ACTIVITY REPORT 2015-16

Institut de Nanociència i Nanotecnologia
de la Universitat de Barcelona

Institut de Nanociència i Nanotecnologia
UNIVERSITAT DE BARCELONA

Institut de Nanociència i Nanotecnologia

Universitat de Barcelona

Cover image
Title: *"Gold Nanocups"*
By: A. Conde-Rubio, N. Alayo, X. Borrisé, F. Pérez-Murano, X. Batlle and A. Labarta

Back cover image
Title: *"Active liquid crystal based on microtubules and molecular motors"*
By: P. Guillamat

Editorial Board and Scientific Management: Ifigènia Saborit Villarroya
Graphic Design and Layout: www.idoate.com

Foreword

Foreword

It gives me great pleasure to present the Activity Report 2015-2016 of the Institute of Nanoscience and Nanotechnology of the University of Barcelona (IN²UB). During these two past years the Board of Directors pushed several actions in order to improve the scientific impact of the research conducted by the different groups of the IN²UB. It has been a period of little but significant changes at various levels whose final aim is to attain scientific excellence and gain national and international visualization of the institute. IN²UB is an institute that gathers 135 permanent researchers, 43 post-docs and 83 PhD students in 2016 from the Faculties of Chemistry, Physics, Pharmacy, Biology and Medicine, all working with different perspectives within the field of phenomena occurring at the nanoscale. Notice that, in opposition to other institutes of Catalonia working in the same or similar fields, all members of the IN²UB are strongly involved in teaching obligations, the most important of being the Master of Nanoscience and Nanotechnology (recently recognised as Erasmus Mundus Joint Master Program) and the Doctoral Program in Nanoscience and Nanotechnology. Research and education are our commitment with the society.

In the period covered by this report, we have concluded that most of the running scientific projects of our researchers are focused on common aspects of nanoscience, nanotechnology and nanobiotechnology. For this reason, we have created interactive platforms to promote the exchange of information and the share of technical capabilities among groups with different background. We want to invert the paradigm of hermetic, sometimes personal, research lines, with narrow specific perspectives, into collaborative projects which will enable different groups to postulate for integrative projects from international agencies. In this regard, we have appointed a Scientific Committee to undertake our evaluation and whose functions are to raise recommendations to delineate a Strategic Plan for the Institute. In the near future will hope to see the results of all the actions initiated during this period, a time called “the maturation of the IN²UB“ by the former Director, Prof. Amilcar Labarta.

In terms of research output of this period, we have increased the number of scientific articles published, increasing also the impact of our publications. As a consequence, more than 75% of our publications fall within the Q1 of their category. We have offered research introductory fellowships addressed to students finishing their degree and willing to follow the aforementioned master program, and fellowships to support students finishing the Ph.D. program. We have also implemented the program ART (transversal research actions) addressed to young researchers starting independent projects and we have financed 13 meetings and conferences, where members of the institute have been engaged as part of the organizing committee. Other important initiatives include the organisation of talks given by students developing their Ph.D., invited conferences and internal symposia on bioAFM, nanoparticles and nanobiomedicine though to develop synergies between groups working in different areas of the institute.

The Board of Directors will continue to push for supporting training, research and applications of nanosciences and nanotechnologies. For the year to come we consider a key initiative to apply for getting excellence recognition of the unit as a whole.

We look forward to reporting on the progress of the IN²UB, and other initiatives in the next Activity Report. By exploit our existing capacities and meet current challenges, we will continue to prepare for future developments.

Prof. Jordi Borrell Hernández
IN²UB Director

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DE LA UNIVERSITAT DE BARCELONA

1. About IN²UB

Presentation

A thorough understanding of the behaviour of matter at both the atomic and the molecular scales is possible nowadays thanks to the wide background of theories and models existing to this end. This is also true for the behaviour of matter at microscopic level. There is, however, an entire field yet to be explored just in the middle, where systems present dimensions of about, or below, 100 nanometers. A large number of processes and phenomena, such as the ones which take place during catalysis, or the ones observable in molecular biology, electronics, magnetism, or optics, present similar lengths as well. A wide range of properties having their origins in the processes which take place in such scale lengths can be modified just by controlling the structure of systems at nanometric scale. The manufacturing and the study of nanosystems which may offer alternative functional properties are therefore the biggest challenges which nanoscience and nanotechnology set before us today, and we can face these challenges with the help of the wide knowledge we already have in these disciplines and of a large choice of methodologies.

The great expectations existing nowadays about the application of new technologies based on the development of nanostructured materials, as well as of new tools aimed at an accurate handling of the nanoscale, have pebbled the way for a research field which is now experiencing a decisive growth: nanotechnology. The various applications of nanotechnology can be seen and felt each day with higher intensity, and its impact on everyday life shall not definitely stop growing in the near future. Nanotechnology can in fact be applied to almost every field of research nowadays and, without doubt, it shall be at the basis of most technologies of the future.

The University of Barcelona created in 2006 the Institute of Nanoscience and Nanotechnology (IN²UB), which has as the aim to coordinate multidisciplinary research activities carried out by several research groups of this institution. The IN²UB wants to contribute to the progress of science and innovation while spurring, at the same time, industrial excellence. IN²UB integrates the most active and competitive groups in Nanoscience and Nanotechnology from UB, gathering a heterogeneous community of researchers from the Faculties of Physics, Chemistry, Pharmacy Science, Biology, and Medicine. Consequently, the IN²UB is one of few Institutes of Nanoscience and Nanotechnology in Spain integrating Nanobiotechnology and Nanopharmacology as the central core of its research.

The institute integrates six different Research Areas:

1. Modeling and simulation of systems and properties of matter in the nanoscale (NModels)
2. Nanobiotechnology (NBioTech)
3. Nanopharmacotherapy (NPharma)
4. Nanomagnetism, nanoelectronics and nanophotonics (NElectroMagΦ)
5. Nanostructured Materials (NMaterials)
6. Nanoenergy: production, storage and environment (NEnergy)

Since its creation, the IN²UB has been pursuing to favour synergies between researchers by encouraging interdisciplinary activities. Among the aims is to enhance scientific projects to push the frontiers of knowledge. Relationships between researchers and corporations with common interest in several applications of nanotechnology have been encouraged. This is done by stimulating the implementation of joint projects that shall suit the technologically challenging requirements of the business sector. In this framework, the IN²UB aims at promoting, both internally and internationally, the collaboration among different groups and research centers by strengthening interdisciplinary activities which integrate both basic and applied research. The IN²UB is thus participating in national strategic programs and in several international projects and actions as well.

Besides, under the umbrella of the IN²UB, its academic staff has a unique role because it is deeply involved in teaching tasks. Teaching is based on research activity, transfer of knowledge and the sharing of experiences and procedures. The academic staff belonging to the IN²UB trains the new generations of scientists and technologists attending the Masters and Doctoral Programmes offered by UB, and in particular, the Master in Nanoscience and Nanotechnology and the Doctoral Programme in Nanosciences.

Organization Chart

EXECUTIVE BOARD

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RESEARCH AREAS COORDINATORS

Area 1: Dr. Martí Pi Pericay
Area 2: Dr. Jordi Borrell Hernández
Area 3: Dra. Maria José García Celma
Area 4: Dr. Albert Romano Rodríguez
Area 5: Dr. Enric Bertran Serra
Area 6: Dr. Narcís Homs Martí

SCIENTIFIC BOARD

Dr. Guillem Aromí Bedmar (Scientific Director)
Dr. Amílcar Labarta Rodríguez
Dra. M. Luisa García López

Research Outputs and Funding Sources

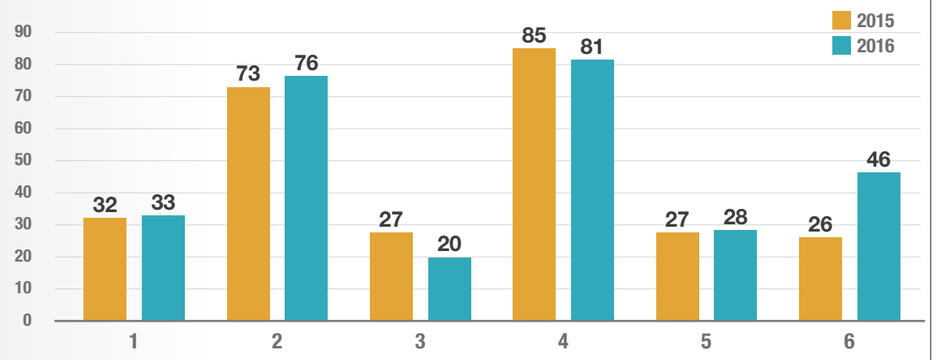
The following major subject areas represent IN²UB scientific production: Chemistry, Physics and Astronomy and Material Science, Biochemistry, Genetics and Molecular Biology, Engineering, Medicine and Chemical Engineering, Pharmacology and Pharmacology, Toxicology and Pharmaceutics. The rest of IN²UB publications, are integrated in other related fields such as Mathematics, Energy and Environmental Science. So, it is to note that IN²UB is really a multidisciplinary research unit, mainly harvesting research in the field of Chemistry, Physics, Material Science, Pharmacology and Biology. The analysis of these areas during 2015-2016 period, represented 554 papers published in indexed journals in Scimago Journal Ranking, with an average of 79.85% of this production at first quartile.

