inorganic Materials & Catalysis Laboratory (LMI)

The focus of the group’s scientific activity is in the chemistry and applications of boron cages. Their geometric forms and the fact that they are made of a semi-metal, boron, give them unique properties largely unexplored. Today, the chemistry of boron clusters, has achieved a sufficient degree of maturity that has led to new applications, in many cases not attainable with conventional organic compounds. For instance, boron clusters readily offer structural hollow spheres, something that is utterly difficult with organic compounds. Boron clusters are applied in this group in the fields of energy, environmental science, molecular electronics and medicine.

departments.icmab.es/lmi

Prof. Jordi Rius Palleiro
Graduated in Geology and holds a PhD in Natural Sciences from the Philipps-Universität (Marburg). His main research area is Crystallography, more precisely the design and subsequent implementation of X-ray diffraction phasing algorithms for the non-routine determination of relevant crystal structures in Chemistry and Mineralogy.

Dr. Xabier M. Turrillas
PhD in physics and Materials Science, is interested in material characterization by X-ray diffraction, to discover the microstructure of the materials and their properties. He is detached at ALBA Synchrotron, in the Experiments Division.

Prof. Elies Molins
PhD in Physics, is interested in how the microscopic structure of materials influences its macroscopic behavior. He is specialist on single crystal X-ray diffraction, Mössbauer spectroscopy and aerogels and related porous materials.

Prof. Carles Miravitlles
Prof. Carles Miravitlles has always combined his research in crystallography and characterization of materials with multiple responsibilities during his career, such as Director and Founder of ICMAB (1986-2008). He is now Ad honorem Research Professor at ICMAB.

Dr. Ignasi Mata
Dr. Ignasi Mata’s research interests are Mössbauer spectroscopy and X-ray diffraction on pharmaceutical products, preparation of nanoporous materials for thermal insulation and catalysis, computational chemistry studies of intermolecular interactions in molecular crystals, and synthesis and characterization of co-crystals.

Dr. Mónica Benito
PhD in Chemistry, is interested in the synthesis and characterization of aerogels, and their functionalization.

Prof. Francesc Teixidor
Prof. Francesc Teixidor graduated in Chemistry and got the PhD in the same area. He became interested in the boron clusters during his postdoctoral stay. Since then, he has contributed to their development understanding their bonding, developing methods of synthesis and its applications. His current interests are in the electron transfer of metallacarboranes and their applications in energy and molecular electronics.

Prof. Clara Viñas
Prof. Clara Viñas graduate in Chemistry and in Pharmacy and got the PhD in Pharmacy. Her career has been developed in industry, institutional laboratories involved in food science analysis as well as environmental control and research laboratories. Her interest is in the development of new methods of synthesis and derattitization of boron clusters to be applied in medicine, biosensors, sustainable environment and energy.

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Dr. Rosario Núñez holds a PhD in Chemistry, is interested in the chemistry of boron and silicon, including the design, preparation and characterization of boron cluster derivatives and new materials of interest in biomedicine especially in BNCT for cancer treatment, and electronics.

Dr. José Giner focuses on the synthesis, characterization and application of inorganic (boron-based) and inorganic-organic hybrid solids. His focus for several years has been on the development of new clusters-based ligands or linkers for preparing a variety of molecular, supramolecular, and polymeric materials. His areas of interest are new concepts in Metal-Organic Framework (MOF) Chemistry, multifunctional molecular materials and crystal engineering.

Dr. José Giner

Dr. Martí Gich is a materials scientist with a background in industrial R&D. His current activities are focused on understanding functional properties in oxides and their applications in information technologies, preparing nanomaterials by soft chemistry and integrating thin films on technological substrates by physical and chemical methods.

Dr. Martí Gich

Prof. Anna Roig, graduated in Physics with a PhD in Materials Science. She is currently involved in two main research lines: i) nanoparticle synthesis and their validation for medical applications as drug delivery vehicles, contrast agents or in cell therapies, and ii) bacterial cellulose-based materials.

Prof. Anna Roig

Dr. Anna Laromaine holds a Chemistry PhD and her scientific work encompasses chemistry, materials science and biology. She currently focuses in the production of bacterial cellulose and their composites for bio-applications and the evaluation of materials using approaches such as cell cultures and the nematode C. elegans.

Dr. Anna Laromaine

Dr. José Giner

Dr. Rosario Núñez

Dr. José Giner

Prof. Anna Roig

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Dr. José Giner

The group interests relate to the fields of nanoscience and nanotechnology, particularly the areas of molecular electronics, molecular magnetism and biology. We design molecular systems capable of providing inputs at the nano-scale and focus our efforts in the control and organization of such species on different surfaces/nanodevices. The main areas of expertise are synthesis of functional molecules, polymers & supramolecular aggregates characterization of our molecular-based materials and surface studies.

Dr. Núria Aliaga-Alcalde’s work focuses on the relevance and necessity of molecular design in nanoscience, where functional molecules play a key role since they provide homogeneous tunable nanometer-size units and properties ready to be exploited (as reliable sensors, switches, quantum computing materials or molecular electronics). Toward this main idea, key factors are the design of specific molecules (CCMoids, porphyrins and diketone systems) and their control and organization on surfaces/nanodevices where their properties can be tuned. So far, the results accomplished have shown the advantages of these systems as biomarkers (fluorescent properties), molecular transistors (gateable molecular junctions) and as single-molecule magnets (SMMs).

Dr. Núria Aliaga-Alcalde

Dr. Arántzazu González-Campo interests focus on the preparation of multifunctional responsive materials for biomedical and energy applications using supramolecular and surface chemistry. With this aim, she is currently involved in three different projects: i) the development of (bio)chemical functionalization of surfaces, ii) development of supramolecular-based responsive polymers and MOFs and iii) development of biocompatible sensors o biosensors.

Dr. Arántzazu González-Campo

This group has quite diverse research interests but with a focus in the rational synthesis of nanoparticles and nanocomposites and the study of their structural-functional properties including those related to the nano/bio interfaces. We envisage the integration of our materials in devices and products for nanomedicine, information technologies or energy and environment. The NN members participate actively of science outreach and gender equality initiatives.

Nanoparticles and Nanocomposites Group (NN)

departments.icmab.es/nn

Dr. Núria Aliaga-Alcalde

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Functional Nanomaterials and Surfaces (FUNNANOSURF)

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departments.icmab.es/nn

Functional Molecular and Nanostructured Inorganic Materials

Functional Nanomaterials and Surfaces (FUNNANOSURF)

The group interests relate to the fields of nanoscience and nanotechnology, particularly the areas of molecular electronics, molecular magnetism and biology. We design molecular systems capable of providing inputs at the nano-scale and focus our efforts in the control and organization of such species on different surfaces/nanodevices. The main areas of expertise are synthesis of functional molecules, polymers & supramolecular aggregates characterization of our molecular-based materials and surface studies.

departments.icmab.es/funnanosurf

Fluorescent Boron compounds
Molecular Nanoscience and Organic Materials (NANOMOL)

NANOMOL is a research group composed by several labs with wide expertise and recognized excellence in the synthesis, processing and study of molecular and polymeric materials with chemical, electronic, magnetic and biomedical properties. We continuously generate new knowledge in our basic and applied research projects regarding the micro and nano structuring of molecular materials. We offer this knowledge to improve the properties of products manufactured in diverse sectors, such as chemicals, pharmaceuticals and electronics, thereby contributing to increasing their added value.

Prof. Jaume Veciana
Prof. Jaume Veciana has a long expertise in the design, synthesis, and processing of functional (poly)radicals, electroactive, redox, bioactive, etc.) organic molecules/polymers as advanced functional molecular materials and their applications in molecular electronics and spintronics and in molecular nanomedicine.

Prof. Concepció Rovira
Prof. Concepció Rovira’s interests are focused on the design, synthesis, and processing of functional organic molecules as advanced molecular materials and their applications in Molecular Electronics such as unimolecular electronics and spintronics and sensors based on conducting nanocomposite thin-films.

Dr. Nora Ventosa
The research activities of Dr. Nora Ventosa’s Lab are focused on the study and application of molecular soft materials for drug delivery and bioimaging. Green procedures using compressed fluids are developed to facilitate the scale-up of nanomedicines and reach clinical testing.

Dr. José Vidal-Gancedo
Dr. José Vidal-Gancedo’s Lab interests are focused on the design, synthesis and characterization of organic radicals and their application to study the radical behavior in different types of molecules, macromolecules or materials based on them mainly focused on biological applications.

Dr. Marta Mas-Torrent & Dr. Núria Crivillers
Dr. Marta Mas-Torrent’s Lab is focused on the design and synthesis/preparation of new functional molecular materials for their application in organic/molecular electronic devices. Our work ranges from fundamental studies in order to better understand materials properties to a more applied perspective aiming at developing proof-of-principle devices. Dr. Núria Crivillers is in this team.

Dr. Imma Ratera & Dr. Judith Guasch
Dr. Imma Ratera’s Lab interests are focused on the design and synthesis of novel multifunctional organic electroactive and radical molecules and their molecular and supramolecular chemistry. The group is interested in the properties of these molecules once nanostructured as self-assembled monolayer, organic nanoparticles or hydrogels towards applications in different fields such as molecular electronics and biology. Dr. Judith Guasch is in this team.

Dr. Elena Laukhina
Dr. Elena Laukhina is a CIBER researcher specialized in molecular electronics. Her research is focused on flexible films with responsive properties, such as hydroresponsive, conducting, piezoresistive, etc. that can be used as sensors, such as for sensing pressure or temperature.

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Laboratory of Multifunctional Thin Films And Complex Structures (MULFOX)

Research group focused on the development and integration of new materials, basically nanometric oxide thin films, and the exploration of their use in photovoltaics, electronics, spintronics, data storage and computing. These broad and scientifically challenging objectives are currently major social demands, as silicon-based electronics is reaching its limit in size, speed and efficiency, and radically new approaches, energy sustainable, are needed. Specifically, current activities include 1.- the search for disruptive approaches to materials and methods in photovoltaic conversion, 2.- development of materials and devices that, based on polar materials, may allow us to contribute to develop more efficient data storage and brain-inspired computing schemes and 3.- explore data storage and data manipulation alternatives to current methods, by using non-dissipative currents or efficient plasmonic signals.

Advanced Characterisation and Nanostructured Materials (ACNM)

The group’s main scientific goal is to generate both fundamental and applied knowledge for the implementation of functional oxide materials in novel technologies as spintronics. It focuses on functional properties, structural characterization of functional defects, nanodevices, complex oxide thin films, self-assembled materials and nanoparticles for life sciences.

Dr. Gervasi Herranz
Dr. Gervasi Herranz’s research is focused on functional oxide interfaces and photonics, especially in exploiting the optical properties of functional oxide interfaces, apart from their magnetic and transport properties.

Dr. Ferran Macià
Dr. Ferran Macià holds a PhD in Physics and has a background in mathematics and telecommunication engineering. His work and interests are magnetism and spin-dependence electron transport (spintronics) in mesoscopic systems.

Dr. Ignasi Fina
Dr. Ignasi Fina is focused on new materials for electronic applications, with two main research lines: the study of magnetoelectric coupling in antiferromagnetic materials and the study of ferroelectric materials for photovoltaic and neuromorphic computing applications.

Dr. Lourdes Fàbrega
Dr. Lourdes Fàbrega research is focused on the development of cryogenic detectors made of superconductors, for applications in space, materials analysis and quantum information. Her work involves design and fabrication of the devices, with special emphasis on the underlying physics of the superconducting state.

Dr. Lluís Balcells
Dr. Lluís Balcells interests are focused on magnetic materials, including thin films and nanoparticles, for applications in electronics and spintronics.

Dr. Felip Sandiumenge
Dr. Felip Sandiumenge scientific interest is focused on the correlation between structure and function in oxide epitaxial films, with emphasis on the atomic structure and defect chemistry of crystalline defects such as dislocations and domain walls.
Dr. Carlos Frontera

Dr. Carlos Frontera has a long experience in the structural characterization of materials using diffraction techniques (X-ray and neutrons). He has applied these techniques to a wide variety of systems in bulk, nanoparticles and thin films form.

Dr. Alberto Pomar

Dr. Alberto Pomar has a PhD in Condensed Matter Physics. He is an experimental researcher with a core expertise in the electronic and magnetic properties of perovskite-based complex oxides. He is devoted to the development and understanding of new routes to nanostructuration and their implications in the final functional properties of the oxide thin films and heterostructures.

Dr. Albert Verdaguer

Dr. Albert Verdaguer’s research is focused on the interaction of water with surfaces. The interest of the research includes studies of wetting at the nanoscale and the study and design of surfaces to control ice nucleation. He has been involved in the developing of new strategies in Scanning Probe Microscopies to study the solid/liquid interface and more recently in chemical recognition modes.

Prof. Carmen Ocal

Prof. Carmen Ocal’s main research field of interest is surface science: crystallography, growth, chemical functionalization as well as characterization including atomic structure, mechanical and frictional (nanotribology) and electronic properties at the nanoscale. Her group has been always involved in developing strategies using Scanning Probe Microscopies in combination with diffraction and spectroscopic techniques.

Dr. Esther Barrena

Dr. Esther Barrena’s research uncovers the structure-property relationships of organic semiconductors. Her research addresses fundamental interface properties at molecular-scale as well as the nanoscale characterization of organic films in devices (such as organic field transistors and photovoltaics). Her expertise includes real-time x-ray diffraction, organic growth, self-assembly and scanning probe microscopies.

Dr. Esther Barrena

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The strategic research lines of the LPR group are focused on the manufacture of improved functional nanomaterials through innovative laser techniques, to be applied mainly in the fields of energy (batteries, supercapacitors, generation of H2) and environment (photocatalysis). The current areas of work are (i) Laser surface processing and (ii) Deposition and growth by MAPLE and LDW techniques, for fabricating supercapacitor electrodes and photocatalysts based on hybrid nanocomposites constituted by carbon nanotubes, reduced graphene oxide and transition metal oxides nanostructures. The scientific and technical objectives in the medium / long term are oriented towards innovation in laser techniques for obtaining new materials with improved performance, as well as the implementation of these technologies in next generation devices and industrial processes.

Dr. Ángel Pérez del Pino and Dr. Enikö György are the managers of the group. They are specialists in
- Processing of functional nanomaterials by the laser techniques: pulsed laser deposition (PLD), surface processing, matrix assisted pulsed laser evaporation (MAPLE) and laser direct writing (LDW)
- Study of laser-matter interactions, and
- Advanced characterization of nanomaterials.

Dr. M. Isabel Alonso is senior scientist and department head. She is a materials physicist interested in semiconducting structures (inorganic, organic, and hybrid) that can contribute to expand the development of modern optoelectronic, energy-related, and sensing devices.

Dr. Miquel Garriga is research scientist. His main research is in spectroscopic ellipsometry of anisotropic and multilayered materials, optical characterization of bulk semiconductors, organic and inorganic semiconductor heterostructures and high critical temperature superconductors.

Dr. Mariano Campoy-Quiles is PhD in experimental physics from the Imperial College London and currently tenured scientist at ICMAB-CISC. His group aims at producing breakthrough scientific advances that strongly contribute to the development of clean energy technologies based on organic and hybrid materials, including photovoltaics and thermoelectrics.

Dr. Agustín Mihi is an expert in large area and low cost photonic crystal and plasmonic structures via unconventional nanofabrication techniques. His research group investigates the design, fabrication and characterization of photonic architectures that enhance light matter interaction applied to emerging optoelectronic devices.

Dr. Sebastián Reparaz is a tenured track researcher with a strong background in nanoscale thermal transport and optical spectroscopy. His research focuses on studying the thermal properties of inorganic/organic nanostructures through advanced characterization techniques.

The group focuses on producing and characterizing advanced semiconducting structures with the main objective of understanding their fundamental behavior in order to tailor and improve their functionalities and empower different applications in the areas of optoelectronics, energy-related, and sensing devices. The group is divided into 4 different research activities: i) Optoelectronics of group-IV semiconductor nanostructures; ii) Organic-Inorganic Thermoelectrics; iii) Photonic Architectures for Light Management and iv) Organic Solar Cells.
The research interests of the Solid State Chemistry group are centered in the areas of battery materials, inorganic and carbon nanomaterials, hybrid materials, biomaterials and nitride-based materials. The design of new inorganic phases, basing on crystal chemical criteria, mixed-valence character and their modification by chemical / electrochemical doping –cationic or anionic- and by changing the size and microstructure, are among our major objectives. The development of new synthetic methodologies, specific for each targeted phase, is also a defining feature of the group. The investigated materials include high power/high capacity electrodes for rechargeable batteries, electroactive materials for neural growth, drug delivery systems, inorganic nanowires, carbon nanotubes, luminescent and electronic materials and catalysts.
Prof. Teresa Puig

Prof. Teresa Puig, group leader, is an expert in superconducting materials, involving fundamental understanding, preparation and micro/nano structure-property relationships of cuprates. Her main activity focuses on film and nanocomposites growth by chemical methods to give rise to novel functional oxides and heterostructures by cost-effective chemical methods to give rise to novel functional oxides and heterostructures. She is interested in the role of reduced dimensionality at interfaces, and defects by sub-Angstrom resolution, and chemical mapping at atomic level with aberration corrected scanning transmission electron microscopy (STEM-EELS).

Prof. Xavier Obradors

Prof. Xavier Obradors scientific interests include materials preparation, particularly complex oxides, with controlled micro/nano structures and the comprehension of the physical mechanisms underlying their superconducting, magnetic and electronic properties. The development of high critical current conductors and their applications is one of the main focuses at present.

Dr. Narcis Mestres

Dr. Narcis Mestres research focuses on understanding the growth mechanisms and functional properties of new complex oxides nanocoates, thin films and nanocomposites synthesized from chemical solutions, with potential impact in electronics, energy savings and environmental science.

Dr. Xavier Granados

Dr. Xavier Granados contributes to the development of the new HTS engineering power devices, modeling, construction and testing, as well as instrumentation development for experimental research. He participates in Platforms as Futuretred, GEA and EERA for energy storage, and Eurofusion.