2015-2016 NUMBER AND QUALITY OF THE PUBLICATIONS

YEAR	Output	Q1	%Q1	1st Decile
2015	270	204	75,56	114
2016	284	239	84,15	121

Output: number of documents published in major subject areas, data from Scopus Data Base
Q1-%Q: number and % of publications published in journals ranked in the first quartile (top 25%)
1st Decile: publications published in journals ranked in the first decile

SCIENTIFIC PUBLICATIONS / RESEARCH AREA



Number of Publications per Area per Year

Hight Index Publications 2015-2016

Presa, A., Brissos, R.F., Caballero, A.B., Borilovic, I., Korrodi-Gregório, L., Pérez-Tomás, R., Roubeau, O., Gamez, P. *Photoswitching the Cytotoxic Properties of Platinum(II) Compounds.* Angewandte Chemie - International Edition. 54(15), pp. 4561-4565. (2015)

Haq S., Wit B., Sang H., Floris A., Wang Y., Wang J., Pérez-García L., Kantorovitch L., Amabilino D.B., Raval R. *A Small Molecule Walks Along a Surface Between Porphyrin Fences That Are Assembled In Situ.* Angewandte Chemie - International Edition. 54(24), pp. 7101-7105. (2015)

Inostroza-Brito K.E., Collin E., Siton-Mendelson O., Smith K.H., Monge-Marcet A., Ferreira D.S., Rodríguez R.P., Alonso M., Rodríguez-Cabello J.C., Reis R.L., Sagués F., Botto L., Bitton R., Azevedo H.S., Mata A. *Co-Assembly, spatiotemporal control and morphogenesis of a hybrid protein-peptide system.* Nature Chemistry. 7(11), pp. 897-904. (2015)

Lloveras P., Stern-Taulats E., Barrio M., Tamarit J.-L., Crossley S., Li W., Pomjakushin V., Planes A., Mañosa L., Mathur N.D., Moya X. *Giant barocaloric effects at low pressure in ferrielectric ammonium sulphate.* Nature Communications. 6,8801. (2015)

Bonetti S., Kukreja R., Chen Z., Macià F., Hernàndez J.M., Eklund A., Backes D., Frisch J., Katine J., Malm G., Urazhdin S., Kent A.D., Stöhr J., Ohldag H., Dürr H.A. *Direct observation and imaging of a spin-wave soliton with p-like symmetry.* 6,8889. Nature Communications. (2015)

Oriola D., Roth S., Dogterom M., Casademunt J. *Formation of helical membrane tubes around microtubules by single-headed kinesin KIF1A.* 6,8025. Nature Communications. (2015)

Kosmalska A.J., Casares L., Elosegui-Artola A., Thottacherry J.J., Moreno-Vicente R., González-Tarragó V., Del Pozo M.Á., Mayor S., Arroyo M., Navajas D., Trepat X., Gauthier N.C., Roca-Cusachs P. *Physical principles of membrane remodelling during cell mechanoadaptation.* Nature Communications. 6,7292. (2015)

Setu S.A., Dullens R.P.A., Hernández-Machado A., Pagonabarraga I., Aarts D.G.A.L., Ledesma-Aguilar R. *Superconfinement tailors fluid flow at microscales.* 6,8297. Nature Communications. (2015)

Dieterich E., Camunas-Soler J., Ribezzi-Crivellari M., Seifert U., Ritort F. 11(11), pp. 971-977. *Single-molecule measurement of the effective temperature in non-equilibrium steady states. Nature Physics.* (2015)

Alert R., Tierno P., Casademunt J. *Formation of metastable phases by spinodal decomposition.* Nature Communications. 7,13067. (2016)

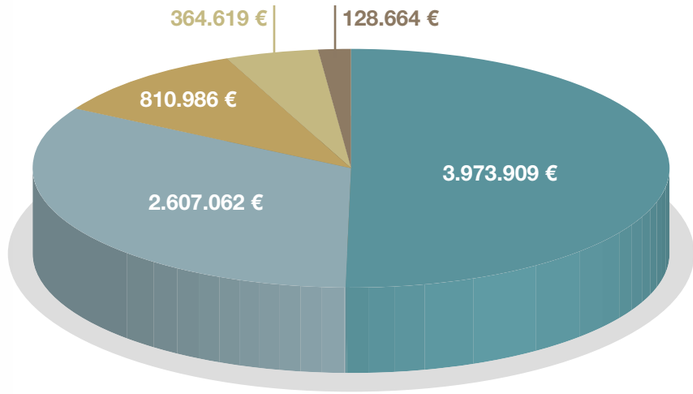
Ortiz-Ambriz A., Tierno P. *Engineering of frustration in colloidal artificial ices realized on microfeatured grooved lattices.* Nature Communications. 7,10575. (2016)

Kim Y., Yeom B., Arteaga O., Yoo S.J., Lee S.-G., Kim J.-G., Kotov N.A. *Reconfigurable chiroptical nanocomposites with chirality transfer from the macro- to the nanoscale.* Nature Materials. 15(4), pp. 461-468. (2016)

Funding Sources

During 2015-2016 period 69 competitive Inputs have been awarded to membres of IN²UB as Principal Investigators.

The public funding represents almost the 90% of IN²UB Inputs sources.



It is outsanding to note, that during this period, three ERC Starting Grant lead by IN²UB researchers were active:

FuncMolQIP (Design and Preparation of Functional Molecules for Quantum Computing and Information Processing) ERC Starting Grant, 2011-2016 lead by G. Aromí.

DynaMO (Dynamics and assemblies of colloidal particles under Magnetic and Optical forces) ERC Starting Grant, 2014-2016 lead by P. Tierno.

BetterSense (Nanodevice Engineering for a Better Chemical Gas Sensing Technology) ERC Starting Grant, 2014-2019 lead by J. D. Prades.

Moreover, on 2016, the ERC-POC - Proof of Concept Grant Making Complex Gas Analytics Friendly and Available ASAP (GasApp) has been awarded to J .D. Prades.

In the frame of H2020 from European Union, other IN²UB researchers are involved in coordinated projects, as partners.

PROSEQO (PROtein SEQuencing using Optical single molecule real-time detection). H2020-FETOPEN-2014-2015-RIA. (F. Ritort).

ABIOMATER (Magnetically actuated bio-inspired metamaterials). H2020-FETOPEN-2014-2015-RIA. (F. Sagués).

Transfer Indicators

On November 2016 *Enlighting Technologies* (by Blas Garrido and Sergi Hernández) started.

Moreover, three spin-offs are being lead by IN²UB researchers: Impetux Optics, S.L., Advanced Nanotechnologies, S.L., and Smalle Technologies, S.L.

During this reference period, IN²UB had applied for 5 priority patents and 6 PCT/EUR/USA patents.

2. Research at IN²UB

2.1. MODELING AND SIMULATION OF SYSTEMS AND PROPERTIES OF MATTER IN THE NANOSCALE (NMODELS)

Statistical Physics and Quantum Mechanics are essential to describe, understand and predict the properties of new nanosystems or engineered biomaterials. The theoretical approach based on ideal systems must be complemented with multiscale simulations of real systems based on several numerical techniques to enable researchers to get insight into the mechanisms ruling the processes at the nanoscale and to reach the predictive quality of the theoretical models. The multiscale approach allows us to breakdown the complexity of real processes into more manageable units. These techniques can be applied successfully to proteins interacting with nanoparticles, molecular motors, nanofiltration, nanocatalysis, nanofluidics, confined phase transitions, Quantum gases, photonics, optoelectronics and magnetooptics. These models help in establishing general rules that can guide the design of new systems.

NModels research area includes the following research lines:

A. Confinement-related Phenomena: Reactivity, magnetism, optoelectronics and Quantum Photonics.
B. Transport and Conduction.
C. Surface Effects.
D. Electronic Structure and Excitations.
E. Bose-Einstein Condensates and Quantum Confined gases.

This research area is composed of the following research groups:

The activities carried out within the **THEORETICAL PHYSICS OF NANOSCOPIC SYSTEMS GROUP** can be grouped into two main areas:

1. Quantum liquids: we have addressed
2. Bose-Eisntein condensates: we have addressed

MEMBERS OF THE GROUP

Manuel Barranco Gómez (Full Professor)
Montserrat Guilleumas Morell (Full Professor)
Ricardo Mayol Sánchez (Full Professor)
Martí Pi Pericay (Full Professor)
Albert Gallemí Camacho (PhD Student)

SELECTED PUBLICATIONS

THEORETICAL PHYSICS OF NANOSCOPIC SYSTEMS GROUP

Area Quantum liquids:

F. Ancilotto, M. Barranco, J. Navarro and M. Pi. ***A Density Functional Approach to Para-hydrogen at Zero Temperature. Journal of Low Temperature Physics****. Volume: 185, 26-38, Published: January 12 2016.*

A. Leal, X. Zhang, M. Barranco, F. Cargnoni, A. Hernando, D. Mateo, M. Mella M. Drabbels and M. Pi.. ***Dynamics of photoexcited Ba+ cations in He-4 nanodroplets. The Journal of Chemical Physics****. Volume: 144, 094302, Published: March 4 2016.*

Area Bose-Eisntein condensates:

A. Gallemí, A. Muñoz Mateo, R. Mayol and M. Guilleumas. ***Coherent quantum phase slip in two-component bosonic atomtronic circuits****. New Journal of Physics. 18. 015003. (2016)*

A. Gallemí, M. Guilleumas, R. Mayol and A. Muñoz Mateo. ***Multidimensional Josephson vortices in spin-orbit-coupled Bose-Einstein condensates: Snake instability and decay through vortex dipoles****. Physical Review A. 93. 033618. (2016)*

A. Gallemí, M. Guilleumas, J. Martorell, R. Mayol, A. Polls and B. Juliá-Díaz. ***Robustness of discrete semifluxons in closed Bose-Hubbard chains.*** *New Journal of Physics. 18. 075005. (2016)*

A. Gallemí, G. Queraltó, M. Guilleumas, R. Mayol and A. Sanpera. ***Quantum spin models with mesoscopic Bose-Einstein condensates****. Physical Review A. 94. 063626. (2016)*

SELECTED PUBLICATIONS

O. Vilanova, J. J. Mittag, P. M. Kelly, S. Milani, K. A. Dawson, J. O. Rädler and G. Franzese. ***Understanding the Kinetics of Protein – Nanoparticle Corona Formation,*** *ACS Nano 10, 10842 (2016).*

V. Bianco, and G. Franzese. ***Contribution of Water to Pressure and Cold Denaturation of Proteins****. Physical Review Letters 115, 108101 (2015).*

J. Wedekind1, L. Xu, S. V. Buldyrev, H. E. Stanley, D. Reguera, and G. Franzese. ***Optimization of crystal nucleation close to a metastable fluid-fluid phase transition****. Scientific Reports (Nature Publishing Group) 5, 11260 (2015).*

F. Leoni, and G. Franzese. ***Effects of confinement between attractive and repulsive walls on the thermodynamics of an anomalous fluid****. Physical Review E 94, 062604 (2016).*

*C. Calero, H. E. Stanley and G. Franzese. S****tructural Interpretation of the Large Slowdown of Water Dynamics at Stacked Phospholipid Membranes for Decreasing Hydration Level: All-Atom Molecular Dynamics****. Materials 9, 319 (2016).*

NANOSYSTEMS STATISTICAL PHYSICS-COMPLEX MATTER GROUP

We study Nanobiointeraccions, that is interactions between nanostructures and biological molecules (like proteins) in aqueous solutions (like human blood). Our results are of fundamental and applicative relevance for their possible use in disease diagnose and therapy or in industry. The group investigates the process by which nanoparticles are coated with proteins once inside our blood. This phenomenon is fundamental to understand how the nanoparticle interacts with the cells and where it ends up in the organism. The study is the basis for possible medical applications and safety tests of nanoparticles, such as those used in everyday products (food, varnishes, mobile, etc.) as well as those produced by environmental contamination (combustion, industrial activities, etc.). Our theoretical and computational multiscale approach has allowed us to design experiments, carried out in world-leading laboratories, that have confirmed our predictions. When a nanoparticle is in a biological fluid, the biomolecules spontaneously adsorb in layers around the surface of the nanoparticle forming the so-called corona of proteins. The corona composition evolves over time due to the competition between the proteins and determines the final destination of the nanoparticles.

Recently [ACS Nano 10, 10842 (2016)] we found a “memory effect” implying that the long-time composition (on hours time scale) of the protein corona is a function of how the environment surrounding the nanoparticle evolves, something that until now had never been understood.

Further research lines of our group include water at bio-interfaces (proteins and bio-membranes) and nano-interfaces (nanotubes and graphene sheets), nanoconfined ice formation, protein folding and design, protein crystallization, self-assembly of bio-membranes and nano-structures.

Members of the group

Giancarlo Franzese (Professor) Responsible
Carles Calero Borrallo (Postdoc)
Oriol Vilanova Gabarrón (PhD student)

Collaborations

Prof. K. A. Dawson, Centre for BioNano Interactions (Director), University College Dublin

Prof. Joachim Rädler, Ludwig-Maximilians Universität, Múnich

Prof. H. E. Stanley, Center for Polymer Studies (Director) and Department of Physics, Boston University

Prof. S. Buldyrev, Yeshiva University, New York

Prof. F. Bruni, Università di Roma Tre

Dr. F. Martelli, Princeton University

Prof. C. Dellago, Dr. I. Coluzza and Dr. V. Bianco, Viena University

Dr. Alfonso de Simone, Imperial College London

Prof. E. Valsami-Jones and Dr. P. Martin, Birmingham University

Scientific Equipment

Laboratorio de Supercomputación en Física Estadística, Departamento de Física de la Materia Condesada, Universitat de Barcelona.

MATERIALS: PHASE TRANSITIONS AND MULTISCALE SYSTEMS

The research of our group has the following three main objectives. The first two are experimental and aim at,

- The development and characterization of new materials with giant caloric and multicaloric response, which are potentially interesting for solid-state refrigeration applications.

- The study of materials that display intermittent response to applied external fields through a sequence of avalanche using high-resolution acoustic emission techniques that are sensitive to local processes taking place within the range from nano to micro scales.

- The model and numerical simulation of both of caloric and multicaloric materials and intermittent dynamic processes and its influence on hysteresis effects in such a class of materials.

SELECTED PUBLICATIONS

D. E. Soto-Parra, X. Zhang, S. Cao, E. Vives, E. K. H. Salje, and A. Planes. ***Avalanches in compressed Ti-Ni shape-memory porous alloys: an acoustic emission study****. Phys. Rev. E, Rapid Comm., 91, 060401(R) (2015).*

P. Lloveras, E. Stern-Taulats, M. Barrio, J.L. Tamarit, S. Crossley, W. Li,V. Pomjakushin, A. Planes, Ll. Mañosa, N. D. Mathur, and X. Moya. ***Giant barocaloric effect at low pressure in ferrielectric ammonium sulphate****. Nature Comm., 6, 8801 (2015).*

J. Tusek, K. Engelbrecht, R. Millán-Solsona, L. Mañosa, E. Vives, L. P. Mikkelsen and N. Pryds. ***The elastocaloric effect: a way to cool efficiently****. Adv. Energy Mater. 5, 1500361 (2015).*

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A. Planes, T. Castán, A. Saxena. ***Thermodynamis of multicaloric effects in multiferroic materials: application to metamagnetic shape-memory alloys and ferrotoroidics****. Philos. Trans. Roy. Soc. A, 374, 20150304 (2016).*

E. Stern-Taulats, P. Lloveras, M. Barrio, A. Planes, E. Defay, M. Egilmez, J. Ll. Tamarit, Ll. Mañosa, N. D. Mathur and X. Moya. ***Inverse barocaloric effects in ferroelectric $BaTiO_3$ ceramics****. APL Material, 4, 091102 (2016).*

Members of the group

Antoni Planes Vila (Full Professor)
Lluís Mañosa Carrera (Full Professor)
Teresa Castán Vidal (Full Professor)

Collaborations

Prof. E.K.H. Salje, Department of Earth Sciences, University of Cambridge

Prof. Mehmet Acet, Physics Department, Universität Duisburg-Essen

Profs. N. D. Mathur and X. Moya, Department of Materials Science, University of Cambridge

Dr. Avadh Saxena, Theoretical Division, Los Alamos National Lab.

Prof. J. L. Tamarit, Departament de Física, Universitat Politècnica de Catalunya

Scientific Equipment

Calorimeters with magnetic field and mechanical stress applied.
Acoustic emission measurement system.

2.2. NANOBIOTECHNOLOGY (NBIOTECH)

This research area studies the organizational patterns observable in the molecular structures that control and rule the biological systems both at the cellular and at the molecular scales. Nanobiotechnology focuses as well in the analysis of the interaction between materials and these molecular systems at nanometric scales. Its most relevant application is that of developing techniques and devices aimed at prevention and diagnose in nanomedicine and in the development of the new therapeutic techniques.

NBioTech area comprehends the following research lines:

A. Functionalisation of surfaces.
B. Cellular and molecular Biomechanics
C. Biomimetic structures and systems
D. Nanofluidics and nanorobotics. Nanomotors.
E. Diagnosis in nanomedicine: marcking and molecular observation
F. Nanobiosensors; DNA and Potein Chips; lab on chip.

The NBioTech area is integrated within our institute by the following research groups:

MAGNETIC SOFT MATTER GROUP

The Magnetic Soft Matter group has focused on different research lines related with the organization and transport of soft colloidal systems in and out of equilibrium conditions and from micro to nanoscale. These particles have been used as model systems to study general phenomena in Condensed Matter Physics such as self-assembly and crystallization processes, phase transitions and particle transport in periodic potentials ("ratchet" motion). The group mainly develop three research lines:

1. Colloidal spin ice systems through combination of magnetic and optical forces. This represent an alternative, mesoscopic model for geometrically frustrated systems, where dynamics could be easily visualized and interactions controlled by simple experimental techniques.

2. Collective dynamics in driven colloidal matter. We developed novel strategies to manipulate, transport, and arrange colloidal matter via controlled motion of nanoscale domains walls in uniaxial ferrite garnet films.

SELECTED PUBLICATIONS

J. Loehr, A. Ortiz-Ambriz, P. Tierno. ***Defect Dynamics in Artificial Colloidal Ice: Real-Time Observation, Manipulation, and Logic Gate****. Phys. Rev. Lett. 117 168001 (2016).*

R. Alert Zenon, P. Tierno and J. Casademunt. ***Formation of metastable phases by spinodal decomposition****. Nature Comm. 7 13067 (2016).*

P. Tierno, T. H. Johansen, J. M. Sancho. ***A Tuneable Magnetic Domain Wall Conduit Regulating Nanoparticle Diffusion****. Nano Letters 16 5169 (2016)*

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3. "Active" propelling particles. We have developed large collections of artificial magnetically actuated micro-propellers that will give rise to novel collective behavior like swarming or active clustering.