Dr. Susagna Ricart

Dra. Susagna Ricart scientific interests include study of chemical and thermal behavior of metalorganic salts in non-aqueous solutions for the CSD approach to superconducting layers. She is particularly expert on synthesis and characterization of nanoparticles, mainly of complex oxide and rare earth fluorides for further applications in the CSD nanocomposite ceramics, biochemistry and catalysis.

Dr. Anna Palau

Dra. Anna Palau scientific interests are mainly focused on the study of the outstanding physical properties functional oxides and in particular vortex matter physics in high temperature superconductors. She has devoted much effort in the opportunities that hybrid superconductor/ferromagnetic structures and advanced nanofabrication technologies can bring to energy efficient electronic devices.

Dr. Mariona Coll

Dr. Mariona Coll scientific interests focus on the processing of functional oxide thin films and heterostructures by cost-effective chemical methods to give rise to novel and enhanced functionalities for energy applications ranging from photovoltaics to superconductivity. She is interested in the relevance of nanometer scale control of materials composition and structure on the device performance.

Dr. Jaume Gázquez

Dr. Jaume Gázquez research concentrates on establishing relations between the structure, chemistry and physical properties of transition-metal oxide nanostructures. In particular, he is interested in the role of reduced dimensionality at interfaces, and defects by sub-Angstrom resolution, and chemical mapping at atomic level with aberration corrected scanning transmission electron microscopy (STEM-EELS).

Dr. Joffre Gutiérrez

Dr. Joffre Gutiérrez expertise is in the field of vortex matter and dynamics in high and low temperature superconductors. In particular, the interactions between microstructure and vortices and how they affect the macroscopic response of superconductors. One of the main focuses is the application of high temperature superconductors to new technologies.
The strategic lines of the Theory and Simulation Group are the simulation of soft-matter, novel functionalities in oxide-based systems, flexoelectricity, thermal transport, electronic and vibrational instabilities in low-dimensional systems and the development and applications of ab-initio simulation codes.
Objectives

The general objectives of the FUNMAT Severo Ochoa project are:

- Achieving a high scientific and technological impact.
- Strengthening the international ICAM network within the functional materials area.
- Enhancing the funding capabilities of the ICAM.
- Enhancing the activities related to outreach and the exploitation of research outcomes.
- Improving the training and recruiting activities of ICAM to attract the best talent.
- Implementing a specific Gender Action Plan aimed to promote gender equality.

Application areas

**CLEAN AND SECURE ENERGY**

The Energy sector is facing a new worldwide paradigm with 20% renewables and 20% decrease of greenhouse emission for 2020. This requires new ways of producing, storing, transporting and stabilizing electricity. The ICAM undertakes this challenge reinforcing its expertise in smart functional materials research and strategically developing cost-effective upscalable technologies, from materials choice all along the value chain process to proof-of-concept devices. Our roadmap promotes greener and cost-effective technologies strengthening materials growth from chemical methods and highlighting additive manufacturing technologies for large area materials at high performance/low cost.

**SMART AND SUSTAINABLE ELECTRONICS**

Current needs in big-data handling are demanding new solutions for the dynamic energy consumption of current computing and data storage devices. Power dissipation and miniaturization are fundamental challenges for nanoelectronic circuits. We envisage sustainable and energy-efficiency approaches to electronics by working along two fronts: exploiting dissipation-less storage and information control by electric fields and involving spin-only currents, rather than charge transport. The use of organic materials/molecules in devices will also provide important guidance towards a new-generation of memories. Great perspectives are expected for the development of devices exploiting the charge as well as the spin of the molecules.

**SMART NANOMEDICINE**

Academia and the innovative industry have directed its interests towards nanomedicine, whose technological breakthrough potentiality is widely acknowledged. It is envisioned that the unique properties of nanomaterials will make a strong impact contributing to solve some of the challenges of Health and Societal Wellbeing. FUNMAT will contribute to Nanomedicine, through improvement of drugs and medicines making them more selective, less toxic, and more efficient. It will also contribute to the advance of medical diagnosis by developing new contrast agents for medical imaging techniques. Further, the use of advanced materials and nanotechnology concepts in synergy with molecular biology will allow the generation of new tools for tissue engineering meaning a giant step for regenerative medicine.
Along with the restructuration of the research, the governance and strategic actions have been updated with the Severo Ochoa mention of Excellence. They include:

**Direction Team**

The Director is Xavier Obradors. The Executive Board is formed by Maria Rosa Palacín and Riccardo Rurali (Deputy Directors) and Imma Moros (Managing Director). Marta Vendrell is the Executive Assistant.

**Governing Bodies**

**Scientific Advisory Board (SAB)**

The Scientific Advisory Board (SAB) is an international committee in charge of the evaluation of the Severo Ochoa Project implementation. It is formed by 12 international members, 11 of which are non-Spanish, and 5 of which are women (42%). The members are:

- Silke CHRISTIANSEN
  Max Planck Institute for Science of Light Erlangen (Germany)
- David LARBALESTIER
  Florida State University; High Magnetic Field Laboratory, Tallahassee (USA)
- Luís LIZ-MARZÁN
  CIC biomaGUNE (Spain)
- Jean-Marie TARASCON
  Collège de France, Chimie du solide et de l’énergie (France)
- David LARBALESTIER
  Florida State University; High Magnetic Field Laboratory, Tallahassee (USA)
- Luis LIZ-MARZÁN
  CIC biomaGUNE (Spain)
- Jean-Mario TARRASCON
  Collège de France, Chimie du solide et de l’énergie (France)
- David LARBALESTIER
  Florida State University; High Magnetic Field Laboratory, Tallahassee (USA)
- Luis LIZ-MARZÁN
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  Collège de France, Chimie du solide et de l’énergie (France)

**Institute Board**

The Institute Board is formed by the Director, the Vicedirectors, the Managing Director, the Heads of the Department, the Staff representatives and the Graduate researchers’ representative. The meetings of the Institute Board are held twice a year.

**Scientific Executive Board (SEB)**

- Mariano Campoy-Quiles
  BL3. Sustainable Energy Conversion and Storage Systems
- Josep Fontcuberta
  BL3. Oxide Electronics
- Marta Mac-Torrent
  BL6. Molecular Electronics
- Immaculada Ratera
  BL5. Multifunctional Nanostructured Biomaterials
- Maria Rosa Palacín - Vicedirector
- Riccardo Rurali - Vicedirector
- Marta Vendrell is the Executive Assistant.
SOMMa is the alliance of Severo Ochoa centres and María de Maeztu units to promote Spanish Excellence in research and to enhance its social impact at national and international levels.

SOMMa was officially launched in October 2017. SOMMa brings together 25 centres and 16 units accredited through these excellence awards and aims to:

- Increase the national and international visibility of the SO and MM programme as an “interdisciplinary and interconnected Spanish research ecosystem of excellence”
- Promote exchange of knowledge, technology and good practices among its members, the international scientific community and key stakeholders.
- Have a voice in Spanish science policy.
- Collaborate with other centres and universities to push forward Spanish science.

100xCiencia meetings

The alliance’s starting activities comprised the establishment of its own governance, the launching of the website (somma.es) and the organisation of task forces to address the different objectives.

SOMMa is organized by a chair, co-chair and project manager, and by a steering committee in charge of different work packages.

The ICMAB participates in “Work package 3: Outreach”, and helps in the organisation of the 100xCiencia meetings.

In 2017, the meeting was held in Alicante, and its topic was “Co-creating value in scientific research” and was focused on technology transfer success stories. In 2018, the meeting was held in Madrid, and the topic was “Bridging science and society” and was more devoted to outreach and educational activities.

The ICMAB Communication & Outreach Officer, Anna May Masnou, is also part of the SOMMa Editorial Board, which is in charge of the website and of the press releases of the SOMMa network.
Mission: contribute in the global energy challenge by advancing in the next generation materials for energy conversion and storage

**Research Lines**

**RL1: Sustainable energy conversion and storage system**

**Mission:** contribute in the global energy challenge by advancing in the next generation materials for energy conversion and storage

- **Strategic fields**
  - Advance in the next generation materials for renewable energy generation:
    - From the sun (photovoltaics): organics, perovskites, boron-based, oxides, nanostructured inorganics, hybrid systems, photonic structures
    - From waste heat (emerging thermoelectrics): organics, nanocarbon (polymer/carbon strategies).
  - Advance in the next generation materials for storage technologies (post-Li-ion battery technologies): hard carbon anodes for Na-ion batteries, electrolytes, anodes and cathodes for Mg- and Ca-based batteries, Zn-air batteries
  - Develop innovative sustainable technologies, replacing critical or toxic materials by others, in the field of metal organic frameworks (MOFs), oxide-nitride layers, carbons and polymeric materials.
  - Advance characterization and theoretical tools that help the understanding of materials for energy (e.g. XRD, AFM/SPM, TEM, IR and Raman spectroscopies, ALBA’s synchrotron lines, theoretical simulations).

- **Highlights 2018**
  - Publications: 72
  - Books: 7
  - PhD defenses: 1
  - Technology transfer: 3 patents filed and contracts (Repsol, Toyota, Enocar …)
  - EU Projects (since 2012)
    - MSCA-IF TELIOTES (2018)
    - MSCA-IF BATCA (2017)
    - ECR-OPEN CARRAT (2017)
    - ERC-SEG GAMBAT (2017)
    - MICA-ITN SEPOMO (2016)
    - ERC-CaG FOREMAT (2015)
    - ERC-CaG ENLIGHTMENT (2015)
    - SOCIETAL-CHALLENGES NAIADES (2015)

**RL2: Superconductors for power applications**

**Mission:** create knowledge on material science and physics of high temperature superconductors to promote their use in energy efficient applications and large scale infrastructures

- **Strategic fields**
  - Low cost and high throughput processing of nanostructured Superconducting Coated Conductors by chemical solution processing and ink jet printing techniques
  - Boost the superconducting state by controlling the strain and electronic states of high temperature superconducting films
  - New functionalities for energy-efficient cuprate superconducting electronic devices based on the metal-insulator transition and superconducting-ferromagnetic interactions
  - Superconducting materials customization for their integration in large scale infrastructures (energy, fusion and accelerations)

- **Highlights 2018**
  - Publications: 20
  - Books: 1
  - PhD defenses: 5
  - Technology transfer: 1 patent filed and contracts (Oxolutia, CEA …)
  - EU Projects (since 2012)
    - EU Projects (since 2012)
    - LEIT-NMBP FASTGRID (2017)
    - CERN HTS-FCCbs (2017)
    - COST NANOCOHYBRI (2017)
    - ERC-AdG ULTRASUPERTAPE (2015)
    - EURATOM EUROFUSION (2014)
    - COOP-ICT FORTISMO (2013)
    - COOP-NMP EUROTAPES (2012)
Mission: the study of transition metal oxides, considered to be the building blocks for efficient and energy friendly data storage, advanced computing and energy harvesting devices.

**Research Lines**

**RL3: Oxide electronics**

- Contribute in exploiting orbital physics and interface engineering to induce emerging properties, using oxides for data storage, communications and light harvesting.
- Engineering magnetic properties, searching and understanding multiferroic materials, integrating ferroelectric and ferromagnetic oxides on silicon, tailoring electronic properties with nitrides and designing and making artificial polar materials.
- Development of thin films of these materials with subnanometric precision.
- Use the most advanced tools of lithography for device microfabrication, prior to electrical, magnetic and optical characterization.
- Structural, morphological and microstructural analysis are done by a combination of in-house techniques (e.g. PLD) and extensive use of large scale facilities (ALBA synchrotron radiation, neutron beams, most advances electron microscopes, etc.).
- Theory and simulation of the properties and behavior of the materials (ferroelectricity, thermal transport...).

**Strategic fields**

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- Engineering magnetic properties, searching and understanding multiferroic materials, integrating ferroelectric and ferromagnetic oxides on silicon, tailoring electronic properties with nitrides and designing and making artificial polar materials.
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- Theory and simulation of the properties and behavior of the materials (ferroelectricity, thermal transport...).
Mission: provide key inputs in the current nanomedicine challenges with strong impact on health: therapy, diagnosis and tissue repair.

**Research Lines**

**RL5: Multifunctional nanostructured biomaterials**

- **Synthesis of nanomaterials for therapy and diagnosis** obtained by new manufacturing schemes and able to cross biological barriers (nanovesicles, nanocapsules, nanoparticles, dendrimers, nanotubes, containing bioactive molecules...).
- **Synthesis of nanomaterials for multimodal diagnosis** enabling to obtain images of the different tissues and metabolites distribution based on contrast agents: magnetic nanoparticles and organic free radicals, X-ray absorbers or radionuclides.
- **Synthesis of nanostructured materials for tissue repair** to understand and control signals directing cell behavior towards vascular or neural repair therapies (biocompatible nanostructured electrodes based on graphene, endothelial cells and magnetic nanoparticles, and surfaces that trigger the organization of growth factors...).
- **Simulation of the behavior and self-assembly of soft and biomaterials.**

**Strategic fields**

- Publications: 51
- Books: 3
- PhD defences: 1
- Technology transfer: 3 patents filed and contracts (Grifols, Nanomol Technologies...)

**Highlights 2018**

EU Projects (since 2012)
- EURONANOMED MAGIBBIES (2017)
- ERC-CoG NEST (2017)
- MSCA-IF TUNING COPs (2017)
- LEIT-NMP SMART-4-FABRY (2017)
- LEIT-NMP KARDIATOOL (2017)
- MSCA-IF NANTOPHOT (2017)
- MSCA-IF 3D-PRINTGRAPH (2016)
- COOP-FOOD SEA-ON-A-CHIP (2013)
- COOP-HEALTH BERENICE (2013)
- MSCA-ITN RADDEL (2012)
- MSCA-CIG 3DINVITRONPC (2012)
### CENTER OF EXCELLENCE

#### Timeline

<table>
<thead>
<tr>
<th>JANUARY</th>
<th>FEBRUARY</th>
<th>MARCH</th>
</tr>
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<tbody>
<tr>
<td>16 Jan</td>
<td>ICMAB offers a course on &quot;Essential Documentation Tools&quot; for young researchers</td>
<td>The initiative “I became a scientist” and posters on the role of women in science for the International Day of Women and Girls in Science 2018 organized by the Gender and Equality Committee researchers</td>
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<td>23 Jan</td>
<td>Next generation graphene-based biosensor for the fast detection of xanthine</td>
<td>Presentation of the Severo Ochoa Excellence Units and Maria de Maeztu Excellence Units Alliance (oSOMMa). The Alliance aims at promoting Spanish excellence science, and preserving its competitiveness</td>
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<tr>
<td>5 Feb</td>
<td>The revolution of nanomaterials: superabsorbers that trap sunlight</td>
<td>ICMAB and IMB-CNMC participate in the European project KardiaTool, developing a portable device to detect heart failure from saliva samples</td>
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<tr>
<td>11 Feb</td>
<td>Researchers from ICMAB, led by Dr. Agustín Mihi, have created materials that largely absorb a wide range of the solar spectrum, between 400 and 1500 nm, using an ultrathin layer of less than 100 nm thick of material</td>
<td>Prof. Francesc Teixidor and his team (LMI-ICMAB) are working on the synthesis and functionalization of the magnetic nanoparticles, which are the support of the specific antibodies for each biomarker.</td>
</tr>
<tr>
<td>20 Feb</td>
<td>ICMAB and IMB-CNMC participate in the European project KardiaTool, developing a portable device to detect heart failure from saliva samples</td>
<td>New organic and miniaturized photodetectors that absorb light beyond the visible range</td>
</tr>
<tr>
<td>12 Mar</td>
<td>ICMAB researchers have prepared a novel hybrid graphene-based electrochemical biosensor for the fast and 100 times more sensitive detection of xanthine, with respect to previously reported sensors</td>
<td>A study led by the Technische Universität Dresden, in which the group of Dr. Mariano Campoy-Quiles of the Institute of Materials Science of Barcelona (ICMAB-CSIC) participated, has developed organic photodetectors that detect light below its absorption band, with high efficiency, in a tunable way and in a very precise wavelength of the electromagnetic spectrum.</td>
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<tr>
<th>APRIL</th>
<th>MAY</th>
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<tbody>
<tr>
<td>16 Mar</td>
<td>The Knowledge Transfer Unit organizes a workshop to assess the technology transfer potentials at ICMAB in collaboration with the Fraunhofer Institute in Germany</td>
</tr>
<tr>
<td>3 Apr</td>
<td>Iridescent photonic cellulose, mimicking the structural color of insects, with optical applications</td>
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<tr>
<td>9 Apr</td>
<td>The study published today in Nature Photonics, led by Dr. Agustín Mihi (NANOPTO-ICMAB) creates for the first time photonic crystals and plasmonic structures of a cellulose derivative through its nanostructuring with the soft lithography technique.</td>
</tr>
<tr>
<td>10 Apr</td>
<td>New organic and miniaturized photodetectors that absorb light beyond the visible range</td>
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<tr>
<td>19-20 Apr</td>
<td>Physicists uncover properties of a magnetic soliton of interest for brain-inspired computing</td>
</tr>
<tr>
<td>3 May</td>
<td>&quot;Solitons are solitary waves, like a tsunami or a tidal bore, are very interesting because they can be used to propagate energy or information, in a similar way as our neurons work. This is why they have promising applications in neuromorphic computing applications, for example&quot; explains researcher Ferran Macià, one of the leaders of this study</td>
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**Presentation of the Severo Ochoa Excellence Centres and Maria de Maeztu Excellence Units Alliance (oSOMMa). The Alliance aims at promoting Spanish excellence science, and preserving its competitiveness.**
**May**

- **16 May**
  - Disentangling the origin of magnetic proximity effects at the magnetic/non-magnetic interface
  - Researchers from ICMAB-CSIC and ALBA have analyzed the microscopic origin of the so-called “magnetic proximity effect” occurring at the interface between a magnetic material (CoFe2O4) and a nonmagnetic metal (Pt), which may induce a magnetic moment in the latter. The results are published in ACS Applied Materials & Interfaces.