Members of the group

Pietro Tierno (Tenured Assistant Professor)
Antonio Ortiz-Ambriz (Postdoc)
Fernando Martinez-Pedrero (Postdoc)

Collaborations

Within UB: ***J. Casademunt, I. Pagonabarraga Mora, J. Ortín, F. Sagués, J. Ignés***

European: ***Andras Libal*** (Uni. Babes-Bolyai), ***Sabine Klapp*** (Frei Universitat Berlin, Germany), ***Hartmut Löwen*** (Uni. Dusserdolf), ***Dr. Reza Shaebani*** (Universität des Saarlandes, Saarbrücken), ***Leticia Cugliandolo*** (Université Pierre et Marie Curie, France).

International: ***Tom H Johansen*** (Uni. Oslo, Norway), ***C. Nisoli, C. Reichhardt*** (Los Alamos National Lab., USA), ***Yair Shokef and Erdal Celal Oğuz*** (Univ tel Aviv).

Scientific Equipment

Inverted optical microscope (Nikon eclipse), Fluorescent microscope, Scanning laser tweezers with acousto Optic Deflector, Spatial Light Modulator.

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A. Ortiz-Ambriz and P. Tierno. ***Engineering of Colloidal Artificial Ice in Frustrated Grooved Lattices****. Nature Comm. 7 10575, (2016)*

P. Tierno. ***Geometric Frustration of Colloidal Dimers on Honeycomb Magnetic Lattices****. Phys. Rev. Lett. 116 038303 (2016).*

NANOBIOENGINEERING GROUP

The Nanobioengineering group is a multidisciplinary team working together in applying nanotechnology for the development of new biomedical systems and devices. The main output are diagnostic and point-of-care systems and integrated microfluidic Organ-on-Chip devices for the study of organ physiology, disease etiology, or drug screening.

The main research activities of the group include the engineering and biochemical functionalization of biomaterials integrated with microfluidics systems. The bioengineered microdevices are used to study cell responses to biomolecular compounds applied to Organ-on-Chip devices, or for the development of new lab-on-a-chip based biosensors.

The goal is to fabricate microsystems containing living cells that recapitulate tissue and organ level functions in vitro and new portable diagnosis devices that can be used as Point-of-Care systems. The projects carried out by the group are focused on clinical and industrial problems and are related to three convergent research lines:

1. Biosensors and Lab-on-a-Chip devices for clinical diagnosis and food safety applications

- DNA sensors and platform arrays for cancer biomarker detection.
- Antibody-based sensors for pathogenic microorganisms' detection and neurodegenerative early detection
- Sensor array for in vivo hypoxia and ischemia monitoring.
- Sensors to mimic the chemical detection of plant roots for robotic applications.
- Microfluidic chip for reagent handling in POC diagnosis devices.
- Microfluidic chip using hydrodynamic forces for cell counting and sorting. Application for detection of circulating tumors cells (CTC).

2. Nanotechnology applied to biomolecule interaction studies and micro/nano-environments for regenerative medicine applications

- Development of bioengineered 2D and 3D micro/nanoenvironments with a topography and chemical composition controlled at the nanoscale for cell behavior studies (adhesion, proliferation, differentiation).
- Biophysical description of cellular phenomena (cell migration, differentiation) using micro/nanotechnologies, cell biology tools and soft matter physics.
- Study of magnetite nanoparticles - Amyloid-Beta interaction in Alzheimer disease.

3. Microfluidic systems for biological studies and Organ-on-Chip devices

- Microfluidic chip for blood/plasma filtering.
- Spleen-on-a-chip development.
- Nanoporous-based systems for kidney-on–a-chip developments.
- Engineering microfluidic platforms for neurobiological studies.
- Development of 3D neuromuscular tissue models for soft robotics and clinical applications.

Members of the group

Josep Samitier Martí (Full Professor)

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A. Urrios, C. Parra-Cabrera, N. Bhattacharjee, A.M. Gonzalez-Suarez, L.G. Rigat-Brugarolas, U. Nallapatti, J. Samitier, C.A. DeForest, F. Posas, J.L. Garcia-Cordero and A. Folch. ***3D-printing of transparent bio-microfluidic devices in PEG-DA****. Lab Chip. 2016 Jun 21;16(12):2287-94.*

M. Sanmartí-Espinal, R. Galve, P. Iavicoli, M.A. Persuy, E. Pajot-Augy, M.P. Marco and J. Samitier. ***Immunochemical strategy for quantification of G-coupled olfactory receptor proteins on natural nanovesicles****. Colloids Surf B Biointerfaces. 2016 Mar 1;139:269-76.*

N. Torras, J.P. Agusil, P. Vázquez, M. Duch, A.M. Hernández-Pinto, J. Samitier, E.J. de la Rosa, J. Esteve, T. Suárez, L. Pérez-García and J.A. Plaza. Suspended Planar-Array ***Chips for Molecular Multiplexing at the Microscale****. Adv Mater. 2016 Feb 17;28(7):1449-54.*

SELECTED PUBLICATIONS

D. Caballero, J. Katuri, J. Samitier and S. Sánchez. ***Motion in microfluidic ratchets.*** *Lab Chip. 2016 Nov 15;16(23):4477-4481.*

M. Pla-Roca, G. Altay, X. Giralt, A. Casals and J. Samitier. ***Design and development of a microarray processing station (MPS) for automated miniaturized immunoassays.*** *Biomed Microdevices. 2016 Aug;18(4):64.*

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Collaborations

Prof. Fernando Albericio, Institut de Recerca Biomédica (IRB), Barcelona, Spain

Prof. José Antonio Andrades, Universidad de Málaga, Spain

Prof. Ezequiel Pérez Inestrosa, Centro Andaluz de Nanomedicina y Biotecnología (BIONAND), Málaga, Spain

Prof. Joan Bausells, Centro Nacional de Microelectrónica (CNM-CSIC), Barcelona

Prof. Albert van den Berg, University of Twente, The Netherlands

Prof. Andre Bernard, Institut für Mikro- und Nanotechnologie (MNT-NTB), Buchs, Switzerland

Prof. H. Börner Max Planck, Institute of Colloids and Interfaces, Golm, Germany

Prof. Josep Maria Canals, University of Barcelona, Spain

Dr. Matthew Dalby, University of Glasgow, Glasgow, UK

Prof. Paolo Dario, Scuola Superiore Sant'Anna (SSSA), Pontedera, Italy

Prof. Ramón Eritja, Institut de Recerca Biomédica (IRB), Barcelona, Spain

Prof. E. Faszewski Wheelock, College, Boston, USA

Prof. G. Fuhr FhG Biomedicine, St. Ingbert, Germany

Dr. Juan C. Izpisúa, Centro de Medicina Regenerativa (CMRB), Barcelona, Spain

Dr. Nicole Jaffrezic, Université Claude Bernard Lyon 1, France

Dr. Graham Johnson, Uniscan Instruments Ltd, Buxton, UK

Dr. Mª Pilar Marco, Institute of Chemical and Environmental Research, Barcelona

Prof. Jean-Louis Marty, Université de Perpignan Via Domitia, France

Prof. Barbara Mazzolai, IIT Center for Micro-BioRobotics (CMBR), Pontedera, Italy

Dr. Edith Pajot, Biology of Olfaction and Biosensors group (BOB) at INRA, Jouy-en-Josas, France

Dr. M. Lluïssa Pérez, Dept. Farmacología, University of Barcelona, Spain

Dr. Hernando del Portillo, Centro de Investigación en Salud Internacional de Barcelona (CRESIB), Barcelona, Spain

Dr. Jaume Reventós, Hospital Vall d'Hebrón, Barcelona, Spain

Prof. L. Reggiani, Nanotechnology Laboratory, INFM, Lecce, Italy

Prof. Daniel Riveline, Laboratory of Cell Physics IGBMC, Strasbourg

Prof. M. Sampietro, Politecnico di Milano, Italy

Prof. Molly M. Stevens, Imperial College, London, UK

Dr. Christophe Vieu, Laboratoire d'analyse et d'architectures des systèmes (LAAS-CNRS), Toulouse, France

Prof. Pau Gorostiza, Institute for Bioengineering of Catalonia (IBEC), Barcelona, Spain.

Prof. Irene Díaz Moreno, 3IIQ-cicCartuja, Universidad de Sevilla-CSIC, Spain.

Prof. Miguel Ángel de la Rosa, 3IIQ-cicCartuja, Universidad de Sevilla-CSIC, Spain.

Industry partners

Biokit S.A. (Werfen group); Genomica S.A.U. (Zeltia group); Tallers Fiestas S.L.; Enantia S.L.; Microfluidic ChipShop GmbH

Scientific equipment and techniques

- Nanofabrication and nanomanipulation

- Automatized microcontact printing system (custom-made)
- 3D Printing system for microfluidic devices.