- **17 May**
  - Photonic leaf” the winning picture of FOTICMAB 2018, our photo contest

- **30 May**
  - Four students from the UAB Argó Program spend 10 days at the ICMAB this summer

- **9-10 Jun**
  - ICMAB researchers develop flexible materials that switch from nano-porous 3D to 2D structures in a reversible way
  - “The spherical shape of the ligands is the key factor that enables the structures to go back to their original shape, allowing for the rearrangement of the different parts, and without collapsing the whole structure” – describes Jose Giner (LMI-ICMAB)

- **14 Jun**
  - Minimalist Biostructures Designed to Create Nanomaterials
  - The study, published in ACS Nano included the collaboration of Isabel Fuentes and Francesc Teixidor from the ICMAB-CSIC

- **26 Jun**
  - The Barcelona Science Festival counts with ICMAB researchers for microtalks, photonic contest and nanotechnology activities

**June**

- **12 Jul**
  - New boost to future calcium batteries – A possible cathode?
  - This breakthrough demonstrates that this oxide could be used as cathode (positive electrode) in future rechargeable calcium batteries. This finding can help solve one of the main problems to produce rechargeable calcium batteries, which consists in finding cathodes that can extract and incorporate calcium ions in a reversible way, explains the ICMAB researcher M. Rosa Palacín, leader of the study

- **17 Jul**
  - Nine Frontier Interdisciplinary Projects (FIP) granted in the third internal call within the Severo Ochoa FUNMAT programme

- **25 Jul**
  - Kick-off of the interactive exhibition ‘Matheroes: Supermaterials, heroes of the future’

- **22 Aug**
  - Extremely sensitive radiation detectors to explore the universe in the forthcoming ESA space missions
  - Dr. Lourdes Fàbrega (MULFOX-ICMAB), leads the development in Spain of a special type of sensors that can detect very small changes in temperature and that will be used in the forthcoming European space missions. These sensors are extremely sensitive and miniaturized microcalorimeters, like small thermometers, that can detect even the energy of one single photon.

- **30 Aug**
  - Some of our researchers and their research were featured in the article “Los materiales que cambiarán el mundo” written by the Journalist Elsa Velasco, in La Vanguardia (Big Vang)

- **31 Aug**
  - Marta Mas-Torrent and Teresa Puig, ERC researchers, in #LasCientíficasCuentan, a project to visibilize ERC women
The ICMAB at the Expominer, with talks, workshops and the Matheores

The ICMAB participated with some outreach talks given by five of our researchers, workshops in our stand about superconducting materials, minerals, diffraction and photonic materials, and with the exhibition “Matheores: Supermaterials, heroes of the future”.

Soft organic materials that change color and charge transfer with the application of an electric field

A group of researchers from the ICMAB-CSIC has conducted a study, published in Nature Communications, which reveals that the epsilon phase of iron oxide (until now considered rare) can be found in the inner layers of the Earth.

Celebrating Christmas 2018 at ICMAB

Xavier Lasauca, from the Direcció General de Recerca (GenCat), gave some insights in the use of twitter and blogs for researchers, and gave us a lot of information and resources about the use of social media for researchers, to increase the impact and networking of the research.

A new iron oxide polymorph found at high pressures

A team of researchers with the participation of ICMAB-CSIC has conducted a study, published in Nature Communications, which reveals that the epsilon phase of iron oxide (until now considered rare) can be found in the inner layers of the Earth.

The ICMAB participated with some outreach talks given by five of our researchers, workshops in our stand about superconducting materials, minerals, diffraction and photonic materials, and with the exhibition “Matheores: Supermaterials, heroes of the future”.

Soft organic materials that change color and charge transfer with the application of an electric field

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FACTS AND FIGURES

Publications

1986-2018

- Sum of citations: 144,924
- Total publications: 5,223

2016-2018

- Total Publications: 231, 203, 226
- Highly cited papers: 8, 3, 1
- Open Access Publications: 86, 69, 70
- h-index (Web): 125, 131, 137

- Publications with IF: 216, 189, 212
- Average Impact Factor: 6.58, 5.64, 6.30
- Publications with IF-ID: 31, 23, 34
- First quartile publications (Q1-SJR): 197, 162, 180
- First decile publications (Q1-SJR): 138, 103, 146

- 2016: 63% 53% 72%
- 2017: 90% 84% 88%
- 2018: 89% 79% 92%
**FACTS AND FIGURES**

**EU Funded Projects**

**ERC GRANTS**
- **9** + 1 CoG and 1 PoC to start in 2019

**NEW PROJECTS (2018)**
- **3**

**ONGOING PROJECTS (2018)**
- **35**

**TOTAL BUDGET (ICMAB)**
- **22.2 M€**

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- 9 + 1 CoG and 1 PoC to start in 2019

**ONGOING PROJECTS (2018)**
- 35

**TOTAL BUDGET (ICMAB)**
- 22.2 M€
Battery ageing

Performance degradation upon Li-ion battery lifetime is rooted in chemical processes mostly determined by battery material components and operation conditions.

Batteries start to degrade as soon as they are assembled, just as human beings start to age from the moment they are born. The process depends on biological/genetic factors (which can be assimilated to battery materials and design), environmental/behavioral aspects (battery operation conditions) and access to medical care (optimised Battery Management System).

Performance degradation upon Li-ion battery lifetime is ultimately rooted in chemical processes the extent of which is mostly determined by battery material components and operation conditions (charge/discharge rates, voltage operation limits and temperature) and can also be influenced by battery design. The two major factors contributing to loss of negative electrode performance are the instability of the passivation layers formed on the electrode/electrolyte interface (enhanced at higher temperatures) and lithium metal plating (intensified at low temperatures). The knowledge of this structure at the nanoscale is crucial to understand key properties that determine corrosion, dissolution, and electrochemical processes. This review focuses mainly in the use of Scanning probe Microscopy (SPM) to study water/solid interfaces. One of the differences of SPM from other techniques is the locality of the information. SPM uses a probe tip to scan over the surface and obtain structural information together with, e.g., electronic, mechanical, and vibrational properties. Because it is not an averaged information over a wide area, as in the case of all the other techniques listed above, detailed investigations of how atomic steps, kinks, and defects residing on the surface influence the adsorption of molecules are possible.

There are few experimental techniques that allow obtaining information over a wide area, as in the case of all the other techniques listed above, detailed investigations of how atomic steps, kinks, and defects residing on the surface influence the adsorption of molecules are possible.

While it would be most useful to be able to monitor degradation at all levels while the cell is being cycled, the feasibility of this approach remains limited, and most approaches involve accelerated testing with ante/post-mortem characterization. Yet, the use of suitable protocols for battery opening and disassembling is crucial to avoid biased interpretation.

Understanding such issues is crucial to extend cycle life of Li-ion batteries to successfully embrace larger scale applications such as transportation or grid. Overall, battery ageing is a very complex and challenging research topic with a too broader scope to be addressed by conventional research approaches and one which will clearly benefit from synergies between academia (model systems, fundamental research with cross cutting approaches and one which will clearly benefit from synergies between academia (model systems, fundamental research with cross cutting characterization techniques available) and industry (real commercial systems, large empiric know how and cumulated knowledge about battery characterization techniques available).

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Water/solid interfaces are of fundamental interest in various fields including geology, metrology, biology, and chemistry. Despite its simple molecular structure, water at surfaces, which determines wetting and reactivity remains unsolved. The knowledge of the structure and interactions of water with surfaces, which determines wetting and reactivity remains unsolved. The knowledge of the structure and interactions of water with surfaces, which determines wetting and reactivity remains unsolved. The knowledge of the structure and interactions of water with surfaces, which determines wetting and reactivity remains unsolved. The knowledge of the structure and interactions of water with surfaces, which determines wetting and reactivity remains unsolved. The knowledge of the structure and interactions of water with surfaces, which determines wetting and reactivity remains unsolved. 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An overview of porous materials preparation under supercritical CO₂

This contribution highlights the main characteristics that make supercritical CO₂ an extraordinary solvent for performing physical processing and chemical reactions to create or modify porous nanostructures.

The field of porous materials is currently at an exciting stage in its technological evolution. The research on ordered−including zeolites, zeotypes, metal−organic frameworks and mesoporous silica−and disordered−including ceramics, sintered metals and foamed polymers−porous solid [1] is among the most creative, fascinating and attractive fields of materials science. The supercritical fluid technology addressed the processing of porous matter for many diff ered types of materials. The basis of the developments of supercritical carbon dioxide (scCO₂) methodologies in porous materials is two-fold: first, the solubility of scCO₂ in polymers, with a pressure−dependent behaviour, is substantial in comparison with conventional solvents; and second, the adsorptive behaviour of scCO₂ in inorganic porous systems is insignificant when compared to liquid fluids, which allows the one-step design of surface graft ing and impregnation processes.[2]

scCO₂ technology applied to nanopores takes profit of the compressed CO₂ as-like viscosity, high diffusivity and null surface tension, so capillary stresses are suppressed, converting this fluid in a non−damaging solvent for those structures, facilitating their synthesis and modification. Most importantly, pore collapse can be avoided because the expansion of scCO₂ directly as a gas does not give rise to a liquid−vapour interface.

When the process is carried out from a liquid solution, the possibility of competition between solvent and solute for the substrate adsorption sites often leads to the incorporation of both components into the internal surface of the porous system. Competition between the solvent and the solute for the substrate adsorption site is reduced in scCO₂ with respect to liquid solvents, since supercritical fluids are essentially not absorbed.

This review explores particular cases of the use of scCO₂ on polymer foaming, aerogel preparation, porous concrete densification, supercritical impregnation of zeolites and modification of mesoporous ordered silica or MOFs preparation.


Colorful cellulose Photonic Crystals

Cellulose photonic membranes featuring optical properties in addition to the biocompatibility and biodegradability of the cellulose material.

Cellulose is the most abundant polymer on earth and for centuries has had a wide technological impact in areas such as textile, packaging or knowledge storage. It is biodegradable, biocompatible and possesses excellent mechanical characteristics that have raised the interest of many engineering fields. The only limit to this potential are the poor optical properties of the cellulose and its derivatives. Typically, cellulose exhibits a white color derived from the light scattering from micron size fibers but can become transparent if its nanometric components are separated and pressed into a thin film. In this work, we revolutionize the field of transient photonics by fabricating for the first time a variety of cellulose based photonic and plasmonic architectures via soft nanoimprinting lithography and illustrate their outstanding performance in several applications such as structural color, photoluminescence enhancement and as disposable surface enhanced raman scattering substrates.

The structural color exhibited by these architectures is produced by arrays of nanoscale pillar−like metallic or dielectric hybrid structures that reflect visible light at different wavelengths. Such structures are also found in nature, for example, in green−winged teal feathers and in some butterfly wings. While traditional colors produced by dyes or pigments fade away with time, structural color can persist longer while also being environmentally friendly. The photonic crystals made with cellulose derivatives can be dissolved in water within seconds, having potential application as a new generation of transient photonic labels.

Society needs to reduce its production of plastics, estimated at around 320 million tonnes each year, of which only 10 % is recycled. The sooner the better given the enormous amount of waste being generated that is damaging our planet’s ecosystems – both aquatic and terrestrial. Biopolymers such as cellulose could come into their own here. Nanocellulose is a promising candidate for making photonic components for use in chiral electronics, photonic electrodes, anti−reflection coatings in solar cells, flexible substrates for plasmonic sensing and many more.
High dielectric metasurfaces exhibiting strong light absorption

In this work, we transform an ultrathin slab of Germanium of less than 70 nanometers into a photonic architecture exhibiting an impressive 81% total absorption from the visible to the near infrared. The strong light absorption in such a thin film of Ge enables novel sensing and energy harvesting devices in flexible and portable substrates. Phasing with a thin metallic substrate acting as a reflector and a system of a two height hole array in the semiconductor, the light finds several ways to resonate and remain within the structure. The photonic system shows almost full absorption in a broad frequency range, vastly exceeding the absorption of a flat film design. Interestingly, as the light confinement is given by the structural parameters of the architecture, by changing parameters such as height or pitch between holes, the absorption can be tuned spectrally, opening a wide range of engineering possibilities. Moreover, the whole nanometric structure is fabricated with a simple and scalable technique termed nanoimprinting lithography, which is similar to conventional pressure or temperature printing, allowing an easy implementation in large area surfaces.

This research provides the key design guidelines for super absorptive portable surfaces readily implementable in many optoelectronic devices. As height or pitch between holes, the absorption can be tuned spectrally, opening a wide range of engineering possibilities. Moreover, the whole nanometric structure is fabricated with a simple and scalable technique termed nanoimprinting lithography, which is similar to conventional pressure or temperature printing, allowing an easy implementation in large area surfaces.

Metals have revolutionized the field of plasmonics due to their morphology-dependent exciting optical properties but also, because they constitute building blocks of more rich and complex plasmonic architectures. These colloids can be assembled into ordered arrays whose engineered optical response can be tailored to specific applications. These supercrystals serve as the ideal platform in which study coupling of different plasmonic resonances sustained by the structure. Precise ordering of these colloids is a challenging task typically achieved using complex lithographic techniques. However, great efforts are being placed to develop colloidal assembly routes that yield high resolution while being inexpensive and producing large area films.

In this work, we employ an inexpensive and scalable template-assisted assembly technique capable of arranging 52 nm gold nanospheres into regular, periodic arrays of well-defined plasmonic clusters over areas as large as 8 mm² with features as small as 300 nm. The resulting supercrystal films exhibit tunable optical properties from the visible to the NIR range. We used patterned elastomeric molds with lattice parameters ranging from 400 nm until 1700 nm. The resulting supercrystal films exhibited both strong near-field coupling and an optical response that can be tuned from the visible through the near-infrared (NIR) range. The hierarchical order present in the supercrystals enables the coupling of the different plasmonic resonances sustained by the architecture and enables us to produce films tailored to specific wavelengths.

Furthermore, we investigated the application of these superlattices as surface enhanced Raman spectroscopy substrates. We studied the correlation between the plasmon resonances sustained by the different geometrical assemblies and their performance as SERS substrates under 785 nm excitation of the Raman probe 4-acetamidothiophenol (4-AMTP).
Stimuli-responsive flexible materials: the role of spherical icosahedral boron clusters

This work demonstrates the role of icosahedral boron clusters to stabilize flexible Metal-Organic Frameworks (MOFs) and thus providing a new generation of porous "stimuli-responsive" or "smart" materials.

We have now developed novel 3D nano-porous materials that go through conformational changes and transform into a 2D non-porous structure as a result of an external stimuli, and then can shift to the original 3D nano-porous structure when the stimuli is reversed. This flexibility is introduced in a new Metal-Organic Frameworks (MOFs), which incorporates a flexible carborane based linker. Icosahedral carborane clusters are three-dimensional molecules with electron delocalization, highly polarizable σ-aromaticity, thermal and chemical stability and geometrical diversity. The use of spherical shaped icosahedral boron-based molecules as linkers instead of planar ones help in stabilizing the flexible structures. The spherical shape of the ligands is the key factor that enables the structures to go back to their original shape, allowing for the rearrangement of the different parts, and without collapsing the whole structure. The idea of spherically shaped linkers avoiding collapse of the structure can also be understood like this: two layers will roll over each other if separated by spheres, whereas they will collapse if non-spherical pillars are used.

As a proof of concept for potential applications, encapsulation of fullerene molecules has been achieved by trapping them during the reversible 2D to 3D transition, while the structure is being formed. The observed process constitutes a new way to encapsulate large molecules that cannot easily diffuse into the porous material.

The so-called "stimuli-responsive" or "smart" materials have the ability to go through conformational changes or phase transitions as a result of external chemical or physical stimuli. Such responsiveness to specific stimuli or local environment is typical for biomolecules in nature but it is particularly difficult to achieve artificially. Such materials form the cornerstone of developing intelligent technologies and are at the forefront of strategies addressing a number of global challenges.
Battery materials research: from commercial chemistries to new concepts

Materials research is crucial in all battery technologies ranging from commercial chemistries to pre-competitive alternatives and also emerging concepts.

Our current research interests are fully focused on rechargeable battery materials covering a wide spectrum from commercial traditional systems, such as NiCad, to promising alternatives such as Na-ion to fully new concepts as Ca metal. Specific emphasis is set in tailoring structure and microstructure of electrode materials to maximise electrochemical performance and in the development of new materials.

Some of the recent achievements involve elucidating the crystal structure of the nickel battery positive electrode material in the fully charged state, which consists of metastable β-NiOOH. This has been possible through a joint approach involving XMR and FTIR spectroscopies, powder neutron diffraction and DFT calculations. The results confirm that structural changes occur during the β-Ni(OH)2/β-NiOOH transformation in each electrochemical cycle. [1]

In the field of Na-ion batteries, hard carbons were prepared from different precursors (phenolic resin and commercially available cellulose and lignin) under different pyrolysis and processing conditions using industrially adapted syntheses protocols. The study of their microstructural features enabled to assess that the nature of the precursor and the temperature of pyrolysis are the major factors determining the carbon yield and the surface area, the latter one having a major effect on the useful electrochemical capacity. [2]

Last but not least, a comparative study of the electrochemical intercalation of Ca2+ and Mg2+ in layered TiS2 using alkylcarbonate based electrolytes was carried out. Reversible electrochemical Ca2+ insertion was assessed both using X-ray diffraction and differential absorption X-ray tomography at the Ca L2 edge. Different new phases are formed upon M2+ insertion, their amount and composition being dependent on M2+ and the experimental conditions. [3]

Overall, crystal chemistry is a very useful tool in battery research, enabling tailoring structure and microstructure of electrode materials to maximum electrochemical performance for traditional technologies and development of new materials for emerging technologies.

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[1] The nickel battery positive electrode revisited: stability and structure of the beta-NiO(OH) phase


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Chemistry of Materials 30 (3), 847-856 (2018)
Ultrafast laser filling of PbI$_2$ into carbon nanotubes: tubular van der Waals heterostructures exhibiting photogeneration of carriers

Cylindrical van der Waals heterostructures of a conductive (CNT) and a light sensitive material (PbI$_2$) have been prepared which conductivity can be tuned upon illumination.

**Schematic representation of the laser-assisted filling of carbon nanotubes.**

Visualizing degradation and defects in hybrid perovskite solar cells

While hybrid perovskites are tolerant to structural defects during fabrication, they present strong reversible and non-reversible degradation paths upon light exposure.

**Efficient perovskite solar cells have been manufactured fulfilling industry requirements including large scale coating technique (doctor blading) and development of inks from non-toxic solvents.** The morphology-performance dependence in perovskite films processed by spin and blade coating is investigated by co-local photoluminescence (PL) and photocurrent maps. Two different degradation mechanisms are clearly identified: fully reversible behavior within the bulk of the perovskite crystal grains and a non-reversible degradation confined at the perovskite grains boundaries. Additionally, the movement of a degradation front is detected, from the boundaries towards the bulk of the perovskite crystal grains and a non-reversible degradation confined at the perovskite grains boundaries. The chemical defects are located at the grain boundaries and do not have detrimental impact on the photogenerated charges.

Moreover, the degradation of the perovskite solar cells at the nanoscale level is addressed by comparing the photoconductive atomic force microscopy and photoluminescence maps. Two different degradation mechanisms are clearly identified: fully reversible behavior within the bulk of the perovskite crystal grains and a non-reversible degradation confined at the perovskite grains boundaries. Additionally, the movement of a degradation front is detected, from the boundaries towards the bulk of the grains. The study suggests, that in order to improve the perovskite stability, grain boundaries need to be minimized or passivated.

**Comparison between photoluminescence shift map for spin coated and blade coated perovskite solar cells. Statistical distribution of the data for the same spin coated (red line) and blade coated (green line) devices presented in the images.**
The evaluation of organic photovoltaic material goes “Fast and Flurrious”

Accelerating more than 50 times the process of optimization of novel organic photovoltaic materials, at a fraction of the material cost

Organic photovoltaics have experienced unprecedented improvement due to the synthesis of novel high-performing materials. Over the last years, thousands of novel organic semiconductors have been screened to evaluate their potential in photovoltaics. One of the major bottlenecks in the material evaluation is, however, the large amount of resources, time and material required for the device optimization. The authors circumvent this bottleneck by shifting from fabrication-intense to measurement-intensive assessment methods, enabling rapid multi-parametric optimization of novel organic photovoltaic systems.

The developed platform combines the fabrication of samples with gradients in the parameters of interest and advanced electrical and optical co-local imaging to identify the values of thickness and composition that result in maximum performance.

In-depth analysis of novel semiconductor polymorphs

A combination of Raman spectroscopy and theoretical calculations provides unprecedented insight into crystal phase engineering in semiconducting nanostructures

Recent advances in the synthetic growth of nanostructures—rod shaped semiconductors of nanometric size—have given access to crystal phases that in bulk are only observed under extreme pressure conditions. The advent of these novel polymorphs, such as hexagonal Ge, promises to overcome some of the limitations that have prevented them to find application in photonics and optoelectronics thus far. The bandgap of hexagonal Ge is predicted to be direct, a fact that could have important implications with respect to the long-standing goal of designing a Ge-based light-emitting materials. Experimental data on these novel materials are scarce and are sometimes limited by the quality of the sample.

In this work, we used Raman spectroscopy, a common technique to probe the vibrational properties of materials and demonstrate its versatility when it comes to the determination of the main crystalline, phononic, and electronic properties of one of the most challenging type of nanostructure: a nanoscale sample with constant material composition, where cubic (in red) and hexagonal (in dark yellow) domains are alternated. Sketches of the Raman spectra acquired are also shown. Two segments of the nanowire are textured with the corresponding TEM image.
Symmetric supercapacitors made of flexible electrodes grown by laser-based technique

An environmentally friendly laser technique was developed for the growth of nitrogen doped reduced graphene oxide and transition metal oxide coatings for energy storage applications.

Graphene-based electrodes were deposited onto metallic or gold-coated polymer substrates. The technique that we developed allows for the chemical transformation and simultaneous deposition of graphene oxide (GO) and GO-NiO nanoparticles. Nitrogen inclusion into the structure of GO was achieved through the addition to the irradiated aqueous target dispersions containing the nanoentities, GO platelets and NiO nanoparticles, nitrogen containing organic compounds (ammonia, urea, or melamine). The obtained flexible electrodes reveal high electrochemical charge storage performance (Figure) as well as outstanding long-term charge–discharge stability.

Addition of melamine to the graphene oxide-NiO dispersions leads to the synthesis of the electrodes with the highest energy storage performance. Melamine, as nitrogen containing precursor, leads to the formation of pyrrolic/amine, graphitic quaternary, and pyridinic nitrogen functional groups. Amine groups and graphitic nitrogen doping of GO are known to reduce the intrinsic resistance of graphene platelets and thus, ensure better electronic transfer through the active material, improving the electrodes’ capacitive performance. Moreover, graphitic and pyridinic nitrogen exhibit large dipole moments that greatly enhance the wettability of graphene materials in aqueous electrolyte solutions, leading to capacitance enhancement. Besides, pyridinic and pyrrolic nitrogen groups are electrochemically active, participating in redox reactions.

The developed fabrication method is cost-effective, fast, and environmentally friendly, characterized by an enormous versatility for the growth of functional nanocomposite coatings. Moreover, the work opens up new possibilities for the synthesis and deposition of new compounds, through the light induced chemical reactions taking place during the irradiation of organic materials.
Unraveling the surface of nanoparticles: From aggregates to patchy Rare Earth Fluoride (ReF₃) Nanoparticles

LnF₃ nanocrystals are synthesized and their different behavior is studied by a combination of experimental and all-atomic molecular dynamics simulations. We show here that the deep knowledge of the surface is a powerful tool to control the final size, shape and behavior of the nanoparticles.

The study not only reveals the dependence of the crystallographic structure with used metal and pH, but also the achievement of assembled particles depending on the final shape of nanocrystals.

Modulation of carrier concentration in strongly correlated oxides offers the unique opportunity to induce Metal-Insulator transitions (MITs) between different electronic phases which dramatically change their physical properties [1]. Particularly interesting are strongly correlated high-temperature superconducting cuprates, in which a reversible modulation of their critical temperature transition can be produced by means of an electric field as the external control parameter. Great progress has been made by inducing electrostatic doping through a ferroelectric polarization or by using a dielectric or electrolyte gating [2]. However, ultrathin superconducting layers and large electric fields must be used to observe significant carrier modulation.

Numerous experiments have shown that the gate voltage can be used to trigger a volume phase transition (not just confined at the vicinity of the interface between the film and the gate electrode but spanning hundreds of nm away from the gate contact). We analyse different device configurations in which the lateral conduction of a bridge is controlled by gate-tuneable vertical and lateral oxygen motion, providing the basis for the design of robust, homogenous and flexible transistor-like devices (Figure a), which show the oxygen concentration.

We propose a novel approach based on the reversible modulation of non-volatile superconducting-insulator phase transition in YBa₂Cu₃O₇−δ films, through oxygen diffusion, that offers several technological and scientific breakthroughs as compared with modulations based on pure electrostatic doping. The key advantage is the possibility to induce a volume phase transition (not just confined at the vicinity of the interface between the film and the gate electrode but spanning hundreds of nm away from the gate contact). We analyse different device configurations in which the lateral conduction of a bridge is controlled by gate-tuneable vertical and lateral oxygen motion, providing the basis for the design of robust, homogenous and flexible transistor-like devices (Figure a), which may operate both at room temperature or exploit their superconducting nature. We analyse the experimental results in light of a theoretical model, which incorporates thermally activated and electrostatically driven volume oxygen diffusion (Figure b).

References:
High temperature superconducting nanocomposites: A plethora for vortex pinning centers

The potentiality of preformed nanoparticles to control vortex pinning and dynamics of chemical solution nanocomposites is disentangled by correlating preparation, microstructure and properties

Mixed anion oxides are emerging materials showing a variety of physical and chemical properties. Among them oxynitrides are widely investigated because of important photocalytic, ceramic, luminescent and electronic properties. Nitrides show more positive free energies of formation than oxides because of the higher stability of N, molecule with respect to O, and the favourable electron affinity of nitrogen compared to oxygen. However the stability of oxynitrides is higher than for nitrides, and they easily form oxides in presence of reactive gases as N3.

The notable development of new oxynitride materials in the last years is a consequence of the improving of synthetic methodologies. Research in the field is increasingly showing that despite the lower thermodynamic stability of nitrides the N3- ion can be easily stabilized in any structural type shown by oxides. Nitriding in ammonolysis reactions is governed by kinetic factors and for more reducible cations the oxynitrides are isolated as metastable compounds that with prolonged time decompose into complex oxides and binary metal nitrides. Recent examples of solution methods in supercritical ammonia show the obtention of highly crystalline powders and small single crystals. The development of crystal growth methods is challenging but necessary to provide large single crystals for measuring physical properties. Within the group of transition metals the majority of oxynitrides have been reported for the groups 4, 5 and 6. Among them the tantalum compounds are the most investigated because of their photocatalytic and dielectric properties. The stabilization of more reducible later transition metals is difficult under the conventional ammonolysis conditions used for Ti, Zr or Ta oxynitrides. However new oxynitrides of more electronegative Cr, Fe, Mn or Zn have been recently prepared at lower temperatures from adequate precursors by conventional ammonolysis conditions used for Ti, Zr or Ta oxynitrides.
Cross talks between strain and chemistry at dislocations

New insight into the nanochemistry and electronic structure of an oxide dislocation core: oxygen vacancies singled out and quantified

D islocations are topological defects ubiquitous in crystals, which despite having been conceptually conceived more than eight decades ago, have largely remained in the drawers of materials science labs owing to the obstinate inaccessibility of their ~1nm cores. This is particularly true for dislocations in oxides, where electrostatic interactions arising from their ionic character can define the core structure and the defect chemistry in the associated strain field.

The strong sensitivity of the defect chemistry, particularly oxygen vacancy formation energies, to dislocation strains, otherwise provide a rich scenario for the development of new confined states exhibiting different properties from those of the host crystal. The transformation of such defects from passive into potentially active functional elements, however, necessitates a deep understanding of their chemical and electronic structure. In [1], we combine different atomic resolution imaging and spectroscopic techniques in the transmission electron microscope to determine the complex structure of misfit dislocations in the perovskite-type La$_x$Sr$_{1-x}$MnO$_3$/LaAlO$_3$ heteroepitaxial system. While the position of the film–substrate interface is blurred by cation intermixing, oxygen vacancies selectively accumulate at the tensile region of the dislocation strain field.

A new Iron (III) oxide phase from ε-Fe$_2$O$_3$ under high pressures

Synchrotron-based diffraction and spectroscopy experiments combined with ab-initio calculations unveiled the fate of ε-Fe$_2$O$_3$ under isostatic compression: transforming to a new polymorph through a spin crossover transition.

The ε-Fe$_2$O$_3$ presents an orthorhombic structure with four polyhedral units: a regular octahedron, two distorted octahedra and a regular tetrahedron (Figure). By X-ray absorption fine structure (EXAFS) the deformation of polyhedral units were monitored under increasing pressures and revealed a remarkable stability, altered by a sudden change in the average interatomic distances at 27 GPa, the limiting pressure to access the upper Earth’s mantle. This structural anomaly is also reflected by a collapse of the unit cell volume revealed by pressure dependent X-ray diffraction. The analysis of the diffraction patterns at different pressures allowed obtaining the pressure-volume equation of state which was reproduced, including the volume collapse, by ab-initio theoretical simulations. These calculations also indicated the phase stability up to 1800 K and provided its structural characteristics above the volume collapse, which were found to be compatible with the experimental diffraction data.

In particular, in the new high pressure x’ phase, one of the irregular octahedron and the regular tetrahedron become very distorted octahedral units, closer to a 5+1 coordination. Synchrotron-based M"ossbauer spectroscopy measurements indicated that the x→x’ transformation is a spin crossover transition.

References


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Ferroelastic domains in motion under electric fields

Optical imaging and first-principles modeling unveil the physics of domain motion driven by electric fields in ferroelastic SrTiO3 crystals

By altering the chemical composition of SrTiO3 or by straining the crystals, a remarkable wide scope of physical phenomena emerges, including superconductivity, ferroelectricity, 2D transport or magnetism. This notable versatility makes of SrTiO3 the paradigmatic ferroelectric BaTiO3, is based on imposing kinetic changes in film composition or substrate. One strategy, illustrated with BaTiO3 films integrated epitaxially with Si(001), we have stabilized the ferroelectric phase of Hf0.5Zr0.5O2 films with retention time longer than 10 years. However, epitaxial films are needed for better understanding of the properties and prototyping devices of nanometric dimensions. We have developed two alternative methods that require chemical substitutions or selection of a particular substrate. We have demonstrated with BaTiO3 films integrated epitaxially with Si(001).

The second strategy permits dynamic control of the polarization by light. As ferroelectric perovskites hold promises of enhanced photovoltaic efficiency in solar cells and photocatalytic activity, these findings may get a far reaching relevance for novel applications of [2].

The recent discovery of ferroelectricity in doped HfO2 represents a breakthrough towards commercial permanent memories based in ferroelectrics. The metastable ferroelectric phase of HfO2, is obtained in polycrystalline films, and epitaxial ferroelectric HfO2 films have been rarely achieved. However, epitaxial films are needed for better understanding of the properties and prototyping devices of nanometric dimensions. We have stabilized the ferroelectric phase of Hf0.5Zr0.5O2 films in epitaxial films, which present high polarization that depends strongly on the thickness and demonstrating by the first time for epitaxial films absence of wake up effect, long retention and high endurance against fatigue. [3]

The ferroelectric polarization of epitaxial oxide films is controlled by growth kinetics and by concurrent action of light and adsorbates

The classical methods to tune polarization of ferroelectric films require chemical substitutions or selection of a particular substrate. We have developed two alternative methods that are more flexible, permitting tailoring polarization without requiring changes in film composition or substrate. One strategy, illustrated with the paradigmatic ferroelectric BaTiO3 is based on imposing kinetic limitations during epitaxial growth. The balance between kinetics and thermodynamics fixes the amount of point defects in the deposited film. These defects produce lattice expansion of BaTiO3, determining the unit cell tetragonality and ultimately the ferroelectric polarization. This method, that allows obtaining a particular polarization without changing composition or substrate, is demonstrated with BaTiO3 films integrated epitaxially on Si(001) wafers [1].

The second strategy permits dynamic control of the polarization by light. Under illumination, photodissociated adsorbates modify the electrostatic screening at the surface of ferroelectric films and modify the switchable polarization. We have shown that water-related adsorbates at the surface of BaTiO3, enable a substantial modulation (up to 75 %) of the switchable remanent polarization by light. As ferroelectric perovskites hold promises of enhanced photovoltaic efficiency in solar cells and photocatalytic activity, these findings may get a far reaching relevance for novel applications of [2].

The ferroelectric polarization of epitaxial oxide films is controlled by growth kinetics and by concurrent action of light and adsorbates.

[1] Tailoring Lattice Strain and Ferroelectric Polarization of Epitaxial BaTiO3 Thin Films on Si(001), Scientific Reports 8, 495 (2018)
Storing information in a ferromagnetic insulating barrier

Magnetic anisotropy converts a tunnel junction device, in which the only magnetic material is the barrier, into a memory devicesize, shape and behavior of the nanoparticles.

**Multiple spin functionalities are tested on Pt/La$_2$Co$_{0.8}$Mn$_{1.2}$O$_6$/Nb/Sr TiO$_3$, a device composed by a ferromagnetic insulating (FMI) barrier sandwiched between nonmagnetic electrodes. FMIs are scarce in nature, as ferromagnetic interactions are typically of exchange-type mediated by charge carriers, and they can play an important role in spintronics as an efficient way to obtain polarized currents when used as spin filters. In our device, the only magnetic element is La$_2$Co$_{0.8}$Mn$_{1.2}$O$_6$ barrier. Moreover, La$_2$Co$_{0.8}$Mn$_{1.2}$O$_6$ thin films present strong perpendicular magnetic anisotropy whose origin lies in the large spin-orbit interaction of Co$^{2+}$ which is additionally tuned by the strain of the crystal lattice[1]. This anisotropy is largely reflected in the transport properties of the junction presenting tunneling anisotropic magnetoresistance (TAMR) values up to 30% at low temperatures, in addition to an estimated spin-filtering efficiency of 99.7%.[2] These results are corroborated by DFT-based calculations. We demonstrate that the DOS of La$_2$Co$_{0.8}$Mn$_{1.2}$O$_6$ has a fully polarized spin-down character above the Fermi level. On the other hand, our calculations estimate a difference in the tunnel barrier height of 8 meV when magnetization changes from OOP to IP, and an exchange splitting of 0.2 eV, in good agreement with values fitted experimentally. Furthermore, we found that the junction can operate as an electrically readable magnetic memory device. Our results probe the existence of a non-volatile bistable resistive state that can be switched by applying magnetic field pulses in perpendicular or parallel directions. Thus, the findings of this work demonstrate that a single ferromagnetic insulating barrier with strong magnetocrystalline anisotropy is sufficient for realizing sensor and memory functionalities in a tunneling device based on TAMR.

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Anisotropic sensor and memory device with a ferromagnetic tunnel barrier as the only magnetic element

Scientific Reports, 8, 861 (2018)
Influence of the magnetic field direction on the magnetoelectric properties of an incommensurate conical improper multiferroic

The complete magnetic and ferroelectric H-T phase diagrams for magnetic fields along the special magnetic directions were determined in a Dzyaloshinskii–Moriya multiferroic crystal with conical antiferromagnetic structure.

Understanding the interplay between magnetism and ferroelectricity in improper multiferroics is of interest in fundamental and applied research. In previous studies we showed the appearance of ferroelectricity in Dzyaloshinskii–Moriya Mn$_{0.80}$Co$_{0.20}$WO$_4$ crystals (x>0.15) due to the stabilization of a rare double-$k$ spin configuration: a transverse conical AFM order, composed of AFM collinear (AF4) and incommensurate (ICOM) cycloidal orders. The objective of the present study was the construction of the complete magnetoelectric phase diagrams for the principal magnetic directions.