- Characterization

- Surface Plasmon Resonance (SPR)
- Potentiostates
- Optical Waveguide Lightmode Spectroscope (OWLS)
- Atomic Force Microscope (AFM)
- Optical Microscopes (white light/epifluorescence)
- Electrical Impedance spectroscopy (EIS)
- Multi-frequency Lock-in Amplifier
- Sub-femtoamp Remote SourceMeter Instrument

- Molecular/cell biology

- Biological safety cabinet (class II)
- Microwell plate readers
- Protein and DNA electrophoresis systems
- Microincubator Okolab
- Nanodrop spectrophotometer
- CO_2 incubator for cells
- Cell culture cabin

- Microfluidics

- High precision syringe pumps
- Peristaltic pumps

SELECTED PUBLICATIONS

J.H. Borrell, M. T. Montero, A. Morros and Ò. Domènech. ***Unspecific membrane protein-lipid recognition: combination of AFM imaging, force spectroscopy, DSC and FRET measurements.*** *Journal of Molecular Recognition. 28, (11), 679 – 686 (2015).*

M.L. Vázquez-González, M.C. Calpena, Ò. Domènech, M.T. Montero and J. Borrell. ***Enhanced topical delivery of hyaluronic acid encapsulated in liposomes: A surface-dependent phenomenon.*** *Colloids and Surfaces B-Biointerfaces. 134, 31 – 39 (2015).*

A.L. Barrán-Berdón, B. Yélamos, L. García-Río, Ò. Domènech, E. Aicart and E. Junquera. ***Polycationic Macrocyclic Scaffolds as Potential Non-Viral Vectors of DNA: A Multidisciplinary Study.*** *ACS Applied Materials & Interfaces, 7, 14404 – 14014. (2015).*

A. Ortiz, Ò. Domènech, M. Muñoz-Juncosa, J. Prat, I. Haro, V. Girona, M.A. Alsina and M. Pujol. ***A study of HIV-1 FP inhibition by GBV-C peptides using lipid nano-assemblies.*** *Colloids and Surfaces A: Physicochemical and Engineering Aspects. 480, 184-190. (2015).*

NANOSTRUCTURE OF BIOMEMBRANES GROUP

Nanostructures in Biomembranes group has traditionally worked with spectroscopic techniques, particularly **spectrofluorimetry, NMR, DSC, Langmuir** monolayers and **Langmuir Blodgett** and since 1999 has joined the Atomic Force Microscopy (**AFM**). What characterizes the group is the fact that the application of these techniques is combined with molecular biology methods for which it is self-sufficient, specifically obtaining the protein, lactose permease, from cultures of Escherichia coli. We do the extraction, purification and its reconstitution in models membrane of the desired lipid composition. Fluorimetric studies of the **surface potential** or Föster Resonance Energy Transfer (**FRET**) inform about the interactions of protein with lipids in close contact to it. The characterization of membrane models with the AFM allows its visual characterization and the interaction with a single protein molecule through Force Spectroscopy AFM (**FS-AFM**) provides quantitative values about the strength needed to unfold the protein pulling it out from the membrane.

Members of the group

Jordi Borrell Hernández (Professor)
María Teresa Montero Barrientos (Professor)
Òscar Domènech Cabrera (Tenure-Track Lecturer)
Martha Leticia Vázquez González (Adjunct Lecturer)
Adrià Botet Carreras (PhD Student)

Collaborations

Peptides and proteins: Physicochemical studies group IN²UB.

Molecular Recognition and Physical Chemistry of substrates of biological interest with colloidal and supramolecular nanostructures. Complutense University of Madrid (UCM).

Singular Scientific Equipment

Langmuir balances and Langmuir Blodgett from NIMA.
Espectrofluorimeter SLM-Aminco 8000.
Multimode Atomic Force Microscope from BRUKER.

PEPTIDES AND PROTEINS: PHYSICOCHEMICAL STUDIES

Currently **Peptides and Proteins: Physicochemical Studies Group** is developing its activity in two research lines a) **Lipid rafts as a target for the development of therapeutic agents for infections caused by enveloped viruses** and b) **New lipopeptide antibiotics: mechanism of action in the membrane.**

Lipid rafts as a target to develop therapeutic agents against enveloped virus infections

In recent years, it has been described that in cellular membranes ordered nanodomains or *lipid-rafts* have been appeared whose composition varies from cell to cell. The scientific community wonders about these domains for better understanding the cell membrane. How these domains have been formed? What is its specific composition? How this varies from cell to cell? What is the reason of its dynamic character? All are questions that have to be answered. It has also described their relationship with a wide variety of diseases such as those caused by virus as the acquired human immunodeficiency syndrome (AIDS). This obviously causes serious physical, psychological and material harm to the patients and their families as well as serious socio-economic repercussions for the whole society. The general aim of this project is to contribute to the scientific knowledge on membrane rafts that are involved in HIV infection virus (as a model of enveloped viruses) in order to introduce new and improved methodologies that facilitate the development of nanocarriers as therapeutic agents. Currently different lipid compositions are being assayed in order to obtain a good model membranes with ordered domains to study their interaction with GBV-C peptides which have been demonstrated their capacity to inhibit the HIV-1 FP. Figure 1 shows a FM image of GUVs with lipid ordered domains.

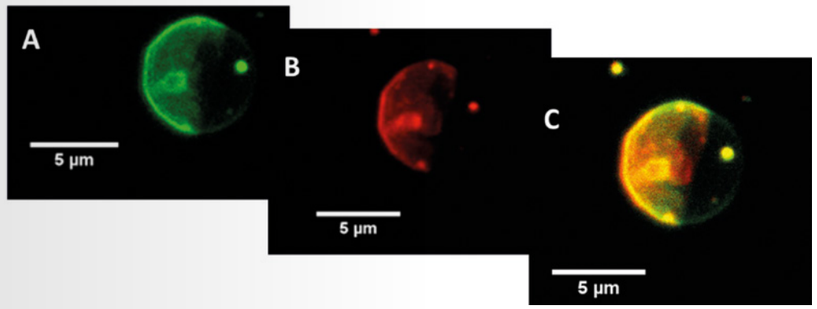

Figure 1. Fluorescence microscopy images of GUVs LIPID 1/ SM/Chol (1:1:1) containing 1 mol % NBD-PC (green), DIL-C20:0 (red). NBD-PC dissolves in LE and LC (image A) phase while DIL-C20:0 prefers LE phase (image B) so lipid rafts looks green (image C). LIPID 1: (DOPC/DOPS (3:2)

SELECTED PUBLICATIONS

R. Galatola, A. Cruz, M.J. Gómara, J. Prat, M.A. Alsina, I. Haro and M. Pujol. ***Surface behavior of peptides from E1 GBV-C protein: Interaction with anionic model membranes and importance in HIV-1 FP inhibition.*** *Biochimica et Biophysica Acta-Biomembranes. 1848: 392-407 (2015).*

A. Ortiz, O. Domènech, M. Muñoz-Juncosa, J. Prat, I. Haro, V. Girona, M.A. Alsina and M. Pujol. ***Study of HIV-1 FP inhibition by GBV-C peptides using lipid nano-assemblies.*** *Colloids and Surfaces A: Physicochemical and Engineering Aspects. 480: 184-190 (2015).*

J. Miñones. Jr, M. Muñoz, J. Miñones Trillo, I. Haro, M.A. Busquets and M.A. Alsina. ***Miscibility and langmuir studies of the interaction of E2(279-298) peptide sequence of Hepatitis G virus/GB virus-C with dipalmitoylphosphatidyl-choline and dimiristoylphos-phatidylcholine phospholipids.*** *Langmuir, 31: 10161-10172 (2015).*

F. Rabanal, A. Grau-Campistany, X. Vila-Farrés, J. Gonzalez-Linares, M. Borràs, J. Vila, M.A. Manresa, and Y. Cajal. ***A bioinspired peptide scaffold with high antibiotic activity and low in vivo toxicity.*** *Scientific Reports, 5, 1-11 (2015).*

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A. Casadó, M.C. Giuffrida, M.L. Sagrista, F. Castelli, M. Pujol, M.A. Alsina and M. Mora.
Langmuir Monolayers and Differential Scanning Calorimetry for the study of the Interactions between Camptothecin drugs and Biomembrane Models.
Biochimica Biophysica Acta - Biomembranes. 1858, 422-433 (2016).

New lipopeptide antibiotics: mechanism of action in the membrane

Infectious diseases are the second-leading cause of death worldwide. Around 2 million patients get hospital-acquired infections every year in the EU of which 175000 die. Polymyxin B and E (colistin) are cyclic antimicrobial lipopeptide antibiotics that are used as last resource antibiotics in hospitals. However, careful administration is needed as polymyxins show nephro- and neurotoxicity. In the last few years our team collaborates with the group of Dr. Francesc Rabanal from the Department of Organic Chemistry. The ultimate goal of our research is to develop novel antimicrobial lipopeptides that are highly active against resistant bacteria and at the same time have low toxicity and low induction of genetic resistance. In the last two years we have studied the mechanism of action of new analogs with activities that are in the low micromolar range by using model membranes that mimic the outer and inner bacterial membranes together with microscopy and flow cytometry of bacteria. We have seen that the mechanism of action of the new AMPs containing tryptophan and arginine is based on the collapse of membrane integrity by depolarization. In collaboration with the group of Dr. Miquel Viñas (IDIBELL), we have started a program to explore synergistic effects between the synthetic analogs and other antimicrobials, such as carbapenems.

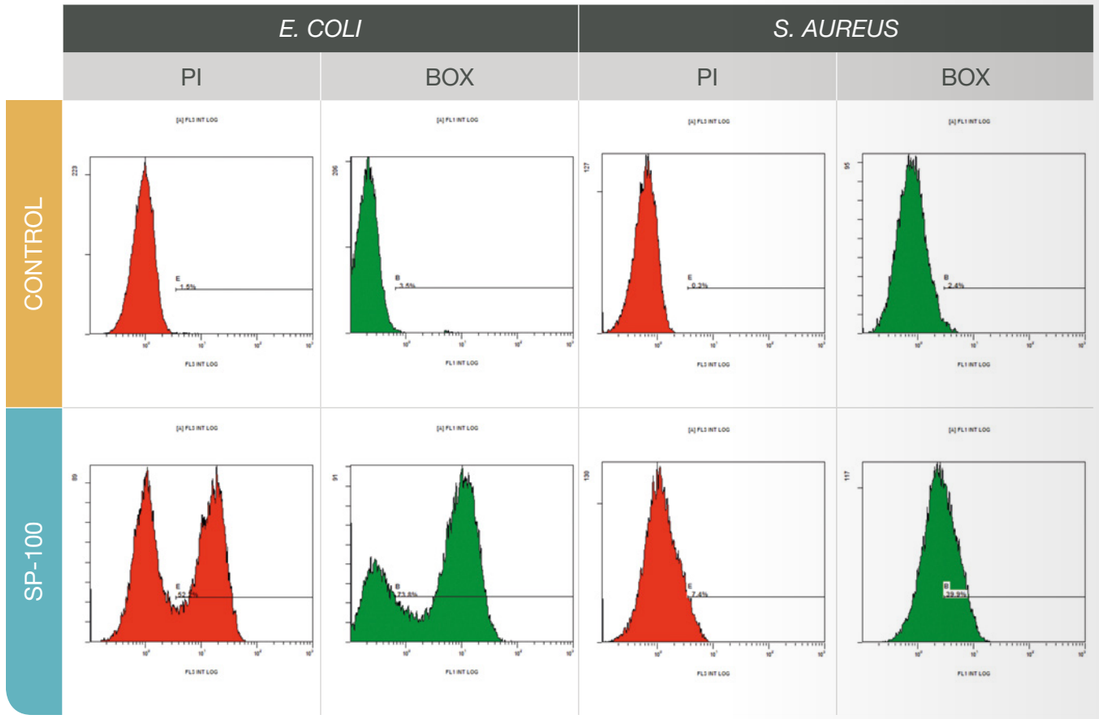

Figure 2. Flow cytometry experiments showing the effect of sp-100 (synthetic analog of polymyxin B) on bacteria.

Members of the group

M. Asunción Alsina Esteller (Full Professor)
Victòria Girona Brumós (Full Professor)
Josefina Prat Aixelà (Professor)
Montserrat Pujol Cubells (Professor)
Yolanda Cajal Visa (Professor)
Montserrat Muñoz Juncosa (Tenured Assistant Professor)

Collaborations

Transport i vehiculització de fàrmacs Group Universitat de Barcelona. Contact: **Dra. Margarita Mora** i **Dra. M Lluïsa Sagrista** (Departament Bioquímica i Biomedicina Molecular de la Universitat de Barcelona).

Monocapas Group Universidad de Santiago de Compostela. Contact: **Dr. José Miñones Conde** (Departamento de Química Física de la Universidad de Santiago de Compostela).

BIOMIL (Biofísica de membranas e interfaces lipo - proteicas) Group. Contact: **Dr. Antonio Cruz** (Departamento de Bioquímica y Biologia Molecular de la Universidad Complutense de Madrid).

Disseny i síntesi de pèptids Group Universitat de Barcelona. Contact: **Dr. Francesc Rabanal** (Departament de Química Orgànica, Facultat de Química de la Universitat de Barcelona).

Singular Scientific Equipment

Langmuir balance KSV 5000. Equipped with Langmuir and Langmuir-Blodgett Troughs to fabricate and characterize monomolecular films, a Surface Potential Sensor and a dipper to transfer films on solid supports.

Langmuir balance Nima P-54 num. 487. Coupled to the UNIVEBA thermostatic bath (select).

Langmuir balance Nima P-54 num. 167.

Langmuir balance Nima P-54 num. 677. Coupled to a KSV Nima microBAM microscope.

Two Langmuir Nima P-54 num. 605.

PTI spectrofluorometer with Felix GX PTI software. Basic equipment. It allows stationary fluorescence measures. Coupled to Thermostatic Bath OSAKA II (SBS)

Spectrefluorimeter Aminco-Boowman series 2 for stationary fluorescence and fluorescence anisotropy measurements.

LIPEX 10 ml Thermobarrell Struder with circulation bath Hubber polystat CC3.

Ultrasonic equipment to obtain liposomes. Laboratory Supplies CO. Model generator G1128P1G num: 11475. Bath: model G112SPIT num: 11756.

Low pressure chromatograph AKTA Prime num. 01153226.

SELECTED PUBLICATIONS

C. Faigle, F. Lautenschläger, G. Whyte, P. Homewood, E. Martín-Badosa and J. Guck. ***A monolithic glass chip for active single-cell sorting based on mechanical phenotyping.*** *Lab on a Chip 15, 1267-1275 (2015).*

OPTICAL TRAPPING LAB – GRUP DE BIOFOTÒNICA

Along this period the group **Optical Trapping Lab - Grup de Biofotònica (BiOPT)** [2014-SGR-807 (Grup de Recerca en Enginyeria dels Fronts d'Ona)] has tackled different problems related to the optical micromanipulation of living samples and the study of their mechanical and rheological properties.

1. **Optical heating of samples:** in optical tweezers, micro- or nano-scale samples are trapped by tightly focused laser beams, which generate an increase in temperature in those samples. When using lasers in the most innocuous near-infrared region for biological species, it is commonly accepted the rule of thumb that 100 mW of laser power in the sample induces a heating of 1ºC, producing an increase in temperature of a few degrees in most typical experiments. However, we have demonstrated that sample heating can be much higher, especially for small trapped particles being far from the end of the chamber - which acts as a heat sink -, and should be assessed before each experiment to avoid the optical trap being harmful to biological samples.

2. **Optical manipulation with acousto-optic devices (AODs)**: we have built a new set-up including acousto-optic deflectors for the creation of multiple traps by time-sharing of the trapping laser, which allows synchronization with the force measurement system for individual force readings at each of the trapping sites. We have also been developing two completely new uses of AOD technology which we plan to protect under the corresponding patents this coming year.

3. **Rheological properties of living samples:** we are now able to measure the rheological properties inside living cells by the active-passive calibration method and from the measurement of changes in light momentum. Along this line, we have started a collaboration with the **Self-organized complexity and self-assembling materials group** to measure the rheological properties of self-assembled microtubule bundles.

Members of the group

Mario Montes Usategui (Professor)
Estela Martín Badosa (Tenured Assistant Professor)
Frederic Català Castro (PhD Student)
Raul Bola Sampol (PhD Student)
Dorian Treptow (PhD Student)
Arnau Farré Flaquer (Collaborator)
Ferran Marsà Samper (Collaborator)

Collaborations

Self-organized complexity and self-assembling materials group, Departament de Química Física (IN²UB).

Jordi Sancho Parramón, Division of Laser and Atomic R&D, Rudjer Boskovic Institute (Zagreb, Croatia).

Singular Scientific Equipment

We have two complete optical tweezers setups mounted on vibration-isolated optical tables, and equipped with high power lasers (@1064 nm) and research microscopes (Nikon TE-2000E) for bright-field, phase-contrast, DIC and epifluoresence imaging. For the dynamic manipulation of samples we have liquid crystal spatial light modulators (Hamamatsu X10468-03) for the creation of holographic trap patterns or, alternatively, acousto-optic deflectors (AA Optoelectronic DTSXY-400-1064) for time-sharing traps. We can directly measure the forces exerted by the traps from changes in the light momentum (Impetux Optics LUNAM T40-i). Other equipment includes conventional CCD and fast and sensitive EMCCD cameras (Qimaging QICAM, Andor Ixon-860 EMCCD), precision opto-mechanical components, position-sensitive detectors (PSDs) and a piezo-electric positioning platform (Piezosystem Jena TRITOR 102 SG). We do also have a fully-equipped cell culture laboratory.

SUPRAMOLECULAR SYSTEMS IN NANOBIOMEDICINE

Micro- and nanoparticles as cell tags and cell sensors (Figure 1.1)

The immobilization of vital fluorophores has been studied, allowing the entry and sensing of monofunctional polysilicon micro- and nanoparticles in cells. Silicon surfaces functionalized with lanthanide-based molecular thermometers were also obtained.

Bifunctional systems have been obtained by orthogonal chemistry, using polysilicon and gold microparticles adhered through a thin layer of chromium. Protocols have been tested and developed to obtain different multifunctional devices, using inter alia: a) Cell adhesion proteins (lectins) labeled with fluorescent probes; b) fluorophores for detection of intracellular pH; c) internalization proteins and fluorophores for bioimaging and intracellular pH sensing (pHRodo).

Fluorophore arrays for intracellular processes analysis: Suspended chips for biomolecular multiplexing (Figure 1.2)

The whole process comprises 4 stages: a) Microfabrication of chips in silicon oxide (transparent for better observation in optical microscopes). b) Functionalization of chips using Polymer Pen Lithography. Functionalization was carried out using biomolecules, such as 2 different proteins from the lectin family and an antibody, for which their post-immobilization functionality was demonstrated using specific secondary antibodies with fluorescent probes. Alternatively, the functionalization was performed with fluorophores, whose fluorescence intensity varies with the pH of the medium. b) Release of the microparticles once functionalized, using a polymer which rips them from the surface by mechanical adhesion, to be suspended after centrifugation and dissolution of the polymer membrane. b) Intracellular pH measurements using the suspension chips, which were introduced into HeLa cells using lipofection. CLSM was used for measurements of

SELECTED PUBLICATIONS

S. Haq, B. Wit, H. Sang, A. Floris, Y. Wang, J. Wang, L. Pérez-García, L. Kantorovitch, D.B. Amabilinon and R. Raval. ***A small molecule that walks along a surface between porphyrin fences assembled in situ.*** *Angew. Chem. Int. Ed., 2015, 54, 7101-7105.*

D. Limón, E. Amirthalingam, M. Rodrigues; L. Halbaut, B. Andrade, M.L. Garduño-Ramírez, D.B. Amabilino, L. Pérez-García, and A.C. Calpena. ***Novel nanostructured supramolecular hydrogels for the topical delivery of anionic drugs.*** *European Journal of Pharmaceutics and Biopharmaceutics, 2015, 96, 421-436*

M. Rodrigues, R. Piñol, G. Antorrena, C.D.S. Brites, N. J. O.Silva, J.L. Murillo, R. Cases, I. Díez, F. Palacio, N. Torras, J.A. Plaza, L. Pérez-García, L.D. Carlos, A. Millán. ***Implementing Thermometry on Silicon Surfaces Functionalized by Lanthanide-Doped Self-Assembled Polymer Monolayers.*** *Advanced Functional Materials, 2016, 26, 200-209.*

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N. Torras, J.P. Agusil, P. Vázquez, M. Duch, A.M. Hernández-Pinto, J. Samitier, E.J. de la Rosa, J. Esteve, T. Suárez, L. Pérez-García and J.A. Plaza. ***Suspended Planar-Array Chips for Molecular Multiplexing at the Microscale.*** *Adv Mater. 2016 Feb 17;28(7):1449-54.*

T. Patino, J. Soriano, E. Amirthalingam, S. Duran, A. González-Campo, M. Duch, E. Ibáñez, L. Barrios, J.A. Plaza, L. Pérez-García and C. Nogués. ***Polysilicon-chromium-gold intracellular chips for multi-functional biomedical applications.*** *Nanoscale, 2016, 8, 8733-8783.*

the fluorescence intensity variation of different fluorescent pH probes, after inducing changes in intracellular pH.