The magnetic and pyroelectric responses to magnetic fields were characterized along the main axes of the conical spin arrangement in quality crystals of Mn$_{0.80}$Co$_{0.20}$WO$_4$ grown by floating zone: the easy $\alpha$ and hard $\omega$ axes, and the $b$ axis. The rotation plane ($\omega b$) of the cycloidal spins is perpendicular to the easy magnetic axis of AF4 ($\alpha$). $\omega$ is the magnetically hard direction within the ac plane ($\alpha \perp \omega$). The magnetic order evolution was studied by single-crystal neutron diffraction (D23, ILL) up to 12 T, and by magnetometry (ac, dc) up to 60 T (at ICMAB and the EMFL Lab. at Dresden). The dielectric polarization was measured up to 20/60 T in static/pulsed fields. Several magnetoelectric transitions were thoroughly investigated:

A: Suppression of the conical antiferromagnetic structure under field $H \alpha$. The complete magnetoelectric phase diagrams were determined for $H//\omega$ and $H//b$, with the field applied along the two elliptical axes of the cycloid in the conical structure. These components can be separately suppressed under field producing a fan-like magnetic configuration. In this phase transition (AF2+AF4 $\rightarrow$ AF3+AF4) the ferroelectric Pb state transforms to a paraelectric phase. At higher fields the paraelectric AF3 (ICOM) and AF4 (ICOM) components are successively suppressed.

B: Conical to cycloidal structure transformation and polarization in $H // \alpha$ axis. Marked differences were found in the $H//\alpha$ topology respect to the magnetoelectric transitions in the previous configurations ($H//\omega$ and $H//b$). An increase of the electric polarization accompanies the first metamagnetic transition (Pb($H$)> Pb(0)) with $H//\alpha$. The COM AF4 spin ordering is transferred to the AF2* magnetic cycloid, which exhibits enhanced elliptical amplitudes (AF2+AF4 $\rightarrow$ AF2*). Increasing further the field, and before the forced FM (paramagnetic) state, another intermediate magnetic phase (Y phase, with no polarization) was detected. For all the phases the symmetry dictated relationships between magnetic order and the polarization tensor have been analyzed. The obtained results might be common for other magnetic materials possessing conical antiferromagnetic structures.

Conical antiferromagnetic structure in the ground state of ferroelectric Mn$_{0.80}$Co$_{0.20}$WO$_4$. H-T magnetoelectric phase diagram of a Mn$_{0.80}$Co$_{0.20}$WO$_4$ crystal for magnetic field along the $\alpha$ easy axis. Sketch of the magnetic and crystallographic axes drawn together with the conical surface that envelopes the spins.
Mecanical stress is arguably the simplest type of external field that can be applied to a crystalline solid. What happens to the electronic wavefunctions in the course of a deformation, however, is nowhere simple; on the contrary, interesting functionalities can emerge that are nowadays under the spotlight of researchers and engineers alike. An example of such functionalities is flexoelectricity, which describes the electrical polarization response to the deformation of a crystal. The control of flexoelectricity is crucial to achieve high performing devices with high reproducibility.

During the last five years or so, we have made tremendous advances towards the development of a modern theory of flexoelectricity, which describes the electrical polarization response to the gradient of a strain. (Figure)

Apart from the methodological advances, which have already been used in public code implementations, our work also uncovers some peculiar and unsuspected aspects of flexoelectricity, e.g., its relationship to the theory of orbital magnetism. These results are an important milestone towards a fundamental understanding of phenomena where an electrical polarization results from a spatially inhomogeneous configuration of the crystal.

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Anions are not naïve players in molecular conductors

Anions are usually considered to act simply as electron donors or acceptors in molecular conductors but they play an essential role in directing their structural and electronic properties.

A nions have often been considered to act essentially as a source or a sink of electrons in molecular conductors. However there is now growing evidence that they play an essential role in directing the structural and hence electronic properties of many of these systems. In this review the basic interactions and different ground states occurring in molecular conductors are considered. How anions influence the structure of donor stacks and often guide them toward different types of transitions (charge and anion ordering transitions, charge and/or spin density waves, etc.) is discussed in detail.

The well-known Bechgaard and Fabre salts are used to illustrate how donor–anion interactions in quarter-filled low-dimensional organic conductors can be used to direct the structural and hence electronic properties of many of these systems. In this review the basic interactions and different ground states occurring in molecular conductors are considered. How anions influence the structure of donor stacks and often guide them toward different types of transitions (charge and anion ordering transitions, charge and/or spin density waves, etc.) is discussed in detail.

The role of anions in directing their structural and electronic properties is now growing evidence that they play an essential role in directing these prototype one-dimensional systems. In this review the basic interactions and different ground states occurring in molecular conductors are considered. How anions influence the structure of donor stacks and often guide them toward different types of transitions (charge and anion ordering transitions, charge and/or spin density waves, etc.) is discussed in detail.

Two-dimensional molecular conductors are also subject to the control of anions. The important role played by hydrogen bonding and the conformational flexibility of donors related to BEDT-TTF is illustrated by several examples as for instance: (i) the concerted action of anion shifts and hydrogen bonding modulation in α-(BEDT-TTF)2X (X: PF6, ClO4, NO3, etc.) salts. The anions also have a crucial role in imposing the nature of the charge localized and charge ordered phases of the Fabre salts, (TMTSF)2X (X: PF6, ClO4, ReO4, etc.).

These molecules are able to accept up to five electrons and to donate one in single electron steps at accessible potentials and in a reversible way. The fact that these new compounds are very soluble in common organic solvents makes them possible candidates for molecular electronics. They offer a wider range of solvents of different nature.

Anions are not naïve players in molecular conductors

Anions are usually considered to act simply as electron donors or acceptors in molecular conductors but they play an essential role in directing their structural and electronic properties.
Improving the stability of the electrode-molecule interface

In this work, we show that Au-C bond can provide a robust and well-defined anchoring geometry for single molecule junctions.

The molecule/electrode contact plays a fundamental role in the performance of molecular electronic devices since it directly affects the charge transport across the interface. The search for a more stable molecule–electrode bond, a well-defined interface geometry, and more conductive interfaces is the driving force to pursue robust and efficient molecule based devices. Interestingly, some recent works have shown that the formation of covalent highly directional σ-bonded C–Au junctions provides high conductance at the single-molecule level. In this field, we are very much interested in exploring organic paramagnetic and electroactive molecules which are attracting interest as core components of molecular electronic and spintronic devices. In this work, we reported the synthesis of a persistent organic radical bearing one and two terminal alkyn groups to spontaneously form Au−C σ bonds. On the one hand, the formation and stability of self-assembled monolayers was achieved and, on the other hand, the electron transport through the SAMs and single-molecule junctions at room temperature was studied. We first demonstrated that the magnetic character is preserved after covalent bonding. Strikingly, it was shown that the investigated system allows for drastic improvements in the reproducibility of single molecule conductance measurements and bond strength when compared to other commonly used contacts such as S-Au. Through a detailed comparison with a similar thiophene functionalized molecule, it was concluded that the Au-C bond provides a more robust and better-defined anchoring geometry as supported by DFT calculations. Our findings open the door to more reproducible spintronics devices based on multifunctional molecules.

New facets of molecular conductors

Molecular conductors still have many uncovered facets like silver-based single molecule metals and anilate-based small polaron hopping conductors. The more challenging preparation of a stable 1D or pseudo-1D metal has first been confirmed by the preparation of Ni[tmdt]₂, a 3D molecular metal. Based on the properties of the two-band conductors it was predicted that stable metals without any doping could exist. This prediction was recently stimulated a large interest. Up to now the oxalate-based valence FeII/FeIII two-dimensional oxalate-based coordination polymers have recently stimulated a large interest. Up to now the oxalate-based materials were found to be poor conductors. However the related anilate-based systems are very good semiconductors, opening the way towards extended coordination materials.

Temperature dependence of the conductivity (left) and Fermi surface (right) of the single component ambient pressure stable metal, [Au(Me-thiazdt)]₂.

The fold of molecular conductors continuously offers new surprises and accomplishments because of the broad tunability range offered by their molecular components. Two of these still uncovered features are the recent preparation of silver-based ambient pressure single molecule metals and anilate-based new two-dimensional semiconductors.
Halogen interactions and rotor dynamics at the nanoscale

Variable temperature proton spin-lattice relaxation experiments and crystallography as well as DFT calculations decode the complex dynamics of crystalline molecular rotors at the nanoscale

Crvystalline arrays of molecular rotors with complex dynamics such as correlated motions and multiple rotational potentials, thermal dynamics coupled to lattice elasticity with a change in the crystal birefringence response or coupled to the electronic response of the system as in switchable dielectrics, and the emerging phenomenon of quantum dissipation addressing the difference of dynamics of the rotors in solids with different electrical properties are of intense current interest. The control of complex dynamic molecular systems at the nanoscale is an essential issue for the development of molecular machines capable of performing useful work. Materials design that includes deliberate use of halogen- and hydrogen-bonding interactions, as well as variable-temperature X-ray and 1H spin-lattice relaxation experiments, and calculations of rotational barriers, provide an in-depth understanding of the switching mechanism of the rotational barriers and of the frequency of associated rotational motion.

We have observed that the monolayer unit cell of a single crystal of the rod-like molecular rotor shown in the figure, abruptly changes below 105 K, experiencing an expansion by seven times its volume to encompass three molecules can be applied as active semiconducting materials in field-effect transistors. In this direction, we highlight here two recent works.

In the first work [1], a single self-assembled monolayer of an anthraquinone derivative is covalently anchored on a conducting indium-tin oxide (ITO) substrate. By application of a voltage, the redox state of the molecule can be switched which, in turn, modifies significantly the wetting properties of the substrate. This effect has been exploited for droplets actuation at low voltage. The device was further integrated in a microfluidic system to perform mixing and dispensing on sub-nanoliter scale. Further, vehiculation of cells across microfluidic compartments was made possible by taking full advantage of surface electrowetting in culture medium.

In the second work [2], crystalline thin films of organic electroactive molecules on surfaces can lead to the development of advanced electronic devices with additional advantages compared to their inorganic counterparts such as low-cost, compatibility with flexible substrates or low-voltage operation. In this direction, we highlight two recent works.

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A core component of integrated circuits, the realization of high-performance organic field-effect transistors (OFETs) from solution processing requires uniform and crystalline films with optimal electronic properties. One of the advances in the solution manufacturing process is raised from the idea of blending small conjugated semiconductor molecules with an amorphous insulating polymer to combine the advantageous properties of the individual components. This strategy has led to an overall rise in the charge carrier mobility and an improvement of device processability, reproducibility, and stability [1]. The key of superior performance of OFETs fabricated from solution processing requires uniform and crystalline films with optimal electronic properties. One of the advances in the solution manufacturing process is raised from the idea of blending small conjugated semiconductor molecules with an amorphous insulating polymer to combine the advantageous properties of the individual components. This strategy has led to an overall rise in the charge carrier mobility and an improvement of device processability, reproducibility, and stability [1]. The key of superior performance of OFETs fabricated from solution processing requires uniform and crystalline films with optimal electronic properties. One of the advances in the solution manufacturing process is raised from the idea of blending small conjugated semiconductor molecules with an amorphous insulating polymer to combine the advantageous properties of the individual components. This strategy has led to an overall rise in the charge carrier mobility and an improvement of device processability, reproducibility, and stability [1]. 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Stable fluorescent nanovesicles as new probes for bioimaging

New fluorescent nanovesicles have been developed, using compressed CO₂ technology developed in-house, to produce efficient probes for bioimaging applications.

In the frame of a Marie-Curie Initial Training Network (ITN), Nano-2-fun, new fluorescent nanoparticles with superior stability and remarkable optical properties, bearing fluorescent organic dyes, have been developed. These fluorescent nanovesicles have already proved to be efficient probes for in vivo and in vitro imaging and have potential applications as biomarkers in bio-imaging, diagnostic, biomedical applications and theranostics [1] (combined therapeutic and diagnostic functionalities). The preparation of the fluorescent nanovesicles offers a great potential for the development of multifunctional nanovesicles integrating for example drugs (such as proteins, small molecules or even genetic material), targeting peptides, and fluorescent imaging agents. Moreover, the fluorescent nanovesicles can incorporate simultaneously several dyes, obtaining probes for more complex applications, such as multicolor imaging. This platform is especially effective for the conveyance of non-water-soluble dyes whose optical properties are usually not stable in physiological media, but remain efficient after incorporation in nanovesicles [2].

cellulose, one of the most abundant biopolymers on earth, emerges as a green, sustainable and natural material for many industrial applications. Especially interesting is the biosynthesized cellulose produced by organisms which represent a suitable alternative to manufacture biodegradable and renewable materials with low energy consumption.

Production of 3D free-standing structures with control in shape and made of biocompatible polymers entails high complexity; however, these structures show great potential in tissue engineering, as soft 3D cell scaffolds or as drug delivery systems. The Soft Matter publication presents an in situ single-step process to produce self-standing 3D-BC structures with controllable wall thickness, size and geometry made of bacterial cellulose (BC). Hollow spheres and convex domes could be easily obtained by tuning the hydrophilicity of the surfaces and interestingly, mouse embryonic stem cells (mESC) could be cultivated inside. Moreover, the volume of the inoculum and time of culture further define the resulting 3D-BC structures.

The ACS Appl. Mater. Interfaces manuscript reports for the first time on the use of bacterial cellulose films to inhibit the differentiation of mESC for many days improving the cultivation of mouse embryonic fibroblast (MEF)-free in comparison to the MEF-supported conventional culture. Stem cells possess unique properties, such as the ability to self-renew and the potential to differentiate into a variety of cell types. These make them highly valuable in regenerative medicine and tissue engineering. In this work, also showed that the culture of mESCs on these flexible, free-standing BC membranes enable the quick and facile manipulation and transfer of stem cells between culture dishes, both of which significantly facilitate the use of stem cells in routine culture and various applications.
Protein Nanoparticles (pNPs) are nontoxic and mechanically stable protein particle gradients from their colloidal suspensions. One way to reproduce these gradients in vitro is one of the most popular and effective approaches to study cell motility. There is no straightforward technique that allows obtaining surface-bound biomolecules and gradients of topography or stiffness by moving to their preferred conditions.

In this work, a versatile evaporation-assisted methodology based on the coffee-drop effect is described to deposit nanoparticles on surfaces, obtaining for the first time patterned gradients of protein nanoparticles (pNPs) by using a simple custom-made device.

The response of cells to the exposure of nanomaterials is crucial for determining their safety in their multiple uses; however, the majority of the in vitro experiments use monolayered cell cultures, 2D cell cultures. Multiple studies highlight the different toxicological response, phenotype, metabolism and composition of cells grown on 2D systems (petri dishes, plastic flat surfaces) compared to their growth in 3D systems, a more realistic environment.

3D in vitro cell culture approaches emerged to obtain in vitro cell culture environments with increasing concentrations of SPIONs. We evaluated parameters analyzing the morphological changes of the cells, iron uptake and cell viability. Results showed that upon exposure to SPIONs, cell viability and morphology are more affected when cells are growing in 3D systems, indicating that the increase of exposed surface area of the cells is a strong parameter to take in account when evaluating SPIONs or other materials or drugs. Our results clearly reinforce the use of more realistic environments, such as 3D, for the design of new drug delivery systems.
Preparation of curcumin bio-metal-organic-frameworks (bio-MOFs)

This article analyses the use of supercritical CO2, green technology in the reactive crystallization processes of a bio-MOF composed by curcumin and Zn (II) metal centres.

To analyse the crystallization mechanism, multiple identical runs were performed under similar experimental conditions to study in each time period the crystal growth progress ex-situ by X-ray diffraction and scanning electron microscopy. These experiments indicated that the process to achieve the sc-CCMOF-1 in a crystalline form involves the formation of amorphous or semi-crystalline metastable phases that derived into hierarchical stable and crystalline nano-flower aggregates. In addition, a potential therapeutic application of the bio-MOF was studied. The crystal structure of the formed nanohybrid biomaterial was fully characterized. The non-cytotoxic profile of [COSAN]- has been demonstrated on V79 fibroblast cells.

The synthesized bio-MOF is composed of curcumin–based bio-MOF and its crystal structure.

Scheme of the formation of curcumin-based bio-MOF and its crystal structure.
The comparative docking analysis of EGFR inhibitor incorporating closo-carborane with compounds bearing bioisoster-substructures, demonstrated the relevance of the 3D aromatic-boron-rich moiety for interacting into the EGFR ATP binding region.

In our previous studies we reported new anilinoquinazoline-icosahedral borane hybrids as gloma targeting for potential use in cancer therapy. The anti-glioma activity of the most powerful compound against glioma cells, a 1,7-close-derivative, displayed at least 5.5 times higher activity than the parent drug erlotinib. According to the cytotoxic effects on normal glia cells, the hybrids were selective for epidermal growth factor receptor (EGFR)-overexpressed tumor cells. These boron carri ers could be used to enrich gloma cancer cells with boron for cancer therapy.

In this article [1] we report that EGFR inhibitor incorporating closo-carborane has been shown to have higher affinity than Erlotinib. The comparative docking analysis with compounds bearing bioisoster-substructures, demonstrated the relevance of the 3D aromatic-boron-rich moiety for interacting into the EGFR ATP binding region. The capability to accumulate in glioma cells, the ability to cross the blood-brain-barrier and the stability on simulated biological conditions render these molecules as lead compounds for further structural modifications to obtain dual action drugs to treat glialblasta oma.

Potential boron-based drugs for glioma treatment

This work demonstrates that Erlotinib-decorated with 3D-boron-rich-cluster resulted in an anti-EGFR lead molecule with IC50 value of 2.3 nM, 10-fold higher than the parent Erlotinib.

Remote control of neural cell behavior using induced dipoles in electroactive conducting implanted materials

Electrostimulation of neurons is possible through the induced dipoles on implanted transparent conductive materials, with distinct effects depending on the material and its intercalation properties.

This effect is known as bipolar electrochemistry, and the final induced dipole potential depends on the applied external field, the material and the geometry of the electrochemical cell. Within the electrochemical safe window of water, intercalation of ions and ionic gradients along the material occur, yielding gradients that modulate the cell growth. The observed neural effects are quite distinct depending on the material. Thus, Iridium oxide materials favor speed of dendrite growth, while PEDOT conducting polymers favor growth turning towards a specific direction. In contrast noble metals show smaller or no effects. Electroactive materials are believed to act differently thanks to the ionic gradients created within the material depending on the specific intercalation properties. Thus, iridium oxide is truly a hydrated oxohydroxide that allows H+, Na+, K+ and OH- intercalation/deintercalation processes at negative and positive poles. PEDOT-PSS on the other hand, has a large PSS anion that cannot move out of the structure and that results in cation intercalation only. This work shows a significant discovery that opens a new possibility: response of neural cells is also possible using electrodes without direct contact to the power source. Immersed conducting materials, with an external field applied by remote external electrodes, render a local dipole between the borders of the material that, in turn, may induce chemical reactions for certain potentials.

Remote electrostimulation of neural cells through induced dipoles on A-C1 metals and transparent nanostructured conducting materials.
Boron clusters bearing Tin complexes: efficient and specific cell-staining conjugates

The results presented herein demonstrate the key role played by the boron clusters, closo-dodecaborate and cobaltabis(dicarbollide), in the cell staining properties of organotin dyes. Whilst those bearing the closo-dodecaborate produce nucleoli and cytoplasmic staining, cobaltabis(dicarbollide)-containing dyes only produce cytoplasm staining. The remarkable fluorescence staining properties showed by these compounds make them excellent candidates as cell-staining fluorescent probes.

Boron clusters are three-dimensional rigid compounds with high thermal and chemical stability. Due to their intriguing electronic properties and their biological compatibility, our group and others have been interested in the development of carborane-containing dyes with potential applications in biomedicine and material sciences. Amongst the wide variety of biomedical techniques, Fluorescence Bioimaging has emerged as an important tool for cell and tissue visualisation, with organotin Schiff-base compounds proving to act as cytoplasm markers in vitro.

Therefore, incorporation of boron clusters in the structure of organotin complexes is an attractive chemical strategy, not only to modulate their photophysical properties, but also to change their cellular internalization behavior. Hence, the design of novel fluorescent organotin compounds bearing closo-dodecaborate ([B_{12}H_{12}]^-) and cobaltabis(dicarbollide) (COSAN) is described, and their cytoplasm and nucleoli staining in vitro (B16F10 cells) is studied.

Organotin compounds bearing an aliphatic chain displayed fluorescent quantum yields (FF) around 24-34%. Solution-state photophysical studies showed a considerably increase in the FF up to 49% when the aliphatic chain is replaced by the [B_{12}H_{12}]^- moiety, whereas those bearing COSAN moieties showed lower quantum yield values (3-7%). Despite this, the fluorescence intensity still allows the analysis of all the compounds by confocal microscopy (see Figure). Two noteworthy conclusions arise from the study of these confocal images. Firstly, there is a striking improvement in solubility for those boron cluster-containing complexes, and no aggregation is observed, neither in the cell media nor on the cell membrane. Secondly, the presence of each boron cluster in the structure produces a different staining effect; those bearing [B_{12}H_{12}]^- produce nucleoli and cytoplasmic staining, while the COSAN-containing dyes are only detected in the cytoplasm.

The striking results obtained for the in vitro studies, highlight the suitability of these boron cluster-containing organotin complexes as potential candidates for cell labelling agents towards medical diagnosis in clinical biopsies.
SCIENTIFIC HIGHLIGHTS

Research Projects

By the end of 2018, nine researchers of the ICMAB had been granted with ten projects of the European Research Council (ERC). The ERC operates according to a “curiosity-driven”, or “bottom-up”, approach, allowing researchers to identify new opportunities in any field of research. Accordingly, the portfolio ERC funded projects spans a wide range of topics and research questions. At the ICMAB we have projects on superconducting tapes, organic energy materials, cancer therapy and diagnosis, graphene-based devices, flexoelectricity, photonic and optoelectronic devices, molecular electronic devices, calcium and magnesium-based batteries and materials for the future 5G technology.

Our researchers have also been awarded with many other European and National projects (MSCA, INFRAEDI, COST ACTIONS, I-D RETOS...). Check them out in our Annual Report 2018 website!!

Advanced Grants

<table>
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<th>Name</th>
<th>Project Description</th>
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<tr>
<td>Teresa PUG (2015)</td>
<td>Ultrafast growth of ultrahigh performance superconducting tapes (ULTRASUPERTAPE)</td>
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<tr>
<td>Núria ALIAGA-ALCALDE (2017)</td>
<td>Efficient electronic transport at room temperature by 7-shaped molecules in graphene based chemically modified three-terminal nanodevices (FemtoTRAINS)</td>
</tr>
<tr>
<td>Gerard TOBIAS (2017)</td>
<td>Nanoeengineering of Radioactive Seeds for Cancer Therapy and Diagnosis (NEST)</td>
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<tr>
<td>Marti GICH (2019)</td>
<td>Ferrite-by-design for Millimeter-wave and Terahertz Technologies (FeMiT)</td>
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Starting Grants

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<tr>
<td>Agustín MIHI (2015)</td>
<td>Photonic electrodes for enhanced light management in Optoelectronic devices (ENLIGHTMENT)</td>
</tr>
<tr>
<td>Alexandre PONROUCH (2017)</td>
<td>Calcium and Magnesium metal anode based batteries (CAMBA)</td>
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Consolidator Grants

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<tr>
<td>Núria ALIAGA-ALCALDE (2017)</td>
<td>Efficient electronic transport at room temperature by 7-shaped molecules in graphene based chemically modified three-terminal nanodevices (FemtoTRAINS)</td>
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Proof of Concept

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<tr>
<td>Marta MAS-TORRENT (2014)</td>
<td>Large Area Organic Devices with Bar-Assisted Metal-assisted Shearing Technology (LAB-TECH)</td>
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Scientific Outputs

ICMAB confirmed its leadership in excellence in science in the Nature Index 2019, which was based on published research articles from 1 January 2018 to 31 December 2018. The Institute was the first in the ranking among the CSIC centers, in terms of research outputs. CSIC was the first research institute in Spain, was ranked 54th in the world ranking, and the 4th of the government institutions. The Nature Index database is an indicator to value the impact of the research outputs, and compare it to other research institutes of the world and within the CSIC. The Nature Index tracks the author affiliations collected from high quality scientific articles published in 82 high-quality science journals independently selected by a panel of active scientists.

Our Institute is characterized by its high quality research outcomes and by its highly talented people. At the end of 2018, we counted with 5,223 publications, and more than 144,000 citations, with an average ratio of more than 26 citations per paper and a total h index of 137.

The ICMAB researchers collaborate mainly with universities (549 collaborations), research institutes, hospitals, synchrotrons and other large facilities or state agencies (348 collaborations), and in a minor way with other CSIC centers (33 collaborations), private companies (18 collaborations) and other consortiums and institutions (6 collaborations). During 2018, ICMAB researchers have written 226 articles in international peer-review science journals of various disciplines: chemistry, physics, materials, nanotechnology, photonics, energy, superconductivity, biochemistry, etc., with an average impact factor of 6.30. The lead index (articles with corresponding author from the ICMAB) is 57 %.

According to the Scimago Journal Ranking (SJR), 88 % of the papers were in first quartile (Q1) journals, 72 % in first decile (D1) journals, and 16 % were published in journals with impact factor above 10 (data from Journal Citation Reports 2018).

70 publications from 2018 are currently Open Access (31 %), either through the gold route (in Open Access journals) or the green route, in Digital CSIC, the institutional repository of the Spanish National Research Council, which organizes, preserves and provides open access to CSIC research outputs. Moreover, 1 publication of 2018 is considered “highly cited paper” by the Web of Science, i.e. it is in the top 1 % mostly cited in its category and year worldwide.

Scientific Collaborations

The internationality and interdisciplinary of our researchers is also confirmed by the high number of collaborations with other countries’ institutions. In 2018, the International Collaboration (IC), i.e., articles with co-authors from other countries, were 71%: The ICMAB had 273 collaborations with researchers from 44 countries, being the top 10 countries: Italy, France, USA, Germany, England, Switzerland, Belgium, Luxembourg, Japan and China.

The ICMAB researchers collaborate mainly with universities (549 collaborations), research institutes, hospitals, synchrotrons and other large facilities or state agencies (348 collaborations), and in a minor way with other CSIC centers (33 collaborations), private companies (18 collaborations) and other consortiums and institutions (6 collaborations).

Regarding the collaborations with large facilities, 51 articles in 2018 are co-authored by researchers from these installations, such as ALBA Synchrotron (24), EMAT-Electro Microscopy for Materials Science-Antwerp (5), Diamond-Diamond Light Source, Elettra-Elettra-Sincrotrone Trieste, ILL-Institut Laue Langevin, IMA at INLAB, de Microscopios Avanzados at INIA, Oak Ridge NL, MatSci Drs, (2 collaborations), and EMB-DEI Neutron and Muon Sources, ALS-Advanced Light Source andSOLEIL Synchrotron (1 collaboration).

The CSIC centers with which we most collaborated in 2018 are the ICN2 (23) and the IIBB-CNM (6) (located at the UAB Campus), and the ICMAB (Zaragoza), CFM (San Sebastián), IIBB (Barcelona) and INCAR (Oviedo) (1 collaboration each).
The journals with Impact Factor (IF) 10 or higher in which the researchers have published an article are the following (data from Journal Citation Reports 2018):
Scientists and awards

**Enric Canadell** elected member of the Royal Academy of Sciences and Arts of Barcelona (RACAB)

**Sole Roig**, PhD researcher at the NN group, finalist of the UAB contest “Test en 4 minutes”

**Arnau Bertran**: Premi Sant Jordi 2018 from the SCQ-IEC for his bachelor’s thesis

**Sole Roig**, PhD researcher at the NN group, finalist of the UAB contest “TesI en 4 minuts”

**Five ICMAB graduates** in Materials Science received the PhD Extraordinary Award - Laura Cabana, Pedro López-Aranguren, Nerea Marullo, David Pequeno and Albert Queraltó

**Arpita Saha** receives the 3rd prize for the Oral Communication at the UAB Jornades Doctorals 2018

**Judith Guasch, Arántzazu González and Ignasi Fina** awarded with a Ramón y Cajal grant

**Arpita Saha** receives the 3rd prize for the Oral Communication at the UAB Jornades Doctorals 2018

**José Jurado, Milena Cervo and Jan Grzelak** received their INPhINIT “la Caixa” fellowship at Caixaforum

**Sole Roig**, PhD researcher at the NN group, finalist of the UAB contest “TesI en 4 minuts”

**Robert Verrelli** winner of the 6th Early Career Scientist Presentation Contest of the World Materials Research Institute Forum

**Mariona Coll** acknowledged by the CSIC for her L’Oréal-Unesco FHIS 2017 Research Award

**PhD Extraordinary award for three ICMAB graduates**: Justo Cabrera, María de la Mata Fernández and Manuel Souto

**Jaume Veciana**: Olivier Kahn Plenary Lecture speaker at the ICMM 2018

**Roberta Verrelli** and Elzbieta Pach, new Juan de la Cierva postdoctoral fellows at ICMAB

**Nora Ventosa** designated new numerary member of the IEC

**Robert Verrelli** and Elzbieta Pach, new Juan de la Cierva postdoctoral fellows at ICMAB

**Nora Ventosa** designated new numerary member of the IEC

**Martí Gilh** awarded with a 2018 ERC Consolidator Grant!

**Judit Morlà-Folch** and the NANOMOL group awarded with a TECNOspring Plus grant

**ICMAB**

The ICMAB awarded with the Gender Equality Certificate by the CSIC

**Communication & outreach projects**

The ICMAB received the Maker of Merit award at the Barcelona Maker Faire 2018

**Research projects and groups**

MIT-Spain grant for ICMAB project: new materials for photovoltaics

NANOMOL group accredited with the TECNIO certification

CIBER-ONC/CIBER-BBN grant for an ICMAB project on cancer immunotherapy: ALYCIA

The project Greenc3D, awarded as best initiative of circular economy by the Generalitat and the PRUAAB

Comfuturo project granted to Ignasi Fina for his project on improving photovoltaic efficiency

NANBIOSIS renews its accreditation as ICTS

**Achievements**

A project to prevent infectious diseases with functionalized catheters led by Imma Ratera awarded by La Marató de TV3

The ICMAB most cited article of all time has more than 7400 citations!

**ICMAB**

The ICMAB is the first center in the CSIC in terms of research outputs per capita, according to Nature Index

**NANBIOSIS** renews its accreditation as ICTS
INSTITUTIONAL HIGHLIGHTS

Research Staff

Scientific staff is formed by the permanent research staff (61), postdoctoral fellows (58), and PhD researchers (115), giving a total of 232 researchers. 52 % of the postdocs and 47 % of the PhD fellows are from abroad.

The support staff (56) is formed by the technical staff (27), the administration staff, the library staff, the IT department and the maintenance and safety staff (21). From the support staff, 56 % have a permanent position and 43 % are female.

In addition, we have visiting researchers (6), undergraduates and master students (34), and the staff working also in spin-offs (6).

Of the total staff, 58 % are male (42 % female) and 30 % are from abroad, from a total of 26 countries. 41 % of the staff has less than 30 years old, and 18 % are more than 50.

External Funding

The Institute secured a total budget of 14.7 ME in 2018. The competitive budget represents a 64 % (9.4 ME) and 36 % comes from the CSIC (5.3 ME). The budget from the European Union represents a 27 % of the total budget (4 ME), and 19 % of the total budget comes from the Ministry of Science, Innovation and Universities (2.8 ME). The budget from private sources (including contracts and services) represents a 5 % of the total budget (0.8 ME).

A 51.8 % of the budget devoted to the scientific projects carried out at the ICMAB comes from the European Union, a 35.9 % from the Ministry of Science, Innovation and Universities, a 10.3 % are Industry Contracts and a 2 % is funding from the Generalitat de Catalunya. The EU funding has been extraordinary high during 2017-2018.

Half of the ICMAB personnel are funded by the CSIC (50 %), while the other half are funded by projects (31 %), other fellowships (13 %), ICREA (4 %) and CIBER (2 %).

Scientific Services

Research is supported by the Scientific Equipment Platforms that provide access to specialized and cross cutting equipment, services and expertise for the advanced technological preparation and characterization for all kinds of materials at different levels. Nine technical facilities run by specialized technicians form the Scientific Equipment Platforms, together with the Nanoquim Platform, a 10,000 Clean Room. These are open to external uses either from academia and industry, with conditions tailored to meet customer technology demands. During 2018, the Scientific Coordinator of the Services is Prof. M. Rosa Palacín, also Deputy Director of the Institute.

On 5 February 2018 we hosted the seminar entitled “Latest innovations in the Nanoquim Platform and ICMAB Scientific Services” to inform about the new released videos for the Nanoquim users and the new website, and to talk about some novelties in the rest of the services, especially in the Low Temperatures and Magnetometry Service and the X-ray diffraction (XRD) lab.

The Cell growth Laboratory, a shared facility between the ICN2 and the ICMAB, was still under construction at the ICN2 building. The new HERTEM facility, to be built at ALBA Synchrotron, and shared between ALBA Synchrotron, BIST, CSIC, ICN2 and ICMAB is still pending of confirmation.

1. Nanoquim Platform

The Nanoquim Platform during 2018 performed a total of 1946 experiments, 3 % more respect to 2017. A total of 143 are active users, 119 from the ICMAB, 19 from the PRUAB, and 1 from an external company. During 2018 the platform acquired two new equipment, both located in Laboratory 1: a Plasma cleaner, and an Optical microscope. The Nanoquim Platform, on behalf of the ICMAB, participated in the Ramón Tobar Prize offered by the CSIC in the field of Health and Safety. In addition, the service receives multiple school visits (ESCOLAB, Bachelor and Master Students, summer schools) and from secondary school teachers. The new videos for the Nanoquim users and the new website was released.

2. Low Temperatures and Magnetometry Service

The laboratory has given service for a total of 10,037 hours, which are distributed quite equitably between the different equipment: 2,605 hours for PPMS (P2), 2,549 hours for PPMS (P3), 2,495 hours for MPMS XL-7 (S1), and 2,388 hours for MPMS XL-7 (S2). Nearly 50 % of the service is devoted to samples from the Superconducting and Large Scale Nanostructures (SUMAN) group, followed by the Advanced Characterization and Nanostructured Materials (AGNM) group (13.5 %) and external users (7.8 %), including the Institut Català de Nanociència i Nanotecnologia (ICN2) and the Universitat Autònoma de Barcelona (UAB). The users of the service belong to 22 PI (principal investigators). The laboratory has also given access to users within the NEFIA Europe project (300 hours).

A recent feature of this lab is the new Helium liquefaction equipment, which allows recycling the Helium used to carry out the measurements at low temperatures. In total, during 2018, 63 % of the Helium used was recycled Helium, and only 37 % had to be bought.

The service has participated in many science education activities, including the 15th edition of the Argó programme, the ESCOLAB school visits, and the Kids’ Day. The service has participated in many scientific publications.
INSTITUTIONAL HIGHLIGHTS

3. X-ray diffraction (XRD) lab

The XRD lab has been used for a total of 4,927 hours in 2018, corresponding to 4,863 samples and 93 users from 32 PI. The equipment used are the diffractometers Siemens D-5000, GADDS and D8 Discover. The service has participated in many science education activities, including the 15th edition of the Argó programme, the ESCOLAB school visits, the Kids’ Day, and the activity “Converteix-te en un detectiu de minerals” for primary school students.

4. Thin Films Laboratory

The thin films laboratory has produced a total of 496 thin films deposited: 349 samples using Pulsed Laser Deposition (PLD) and 147 samples using Sputtering. 61 % of the samples are for the Laboratory of Multifunctional Thin Films and Complex Structures (MULFOX), 37 % for the Superconducting and Large Scale Nanostructures (SUMAN) group and 2 % for the Crystallography of Magnetic and Electronic Oxides and Surfaces (CMEOS) group. The laboratory has also given service to NFFA Europe users (59 samples). The service also participates in some outreach activities, especially school visits and secondary school teachers visits who love to use the PLD equipment.