Studies on molecular switches and surface walkers (Figure 1.3)

The displacement of a molecular component deposited on a copper surface by STM has been achieved. We have described a bimolecular system, formed by a molecule that incorporates two imidazole rings, a molecule that moves (walker) at room temperature on a mono-crystalline copper (path) surface. This displacement is modified by the presence on the surface of a second molecule, a porphyrin that forms stacks on the surface, and acts as a barrier to the movement of the former.

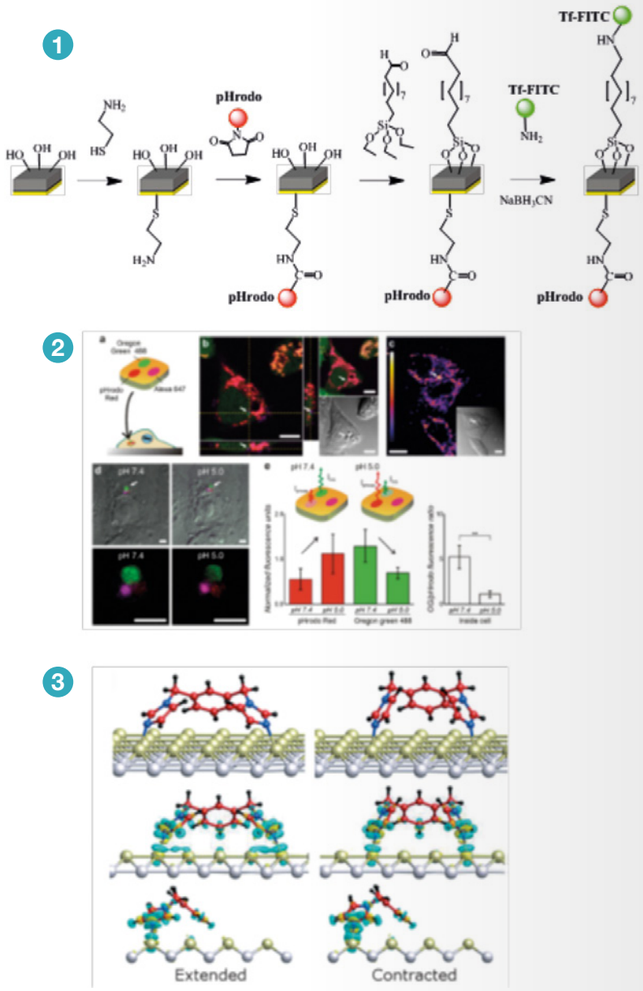

Fig. 1: **1.** Schematic representation of orthogonal bi-functionalization of pHrodo and Transferrin in bifunctional particles. **2.** Internalization of chips, functionalized by Polymer Pen Lithography, in HeLa cells and measurement of intracellular pH. **3.** Schematic representation) of the molecular components (porphyrin and walker) that move on the surface of monocrystalline copper.

Members of the group

M. Lluïsa Pérez García (Professor)
Ana Mafalda Nunes Rodrigues (Adjunct Lecturer)
María Elisa Alea Reyes (PhD Student)
David Limón Magaña (PhD Student)
Ezhil Amirthalingam (PhD Student)
Sandra Giraldo Clemente (PhD Student)

Collaborations

Prof. J. Fraser Stoddart, Northwestern University, US.

Prof. David A. Russell, University of East Anglia, UK.

Prof. David B. Amabilino, University of Nottingham, UK.

Dr Josep Puigmarti, ETH, Switzerland.

MICROBIAL ENZYMES FOR INDUSTRIAL AND ENVIRONMENTAL APPLICATIONS

The group Microbial Enzymes for Industrial and Environmental Applications works on the development of enzymes that catalyze the hydrolysis, synthesis and/or biotransformation of natural polymers.

Main topics of research are the study of molecular biology of carbohydratases and esterases, and the identification and design of new enzyme variants for biotechnological applications in pulp bleaching and paper recycling, production of biofuels, synthesis of new compounds from wastes, improvement of textile fibers, food industry, and development of new materials based on natural compounds.

The research group is currently working on the biochemical characterization and genetic improvement of lipases, cellulases, lytic polysaccharide monooxygenases (LPMOs) and expansins, from the early stages of sampling, cloning and purification up to studies of structure-function relationship and enzyme engineering. Exploration of biodiversity to expand the toolbox of new enzymes, or their improvement by protein-engineering strategies is the main goal of our research.

In the past year, we have focused on the evaluation of hemicellulosic glycosyl hydrolases. We identified a unique GH8 exo-xylanase, Rex8A, active on branched xylooligosaccharides, providing original and useful information on the properties of a new example of the scarcely studied Rex enzymes (Fig. 1).

SELECTED PUBLICATIONS

M. Estupiñán, D. Álvarez-García, X. Barril, P. Diaz and A. Manresa. ***In Silico/In Vivo Insights into the Functional and Evolutionary Pathway of Pseudomonas aeruginosa Oleate-Diol Synthase. Discovery of a New Bacterial Di-Heme Cytochrome C Peroxidase Subfamily.*** *PLoS One. 2015 Jul 8;10(7):e0131462.*

M.A. Sainz-Polo, B. González, M. Menéndez, F.I. Pastor and J. Sanz-Aparicio. ***Exploring Multimodularity in Plant Cell Wall Deconstruction: Structural and Functional Analysis of Xyn10C Containing the CBM22-1-CBM22-2 Tandem.*** *J Biol Chem. 2015 Jul 10;290(28):17116-30.*

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S.V. Valenzuela, S. Lopez, P. Biely, J. Sanz-Aparicio and F.I. Pastor. ***The Glycoside Hydrolase Family 8 Reducing-End Xylose-Releasing Exo-oligoxylanase Rex8A from Paenibacillus barcinonensis BP-23 Is Active on Branched Xylooligosaccharides.*** *Appl Environ Microbiol. 2016 Aug 15;82(17):5116-24.*

A. Valls, P. Diaz, F.I. Pastor and S.V Valenzuela. ***A newly discovered arabinoxylan-specific arabinofuranohydrolase. Synergistic action with xylanases from different glycosyl hydrolase families.*** *Appl Microbiol Biotechnol. 2016 Feb;100(4):1743-51.*

P. Panizza, S. Cesarini, P. Diaz and S. Rodríguez Giordano. ***Saturation mutagenesis in selected amino acids to shift Pseudomonas sp. acidic lipase Lip I.3 substrate specificity and activity.*** *Chem Commun (Camb). 2015 Jan 25;51(7):1330-3.*

Members of the group

Francisco I. Javier Pastor Blasco (Full Professor)

Pilar Díaz Lucea (Professor)

Josefina Martínez Martínez (Professor)

Susana Valenzuela Mayorga (Postdoc)

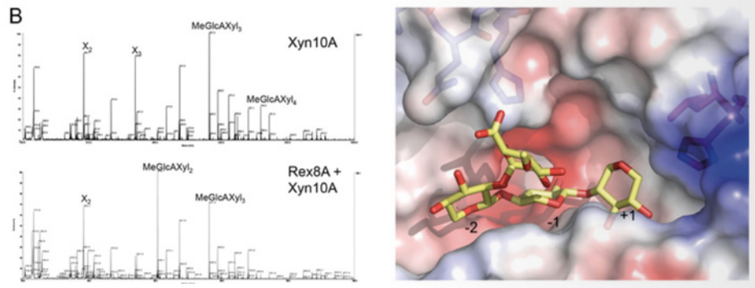

Figure 1. LEFT: MALDI-TOF MS spectra of products of beechwood xylan hydrolysis by a typical glycosyl hydrolase of family GH10, Xyn10A (top) or Xyn10A plus Rex8A (bottom). RIGHT: Surface structure representation of Rex8A active site, with positively and negatively charged regions colored in blue and red, respectively. A decorated xylotriose ligand with 4-O-MeGlcA at O2 of xylose occupying subsite –2 was modeled at the crevice. Residues blocking subsite +2 (purple) and in close contact with the substitution at subsite –2 (blue) are represented as sticks.

Another research pursued in 2016 concerns the production of bacterial nanocellulose (BNC). BNC displays exceptional physicochemical properties, such as an ultrafine reticulated structure, high crystallinity, high tensile strength, high hydrophilicity, and biocompatibility. These unique properties enable many applications and make of BNC a multifunctional nano-biomaterial for new composites.