5. Spectroscopic Techniques Laboratory

The Spectroscopic Techniques Laboratory includes the FT-IR equipment, the UV-Vis-NIR instrument, the optical microscopy and the EPR (Electron Paramagnetic Resonance) equipment. All the equipment have a high internal use. The external users represent the 5 % of the total users. Specifically, 26 PI have used the FT-IR service, 23 the UV-Vis-NIR service, 16 the optical microscopy and 8 the EPR. The UV-Vis-NIR service has been the most used, with a total of 727 hours.

6. Preparation and Characterization of Soft Materials (Soft Lab)

The Soft Lab counts with 50 % of external users, 33 % of the users come from the CIBER-BMN, and 17 % are internal users from the ICMAB (from 8 PI). The external users during 2018 include: Institut de Biotecnologia i Biomedicina (IBB), Vall d’Hebron Research Institute (VHIR), Universitat Autònoma de Barcelona (UAB), Instituto de Ciencias del Mar (ICM-CSIC), Institut d’Investigacions Biomèdiques de Barcelona (IIBB-CSIC), Universitat de Barcelona (UB), Institut Català de Nanociència i Nanotecnologia (ICN2), Universitat de Salamanca, Instituto de Ciencias Fóticas (ICFO), Instituto de Investigaciones Biológicas de Bellvitge (IDIBELL), Hospital de Salamanca, Centro Investigación Cáncer (CIC), Hospital de Sant Joan de Déu, Pragmatics Diagnostics, Nanomol Technologies, BCN-Peptide, Carbores Metàl·lics, Lekat and Spherिtom Biomel.

7. Scanning Probe Microscopy (SPM)

This service, which counts with two Atomic Force Microscopy (AFM) equipment, has given service to 65 users, giving a total of 4,770 images, corresponding to 12 PI. The service has also actively participated at the NFFA Europe project. The users of the NFFA Europe project and the SPM service have collaborated in many scientific projects.


The Electron Microscopy service is formed by the Transmission Electron Microscopy (TEM) and the Scanning Electron Microscopy (SEM), which are run by two technicians. The TEM in 2018 gave service for a total of 489.5 hours: 42 % of the hours were for the Nanoparticles and Nanostructures group, 20 % for the Solid State Chemistry group, 11 % for the Inorganic Materials and Catalysis Laboratory, 6.3 % for the Superconducting Materials and Large Scale Nanostructures, and the rest distributed between the Crystallography, Functional Nanomaterials Surfaces. Advanced Characterization and Nanostuctural Materials, Nanostuctured Optoelectronic Materials, Molecular Nanoscience and Organic Materials; and only 9 hours for external users. During 2018, 15 publications of the Institute used the TEM service.

The service has participated in many science education activities, including the ESCOLAB school visits, and the Kids’ Day, and has participated in many scientific publications (6 in 2018).

9. Thermal Analysis Lab

The Thermal Analysis Lab is formed by two equipment: the TGA (thermogravimetric analysis) and DSC (differential scanning calorimetry). Regarding the TGA, of a total of 225 samples (450 experiments, because each sample is done twice, 81 % of them belong to internal users from the ICMAB, and 19 % from external users. Among the internal users, the samples belong to 12 PI and 7 research groups, 30 % from the LMI group, 25 % from Solid State Chemistry, 23 % from the NN group, and the rest distributed between the Crystallography group, the FunNanoSurf, the MULFOX and the SUMAN group. The external users during 2018 were the ICN2, the Universidad del Paìs Vasco, APPLUS, and the UAB.

The DSC equipment has been used to analyse 53 samples, 45 % belong to internal users and 55 % to external users. The internal samples correspond to 6 PI and 3 research groups: 52 % from the Nanomol group, 28 % from the Solid State Chemistry group and 20 % from the LMI group. The external users during 2018 were the ICN2, Laboratorios Maverick, APPLUS and the UAB.

The service has participated in the ESCOLAB school visits during the year.
Library

The library of the Institute is specialized in Materials Science. It is part of the global CSIC Library Network, which includes a total of 80 specialized libraries distributed among 21 cities. The library collection covers subject areas related to Materials Science such as Physics, Chemistry and Crystallography. It has more than 2,000 monographs and 105 periodic publications.

The library is open to all ICMAB staff and other CSIC personnel and also to other Research or Academic Centers who would like to make use of it. Alejandro Santos is the Librarian & Documentalist of the ICMAB Library “Manuel Cardona.”

Library Activities 2018:

The library has 2,363 titles registered in the institution’s collective catalogue, with 17 new acquisitions in 2018, and 77 open subscriptions to scientific journals. The library has registered 29 monograph loans from 25 active readers during the year.

The service for requesting documents counted with 79 external requests (42 from CSIC centers, including 68 for journal articles and 11 for monographs, according to the URICI statistics. For several months, the library, in collaboration with the Communication and Outreach Office, gave the "Essential Documentation Tools" course for young researchers. The training course included modules focused on documentation resources, such as "Document access," "Publication and Open Access," and "Databases," among others.

In March, after several specific training sessions, the integral library management system of the CSIC Library Network was changed from Aleph to ALMA in order to improve the management of information and the quality of the service to our users.

The library participated in face-to-face training courses in reference databases, Scopus and Web of Science, at the Research and Development Centre (CID) in Barcelona. The library also carried out various bibliometric calculations for researchers and for the centre as a whole, such as, for example, the bibliometric report for the SAB evaluation of the Severo Ochoa project.

Maintenance Service

The Maintenance Service is in charge of the maintenance and conservation of the building, of all its facilities and of the equipment. It works from the year 1991, when the Institute moved to the new building.

It is also responsible for all the equipment, materials and tools (mechanic, electronic and electric) available to all the ICMAB personnel. The Maintenance Service was formed in 2018 by Toni Pons, Oriol Sabater, José Manuel Rodriguez, José Ángel Algar, Pere Fernández, Juan José Monis and Roberto Díaz. In August 2018, Toni Pons, who was in charge of the Maintenance Service from its origins, retired. On 23 July 2018 we wished him good luck, with a nice breakfast and gifts from all the staff. Oriol Sabater, who worked hand in hand with Toni since the year 2000, became then the head of the Maintenance Service.

New laboratories and offices

In 2018 we inaugurated two new laboratories in the third floor of the MATGAS building: a new Cleanroom and a Chemistry Lab, corresponding to the ERC-Ultrasupertapes project. In the ground floor, the plans were to begin the works for a new Chemistry Lab, corresponding to the ERC-Tmol4Trans project, and a Chemistry and a Physics Lab, corresponding to the ERC-Tmol4Trans project. The works finally started in 2019.

Moreover, during 2018, more space was made, both at the MATGAS and ICMAB buildings, to allocate more tables for scientific, technical and support staff.

Administration

The ICMAB Administration is responsible for all of the administrative processes at the Institute, mainly general accounting, charging and payments, and also the accounting of the different research projects. It is also responsible for the inventory, purchasing and public tenders.

Information Technology Department

The IT Service, formed by Joan Figuerola, Ángel Elbaz, Javier Rubio, Albert Moreno and José Antonio Gómez, manages all the computer systems, the data network, internal software and the digital presence of the ICMAB, placing them at the service for the researchers and management staff.

During 2018, the IT Service has carried out the following activities:

• Improvement of the ICMAB hardware and network: new WiFi infrastructure, incorporation of new audiovisual and conference call equipment in common spaces, maintenance and improvement of the network infrastructure, adaptation of the common spaces to HPC (high performance computing) equipment.
• Improvements in security measures: update of the website and servers with new security measures, maintenance of the websites (around 10%), implementation of granular back up for file recovery, migration of equipment to an Active Directory domain, network implementation for replication of virtual machines. Update and securitization of the 1P telephony server and full integration with SIP CSIC telephony system.
• Software development and improvement: development of conference websites (hpsp18) and department and projects websites, online system for personnel recruitment, maintenance and evolution of programs (purchases, invoices, booking experiments, personnel management, projects...)
• Improvements in the user’s PC: extensions and improvements in user’s PC, update of Windows 10 in all the computers.
• Infographics and design of all the websites and corporative material, including flyers, banners and posters, in coordination with the Communication and Outreach Office.

Administration

Library

Maintenance Service

Information and Technology Department
Frontier Interdisciplinary Projects (FIPs)

Continuing the Strategic Vision for the Severo Ochoa programme FUNMAT ("Smart FUNCTIONal MATERIALs for social grand challenges"), the ICMAB opened in 2018 the call for the third edition of the Frontier Interdisciplinary Projects (FIP). Out of all the proposals submitted, 9 projects in different fields were granted.

The FIP are an internal call of proposals for researchers of the Institute aimed for the development of high-risk exploratory projects of interdisciplinary character to generate cutting-edge research in the application areas of clean & secure energy, smart & sustainable electronics or smart nanomedicine. FIP projects aim to reinforce the internal links and scientific critical mass of ICMAB’s researchers, and to contribute to strengthen the international leadership of the Institute in the area of functional materials.

The researchers of the Institute are able to propose innovative and risky ideas with potential to end up in the market, “proof-of-concept” trials based on previously obtained results or novel ideas for radically new technologies. The projects run for 1 or 2 years, and can be individual or collaborative (between researchers of different research groups).

In 2016 we granted 6 projects with a total of 400,000 € for the Institute researchers, allowing the contracts of 3 PhD fellows and 3 postdoctoral fellows within these projects. In 2017 we financed 9 projects with a total of 550,000 €, 1 of which was in the new-created category “proof of concept”, allowing the contracts of 1 PhD fellow and 7 postdoctoral fellows. In 2018 we financed 9 projects with a total of 540,000 €, allowing to recruit 2 Master students, 5 PhD researchers and 3 postdoctoral fellows. From these 9 projects, 2 of them were individual, 6 collaborative and 1 proof-of-concept. In total, during the Severo Ochoa period, we financed 24 FIP projects: 6 for RL1, 2 for RL2, 7 for RL3, 2 for RL4 and 7 for RL5.

The granted FIP projects of this call 2018 are the following:

**Individual FIP**

- José Vidal: Developing New Contrast Agents for Magnetic Resonance Imaging
- Xavier Torrellas: Oxide Surfaces with catalytic activity in switchable films by reversal ferroelectric polarization of the substrate

**Proof of concept**

- Joffre Gutiérrez: High field superconductors’ technology for particle accelerators

**Collaborative FIP**

- José Giner and Concepción Domingo: Exploring the limits of the uniqueness of hierarchical hybrid adsorbents for energy applications
- Aitor Ariztia González and Ana M. López-Periago: Preparation of bifunctional nanodevices for photodynamic therapy obtained from surface anchored Metal Organic Frameworks using sustainable CO2 technology
- Anna Palau and Narcís Mestres: Reversible switching of superconductor-insulator transition for green electronic devices
- Florencio Sánchez and Ignasi Fina: HfO2-based EPItaxial ferroelectric tunnel junction MEMories integrated with Si
- Alberto Pomar and Benjamín Martínez: All-oxide heterostructures for pure spin currents generation and detection
- Jaume Veciana and Paula Mayorga: Higher efficient charge-transport induced by chiral perchorotriphenylmethyl radical based

Important outputs of the FIPs are already detected, including strong generation of internal synergy, high risk of ideas incentivized and enhanced competitiveness. Some of the outputs include 27 publications, 56 presentations in conferences, 15 training contracts, 12 new projects, 5 dissemination activities, 2 patents, 4 contracts with the industry and 6 new established collaborations.
Talent attraction and recruiting

The objectives of the talent attraction and recruiting actions are to improve our current training programs, to attract scientific talent, to educate, support and guide the young researchers and to boost our internationalization. The targets of the actions are especially focused on Master students, PhD and postdoc fellows, and permanent researchers. In total, during the Severo Ochoa period, 21 Master students, 61 PhD researchers, 24 postdoctoral fellows, 5 technicians and 6 tenured scientists have been recruited so far.

TOOLS & ACTIONS

MASTER STUDENTS ACTIONS

1 - Severo Ochoa Master internships

We have created a Master’s students call, which was first launched in 2016 in collaboration with the CSIC, so that Master students could complete their Master’s final research project in one of our ICMAB research groups. In 2016 we granted 7 scholarships for 3 months and 3,000 € each, in 2017, 7 scholarships for 3 months and 5,000 € each, and in 2018 we granted 7 more scholarships for 3 months and 5,000 € each. A total of 21 scholarships for Master students have been granted in these three years.

2 – University of Barcelona Careers Fair (Fira d’Empreses)

On May 2018, the ICMAB was among the over 100 companies and research institutes to interact with students taking the first steps towards a career in science at the UB Physics Faculty. We explained the students our PhD program and opportunities to carry out research with us.

PREDOCTORAL ACTIONS

1 - Own doctoral programme COFUND MSCA DOC-FAM

With this MSCA COFUND DOCoral training programme in Functional Advanced Materials (DOC-FAM) project, coordinated by the ICMAB and with 4 more partners (ALBA Synchrotron, IMB-CN2-CSIC, IReC, ICN2) we have incorporated 5 new PhD fellows in the first call in 2017 and 4 more will be incorporated in the 2018 call (financial assistance 35,000 €/year for 3 years). A total of 22 early stage researchers (ESR) will be part of this programme.

2 - COFUND MSCA INPINIT

We also participate in the COFUND MSCA INPINIT coordinated by "La Caixa" Foundation, hosting 5 PhD fellows in the 2017 call, and 1 PhD fellow will start within the 2018 call (financial assistance 34,800 €/year for 3 years).

3 - Spanish Ministry of Science, Innovation and Universities Program

We also host PhD fellows from the National Programme for the Promotion of Talent and its Employability (Spanish Ministry of Science, Innovation and Universities). Some of the predoctoral researchers have a Severo Ochoa Fellowship: 6 fellows from 2016, 4 fellows from 2017 and 4 fellows from 2018 (financial assistance 10,000-20,600 € for 4 years), 5 fellows have a FPU (Training of University Teachers), and 8 fellows a FPI (Training of Research Personnel).

4 – Generalitat Program

We host 3 fellows with a PhD grant from the Generalitat de Catalunya.

5 – China Scholarship Program

In 2018, we have a total of 21 PhD fellows from China carrying out their PhD at the ICMAB thanks to the China Scholarship Program grants.

POSTDOCTORAL ACTIONS

1 – COFUND MSCA P-SPHERE

We are partners of the UAB-coordinated COFUND MSCA p-SPHERE for postdoctoral fellows. At the Institute we have 1 fellow from 2016 and 4 from 2017 (financial assistance 48,900 € for 3 years).

2 – MSCA Individual Fellowships (IF)

We support researchers in the preparation of proposals to MSCA-IF. In 2016, 3 proposals were awarded, in 2017, 1 proposal was awarded, and in 2018, 2 proposals were awarded. These fellowships are for 2 years of postdoctoral research at the ICMAB.

3 - National and regional calls (JdC, RyC, BfP)

We support the already existing calls for pre-disc and postdoc researchers, including the Juan de la Cierva (10 researchers currently), Beatriu de Pinós and Tecnio (5 researchers), Ramón y Cajal (4 researchers), and Jóvenes Investigadores (1 researcher).

PERMANENT RESEARCHERS

1 – Start-up package for new permanent researchers

We support the new permanent researchers with 25,000 € so that they can begin new projects, thanks to the Severo Ochoa project. In total, 1 CSC permanent researcher was incorporated in 2016, 2 in 2017 and 3 in 2018.

TECHNICIANS

From the 5 technicians recruited during the Severo Ochoa period, 3 are PTA cosigned with the CSIC and 2 have Severo Ochoa contracts.

Mobility Actions, Training, and Internationalization

PHD THESSES 2018

In total, by the end of 2018 the ICMAB graduates amounted 254, and 113 PhD fellows were carrying out their thesis. During 2018, 14 PhD theses were defended, 5 women (36 %) and 9 men (64 %), and of the 25 supervisors of the graduated fellows, 15 were women (60 %) and 10 men (40 %).

SEMINARS

Three types of seminars are organized within the ICMAB. The first and more known are the ICMAB Periodical Lectures, organized by the Seminars and Training committee. These biweekly seminars are talks of general interest for the material science community. The invited speakers are selected by the committee among a pool of candidates nominated by scientists of the institute. The goal of these seminars is two-fold: (i) to provide a general introduction to a non-specialized audience in that particular topic; (ii) stimulate the collaboration with ICMAB researchers or reinforcing them, if already existing.

The second type of seminars are the Invited Seminars: invited researchers that come to the ICMAB to present their research and collaborate with some of our researchers, participate in a conference in the area, etc. This are hosted whenever the invited researcher is available, although most of them are on Mondays.

The third type of seminars are special seminars to commemorate a special day, such as the International Day of Women and Girls in Science or Christmas, for example. An invited speaker expert in a field (not necessarily Materials Science) is proposed by either the staff or the Communication and Outreach committee and invited to give a one-hour lecture for all our staff.

CONFERENCES AND MEETINGS

ICMAB researchers have presented their results in more than 139 international meetings and 17 national meetings. Of the communications, 53 were invited Conferences, 75 Oral Communications, 3 Plenary Talks and 25 Poster Presentations. The conferences are of a broad range of topics: superconductivity, phosphorus, boron and silicon, nanocomposites, materials science, coordination chemistry, nanoparticles’ applications, lithium batteries, organic and hybrid thermoelectrics, colloids, solid state physics, paramagnetic materials, nanoscience and nanotechnology, low temperature electronics, synthetic metals, molecule-based magnets, medical chemistry, semiconductors, etc.

In addition, the researchers organized 3 international conferences, co-organized many symposiums in international conferences and participated in the scientific committees and as chair members, and participated in the SOMMs 100sciences 3 meeting.

12-14 March: COST TO-BE Spring Meeting "Towards Oracle Electronics" organized by RLS ICMAB researchers in Sant Feliu de Guíxols

23-27 July: International Conference and Workshop on High Pressure Semiconductors & Superconductors Physics in CosmoCaixa (Barcelona) organized by RLS ICMAB researchers

15 November: 100Mètges 3 Meeting: Bridging Science and Society in CNIO (Madrid) with the participation and collaboration of ICMAB researchers

10-12 December: International Conference on Phosphorus, Boron and Silicon (PBS 2018) organized in Barcelona by RLS ICMAB researchers
COURSES AND WORKSHOPS

Workshops and Summer schools
Each RL organizes a workshop and/or a summer school per year. Workshops are small conferences that typically last two days and feature international invited speakers. It also gives ICMBE students and young postdocs an opportunity for visibility of their research activity and exposure them to a stimulating international environment. Summer schools are weekly long schools that include lectures and hands-on sessions with international professors and networking activities. In 2018, the RL1 and RL2 organized the summer school “Materials for Energy” (MATENER) on 17–20 September 2018. More than 40 students participated in the event. In addition, the RL3 organized the summer school in the framework of the EU COST action “TO-RE” on Oxide Electronics. The RL5 organized the one-day workshop “Nanomaterials and plants” in collaboration with the CRAG (Center for Research in Agricultural Genomics), and the RL5 co-organized a workshop on Atomic Layer Deposition. ICMBE researchers also collaborated in the organization of two other summer schools: the ICFO school on emerging photovoltaics (in collaboration with ICFO), and organized a workshop on Atomic Layer Deposition. ICMBE researchers CRAG (Center for Research in Agricultural Genomics), and the RL3 co-organized a workshop on Atomic Layer Deposition. ICMBE researchers also collaborated in the organization of two other summer schools: the ICFO school on emerging photovoltaics (in collaboration with ICFO), and the summer school in nanoscience (organized by the UIMP).

Complementary skills courses and workshops
At the ICMBE we also make an effort to offer transversal knowledge to our researchers’ skills on scientific presentations, use bibliographic tools, project management or how to protect knowledge through patent filing are essential. Researchers also learn scientific writing and results communication.

Support the participation in international conferences
We financially support the attendance to international conferences for our researchers (especially PhD fellows), so that they can present their research outside the walls of the ICMBE. In the two calls that we opened we were able to support the travels of 14 PhD students, all of them delivering an oral presentation at flagship conferences about materials science.

Networking activity during the “Materials for Energy” Summer school (MATENER)

Technology and Knowledge Transfer

The mission of the Knowledge Transfer Unit (KTU) at ICMBE is to translate the ICMBE research into social use via technology and knowledge transfer through a process that provides social and economic benefits to the ICMBE, the Industry and the society.

We are approaching a quality improvement of our technology transfer processes, especially for new marketing opportunities of our research results. For this reason, in 2018 we have completed the project “Review of technology transfer practices at ICMBE: assessing the technology transfer potentials along selected value chains” commissioned by the Fraunhofer IMW.

Following the KTU improvement plan, we have increased our Human Resources by incorporating one new expert with strategic capabilities, especially in IP issues.

To date we have filed and licensed a significant number of patents, and we are responsible of advising our researchers in IPR related matters.

The ICMBE has signed many contracts and collaborations with different types of companies, and, in addition, our researchers contribute by developing new knowledge in collaboration with our industrial partners in many European projects:

- **FORTISSIMO** on computationally intensive simulations.
- **COMMON SENSE** responds to requests for integrated and effective data acquisition systems by developing innovative sensors that will contribute to our understanding of how the marine environment functions.
- **SEA-ON-A-CHIP** deals with the real-time monitoring of SEA contaminants by an autonomous Lab-on-a-chip biosensor.
- **NAADES** with the aim of develop and demonstrate the ambient Na-ion battery under realistic conditions as an effective alternative to the Li-ion battery for stationary Electric Energy Storage (EES) application.
- **SMART-4-FABRY** deals with the reduction on the Fabry disease treatment cost and a substantial improvement in the life-quality of Fabry disease patients.
- **FASTGRID** with the aim of enhancing the technical and economical attractiveness of high-temperature superconductor (HTS) coated conductors (REBCO conductors) for their application in SuperConducting Fault Current Limiters (SCFCL).
- **KARDITOOL** translates a laboratory proven concept of a saliva biosensor to the clinical practice for addressing the priority needs in personalized HF diagnostics and therapy monitoring at the point of care.

**E-MAGIC** aim is on practical Rechargeable Magnesium Batteries (RMB) as a cutting-edge high-risk / high-reward research and innovation that aim to demonstrate a new technological paradigm.

In 2018, particularly, we signed contracts with the following companies and institutions:

- Pharmaceutical companies: Grifols, Interiqm, Moheb and Medichem
- Energy storage and batteries: Repsol
- Spin-offs: Nanosol Technologies, Oxolutia
- Technological centers: Fundacio Eureca
- Global Institutions: CEA-Comisariat à l’énergie atomique et aux energies alternatives, SRON-ESA, DSG Global and USAID, Max Planck, WWSC.

We also participate in industrial national projects called “Retos colaboracion”, which are led by the following companies: Pharma Mar and Almirall.

In 2018, the ICMBE has applied for 6 patents:

1. A post-functionalizable, sustainable and cost-effective graphene aerogel. A. Lòpez-Petitpas
2. Flexible graphene oxide electrodes by laser radiation. A. Pérez
3. Quantum rods obtained in water with enhanced fluorescence intensity. F. Teixidor
4. Quantum rings obtained in water with enhanced fluorescence intensity. F. Teixidor
5. Mineral ice nucleation in sprays at high temperatures. A. Verdaguer
6. Superconducting material and process for producing the same. T. Puig

Some of our patents are co-ownership with companies:

- Insect repulsion and/or barrier arrangement and method for repelling insects. E. Molins, with Biogent
- Mineral ice nucleation in sprays at high temperatures. A. Verdaguer
- Superconducting material and process for producing the same. T. Puig, with Oxolutia

And we have licensed the following patent:

- Mineral ice nucleation in sprays at high temperatures. A. Verdaguer. Company: Technalpen
Communication & Outreach
The ICMAB Communication & Outreach Office offers a range of services to effectively disseminate the knowledge generated at the Institute. Its goal is to maximise impact across all key stakeholder groups. Its actions are aimed at finding the most effective way to engage a range of audiences, from the internal community to industry and schools. Among its responsibilities are:

- Internal communication: encourage collaboration, act as an information and consultation point, welcome Protocol, organize events, communication plan
- Corporative image: institutional image, visual identity, logos, templates, posters, graphic design, ensure the quality of internal and external texts
- Relationship with the press: press releases, science websites, coordination with the CSIC Communication Department
- Public engagement and science education activities and school visits: joint activities with BNC-b cluster and CSIC, prepare proposals for funding (FECYT, FGCSC), promotional videos, contests and exhibitions
- Scientific events: coordinate summer schools, scientific meetings and seminars organized by ICMAB researchers

PRESS
The ICMAB was deeply engaged with the media in connection with the new findings published by our scientists in high-profile journals and institutional and outreach activities, which led to articles in the press and online media as well as participation by scientists in radio or TV programmes. In particular, our press releases have made it to La Vanguardia, El Periódico, Agenzia SINC, Hipertextual, Madrid semanal or Nanotecnologia, to name a few.

A couple of news reports appeared in La Vanguardia and El Periódico, in which our researchers were stars, and we were also on the radio and TV:
- Els materials que canvien el món (La Vanguardia, 19 August 2018)
- El rept de sort científiques i marcs (El Periódico, 23 September 2018)
- Superconducting materials and levitation of magnets with Teresa Puig (The ICMAB, 2018)

SCIENCE EDUCATION ACTIVITIES
MATHEROES: Supermaterials, the heroes of the future
This is a project with FECYT and Severo Ochoa funding, in collaboration with Esciencia (Zaragoza), and with the participation of many ICMAB researchers.

A researcher in your classroom (12 sessions in 2018)
In this programme, an ICMAB researcher gives a talk in an educational center, usually a highschool or primary school.

Student stays at ICMAB during July 2018:
The students who joined us, spend some weeks doing a research project within one of our research groups.
- Joves Científics (Fundació Catalunya La Pedrera) (7 students for one month)
- Programa Argó UAB (4 students for 3 weeks)

Students from the Societat Catalana de Química (2 students for 2 weeks)

ESCOLAB – School visits at our center (7 visits in 2018)
This programme allows us to receive the visit of highschool students who spend a morning with us for a science talk and visit to some of our laboratories.

Dramatised Reading “Madame Châtelet and her Instagram Followers”
This dramatised reading, prepared by a group of women from the ICMAB, explains the life and discoveries of some wise women of our history, to visibilize the role of women in science and encourage science vocations.

Other courses and visits:
- Seminars/Permanent Fisca (Química)
- "Dolèncs de la Fisca"
- Students visit from the Festival Nanoscience and Nanotechnology Itdalamons®

WEBSITE AND SOCIAL NETWORKS
There is a 53 % increase in the number of users of our website, compared to 2017, and a 23 % increase in the number of sessions. Moreover, we have more users between 25 and 35 years old than what we used to have.

We are happy to announce that the ICMAB website was the most visible CSIC website in 2018, according to the “Research centers websites ranking”, and rose from the fourth place to the second place in the total score, out of a total of 1,36 CSIC institutes websites.

In addition, a 30% increase in followers has been observed in our main social networks, Twitter (>2200), Facebook (>1200), a 14 % increase in LinkedIn (>2100) and an 86 % increase in Instagram (>490), in the same period.

MAILING & INTRANET
The new weekly newsletter has nearly 500 subscribers. In every newsletter we send the latest news from our website, plus the forthcoming events and seminars at the ICMAB or BNC-b cluster, job offers and conferences and meetings organized by our researchers. We have another mailing list only for our staff, and another one for students and young people who might be interested in starting out their research career with us.

OUTREACH ACTIVITIES
This year we have organized:
- Book exchange for Sant Jordi
- The Institute’s Anniversary Party
- FOTICMAB photo contest for our staff. The “Photonic leaf” was the winner of the contest, by Cristian Mairacardi
- The Christmas party with a talk by Xavier Lasauca
- The Kids’ Day with more than 80 kids from our staff
- Toni Pons retirement

CORPORATIVE IMAGE & MERCHANDISING
We have prepared institutional presentations and posters with information of our R&I, a catalogue and flyers of our activities and of our job opportunities. We continue with our welcome pack for our staff (old-timers and newcomers) consisting of a mug and a bag. This year, the new merchandising includes black and blue pens, USBs and folders for our conferences and meetings.
STRATEGIC PRIORITY ACTIONS

Strategic Managing Unit

The Strategic Managing Unit, responsible for the implementation of the funding obtained by the Institute, was created in 2016 to reinforce the strategic projects, support all the initiatives related to the Severo Ochoa FUNMAT governance and initiatives, coordinate with the Managing Director the expenditures control and justification, promote the achievement of strategic projects complementing the FUNMAT actions and provide support to researchers in preparing, submitting and reporting new projects and grants. In close collaboration with ICMAB’s governing bodies and the other available Units, it promotes a continuous development strategy to position ICMAB as one of the leading European Research Centers in Materials Science.

Among its main objectives, the Unit is responsible for the constant search for new funding opportunities focusing on the strategic and innovation objectives of our Severo Ochoa FUNMAT project with the aim of enhancing ICMAB’s scientific excellence, with an open-minded approach to detect new opportunities for our researchers. In 2018 the Unit was formed by Montse Salas, and Laura Cabana, who substituted Jorge Pérez.

RESEARCH PROJECTS

The ICMAB is leading several collaborative research projects funded by the European Commission under its Framework Programmes and several national (I+D0 and I+D Excelencia) and regional projects. This continued leadership results in high visibility, a strong reputation as well as relevant scientific and innovation output. In 2018 we continued with a high success in international grant attraction: 3.8 M€ were from European H2020 projects, and 2.6 M€ from National projects. In total, we had 34 EU ongoing projects, 4 of them started in 2018: a new ERC Consolidator grant was awarded, a new FET-Prospective project, as well as two MSCA IF projects.

COFUND MSCA DOC-FAM

The Institute of Materials Science of Barcelona (ICMAB-CSIC) coordinates the first MSCA-COFUND programme awarded to CSIC. The doctoral fellowship programme DOC-FAM (DOctoral training programme in Functional Advanced Materials) will allow the mobility of 22 Early Stage Researchers in the field of functional advanced materials, 9 of them will be recruited by the ICMAB. The first call of the project was on October 2017, and the first fellows were incorporated during the second semester of 2018. 5 of them stated at the ICMAB their PhD.

Two other participants in DOC-FAM programme are the Institute of Microelectronics of Barcelona (IMB-CSIC-CSIC), the Catalan Institute of Nanoscience and Nanotechnology (ICN2), the Catalonia Institute for Energy Research (IREC) and the ALBA Synchrotron. The duration of the programme is 5 years and involves a budget of 3,453,120 €. Half of this budget will be supported by the 1,726,560 € ERC grant, while the other half will be cofunded by the project participants.

NFfA EUROPE

ICMAB is one of the host institutions of the NFfA-Europe (Nanofoundries for fine analysis) project for the synthesis and characterization at the nanoscale across Europe, which started in 2015 and will finish in 2020. During 2018, ICMAB has participated in the following way: we have received 16 users to our facilities, from France, Italy, India, Switzerland, Russia, Germany and China.

The installations used in 2018: scanning electron microscopy (SEM), atomic force microscopy (AFM), X-ray diffraction (XRD), electron paramagnetic resonance (EPR), magnetometry by Superconducting Quantum Interference Devices (SQUID), Raman Spectroscopy, Pulsed Laser Deposition (PLD) and lithography. We also hosted one researcher who came to the ICMAB to learn the Raman spectroscopy technique with Alejandro Gotsi for one week.

Two articles were published as a result of the NFfA exchange programme:

• Direct and Converse Piezoelectric Responses at the Nanoscale from Epitaxial BiFeO3 Thin Films Grown by Polymer Assisted Deposition.  
  José M. Vila-Fungueiriño, Andres Gomez, Jordi Antoja-Lleonart, Jaume Gazquez, César Magén, Beatriz Noheda and Adrian Carretero-Genevrier. Nanoscale, 2018, 10, 20155-20161. DOI:10.1039/C8NR05737K

• Epitaxial La0.7Sr0.3MnO3 thin films on silicon with excellent magnetic and electric properties by combining physical and chemical methods.  
RESPONSIBLE RESEARCH AND INNOVATION (RRI)

At the ICMAB we are clearly aware that any activity carried out at the ICMAB should be conducted by adhering to Responsible Research and Innovation (RRI) principles, namely:

1. - Governance to prevent harmful or unethical developments of our research and innovation.
2. - Open Access to research results and publications to boost innovation and increase the use of scientific results.
3. - Ethics to respect ethical standards and fundamental rights in response to societal challenges.
4. - Gender equality, and in a wider sense, diversity in research teams and topics.
5. - Public Engagement of all societal actors (researchers, industry, policy makers, civil society) for a reflective research process.
6. - Science Education to enhance current education processes and to better equip future researchers and society as a whole, with the necessary competences.

ETHICS

On 16 March 2018, with the aim of introducing this concept to the research community at ICMAB, and in collaboration with the Marie-Curie Initial Training Network (ITN) i-Switch, a workshop on “Ethics and Responsible Research & Innovation in Research” (IRRI2018) was organized. The workshop gathered several experts from the field that provided us with some insights on how to deal with some of the aspects included in RRI, from ethics and gender aspects in research to integrity and scientific misconduct. Two practical workshops focusing on the promotion of RRI and the available methods to implement it, by Rossana Malagrida (IrisCàixa), were also included.

OPEN ACCESS

At the ICMAB we encourage the Golden Route to open access publications by the systematic use of CSIC’s open access publication support agreements (RSC, ACS, Frontiers, PNAS, Springer Open), and we optimize the self-archiving (Green Route), by uploading the postprints to the Digital CSIC Institutional repository with the help of our Librarian & Documentalist. Giving open access to our scientific results is essential to boost the benefits of the public investment in research and increase knowledge dissemination, following European and National policies. We are planning to implement a system for the progressive increase of datasets associated to the published articles deposition and to offer specific training for our research staff on open access, open science and RRI issues.

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GENDER EQUALITY

In 2018, the ICMAB was awarded by the CSIC with the Gender Equality Certificate (Distintivo de Acreditación en Igualdad de Género), in its first edition. This certificate was promoted by the CSIC President, Rosa Menéndez, following an explicit commitment to offer equal opportunities for men and women in their workplaces. The objectives of the call was to promote gender perspective in all the CSIC institutes, and to promote measures to eliminate the barriers that women may encounter during their career. The Gender Equality Committee was engaged to organize the activities to celebrate the International Day of Women and Girls in Science. During the second and third weeks of February, the ICMAB celebrated the International Day of Women and Girls in Science, which was declared in 2018 by the United Nations to be on February, 11.

The slideshow and twitter campaign “I became a scientist” showed how and why did the women at ICMAB became researchers, and what did they want to do when they were kids.

In the framework of “11defebrero” and “A researcher in your classroom”, researcher Ana M. López gave a talk to secondary school students at La Fefera (Montcada), Stefania Sandoval at La Guineueta (Barcelona), and Esther Barrena at Institut Provençana (Hospitalet de Llobregat). Anna Roig brought the play “Madame Châtelet and her Instagram followers” at Escola Can Periquet (Palau-solità i Plegamans).

To raise awareness about gender issues also among our staff, we hang some posters with some quizzes prepared by the Gender Equality Committee about curious facts on women in science and gender issues.

Anna May, Communication & Outreach Officer, and Mariona Coll, researcher at the Superconducting Materials Groups, participated on February 6 at a roundtable on “Women and Science: Breaking Stereotypes”, at Ateneu Barcelonès (Barcelona). The event was organized by EsquiNANO, the Gender Committee of the Physics Department at UR, and the Nanoscience and Nanotechnology Festival “10 a la menos 9”.

The dramatized reading “Madame Châtelet and her Instagram followers” was represented for a highschool in Barcelona (13 February 2018) and at the ICMAB (9 March 2018).
ACKNOWLEDGEMENTS
Annual Report 2018

We are sure that you have felt the ICMAB environment and enthusiasm all through this report. If you want to still have more information about the ICMAB activities you can access the website version of our report at resources.icmab.es/annualreport2018