Other tasks addressed deal with the conversion of lipids by lipases/esterases from different microorganisms, or by a complex diol synthase system discovered in Pseudomonas aeruginosa. These natural tools enable production of added value products like food additives, biofuels or pharmaceutical building blocks through simpler, sustainable and more competitive pathways.

Collaborations

Teresa Vidal's Lab:
CELBIOTECH_Paper Engineering Research Group, Universitat Politècnica de Catalunya, BarcelonaTech, 08222 Terrassa, Spain.

Angels Manresa's Lab
Unitat de Microbiologia i Parasitologia Sanitàries, Facultat de Farmàcia, University of Barcelona, Barcelona, Spain.

Peter Biely's Lab
Institute of Chemistry, Slovak Academy of Sciences, Dúbravska cesta 9, 845 38 Bratislava, Slovakia.

Sonia Rodriguez Giordano's Lab
Bioscience Department, Facultad de Química, Universidad de la República, Gral. Flores 2124, 11800 Montevideo, Uruguay.

Julia Sanz-Aparicio's Lab
Department of Crystallography and Structural Biology, Institute of Physical Chemistry Rocasolano, CSIC, Serrano 119, 28006 Madrid, Spain.

Diana Ciolacu
"Petru Poni" Institute of Macromolecular Chemistry, Department of Physical Chemistry of Polymers, 41A Grigore Ghica Voda Alley, 700487 Iasi, Romania.

Singular Scientific Equipment

- Cellular lysis:
  - Panda Plus 2000, for high pressure homogenization.

- Protein purification:
  - ÄKTA protein purification system: for chromatographic separation of proteins.

- Screening of activity:
  - ASYS UVM340 Microplate reader.
  - Agilent, Varian Cary Eclipse Fluorescence Spectrophotometer, for microplate.

NANOMALARIA GROUP

Malaria is arguably one of the main medical concerns worldwide because of the numbers of people affected, the severity of the disease and the complexity of the life cycle of its causative agent, the protist *Plasmodium spp*. The clinical, social and economic burden of malaria has led for the last 100 years to several waves of serious efforts to reach its control and eventual eradication, without success to this day. With the advent of nanoscience, renewed hopes have appeared of finally obtaining the long sought-after *magic bullet* against malaria in the form of a nanovector for the targeted delivery of antimalarial drugs exclusively to *Plasmodium*-infected cells. Nanotechnology can also be applied to the discovery of new antimalarials through single-molecule manipulation approaches for the identification of novel drugs targeting essential molecular components of the parasite. Finally, methods for the diagnosis of malaria can benefit from nanotools applied to the design of microfluidic-based devices for the accurate identification of the parasite's strain, its precise infective load, and the relative content of the different stages of its life cycle, whose knowledge is essential for the administration of adequate therapies. The benefits and drawbacks of these nanosystems have to be considered in different possible scenarios, including economy-related issues that are hampering the progress of nanotechnology-based medicines against malaria with the dubious argument that they are too expensive to be used in developing areas. Unfortunately, it is true that the application of nanoscience to

SELECTED PUBLICATIONS

E. Moles, K. Moll, J.-H. Ch'ng, P. Parini, M. Wahlgren, and X. Fernàndez-Busquets. ***Development of drug-loaded immunoliposomes for the selective targeting and elimination of rosetting Plasmodium falciparum-infected red blood cells.*** *J. Control. Release (2016) 241, 57-67.*

J. Marques, E. Vilanova, P.A.S. Mourão, and X. Fernàndez-Busquets, ***Marine organism sulfated polysaccharides exhibiting significant antimalarial activity and inhibition of red blood cell invasion by Plasmodium.*** *Sci. Rep. (2016). 6, 24368.*

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E. Moles, P. Urbán, M.B. Jiménez-Díaz, S. Viera-Morilla, I. Angulo-Barturen, M.A Busquets, and X. Fernàndez-Busquets. ***Immunoliposome-mediated drug delivery to Plasmodium-infected and non-infected red blood cells as a dual therapeutic/prophylactic antimalarial strategy.*** *J. Control. Release (2015). 210, 217-229.*

P. Urbán, E. Ranucci, and X. Fernàndez-Busquets. ***Polyamidoamine nanoparticles as nanocarriers for the drug delivery to malaria parasite stages in the mosquito vector.*** *Nanomedicine (2015) 10, 3401-3414.*

E. Moles, J.J. Valle-Delgado, P. Urbán, I.G. Azcárate, J.M. Bautista, J. Selva, G. Egea, S. Ventura and X. Fernàndez-Busquets. ***Possible roles of amyloids in malaria pathophysiology.*** *Future Science OA (2015) 1, FSO43.*

infectious disease has been traditionally neglected, with most research resources overwhelmingly biased towards other pathologies more prominent in the developed world. Thus, extra ingenuity is demanded from us: malaria-oriented nanomedicines not only need to work spotless; they have to do so in a cost-efficient way because they will be deployed in low-income regions.

The current activity of the **Nanomalaria** group is focused on the development of nanomedicine-based systems to be applied to malaria prophylaxis, diagnosis and therapy: (i) Exploration of different types of encapsulating structure (liposomes, synthetic and natural polymers), targeting molecule (protein, polysaccharide, nucleic acid), and antimalarial compound (e.g. new structures derived from marine organisms and antimicrobial peptides) for the assembly of nanovectors capable of delivering their drug cargo with complete specificity to different *Plasmodium* stages. (ii) Study of metabolic pathways present in *Plasmodium* but absent in humans, with the aim of identifying specific enzymes as therapeutic targets. (iii) Design of new methods for the targeted drug delivery to *Plasmodium* stages in the mosquito vector. (iv) Investigation of novel drugs against insect-borne diseases working through radically new mechanisms.

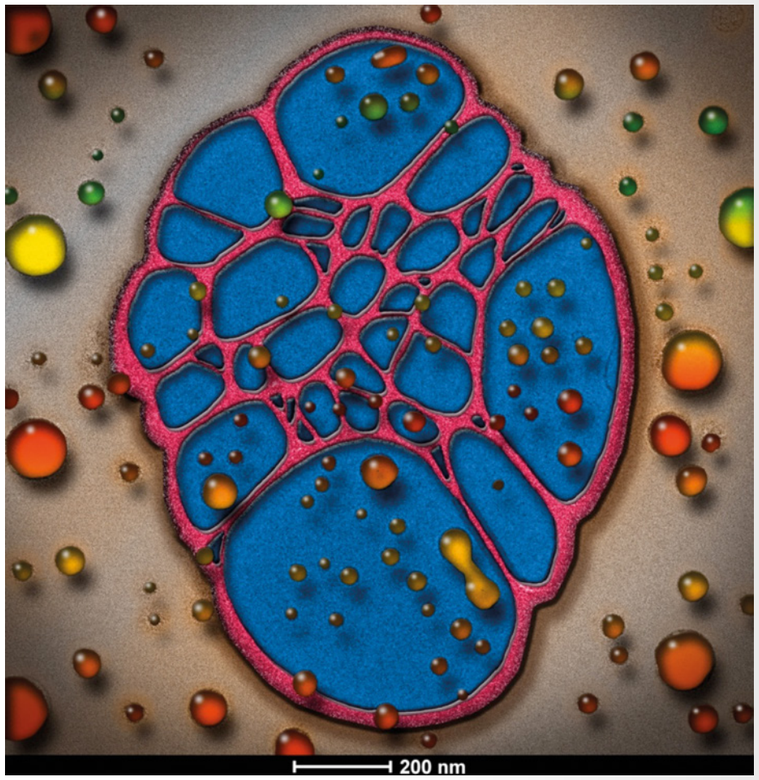

Figure 1. Cryo-transmission electron microscope image of liposomes being assayed for the encapsulation of drugs specifically targeted to red blood cells infected by the malaria parasite Plasmodium falciparum. CryoTEM image artistic editing by Marc Cirera, www.marccirera.com.

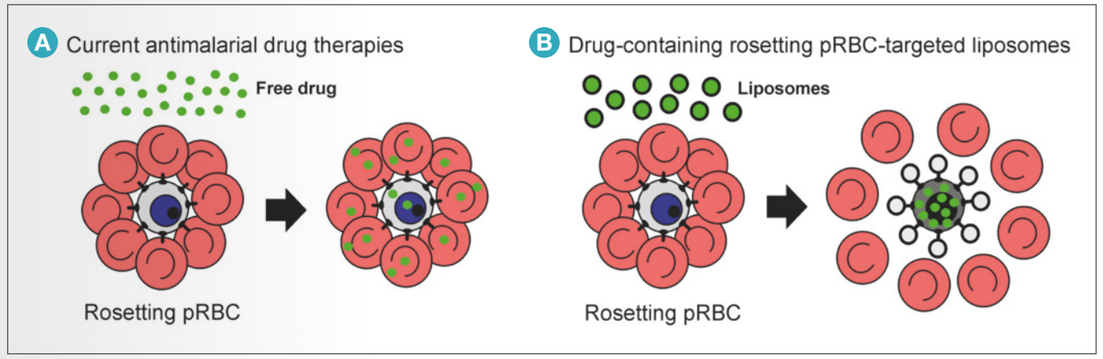

Figure 2. Development of drug-loaded immunoliposomes for the selective targeting and elimination of rosetting Plasmodium falciparum-infected red blood cells.

Members of the group

Xavier Fernández Busquets (Senior Researcher)
Santiago Imperial Ródenas (Professor)
Carlota Roca Martínez (PhD Student)

Collaborations with other research centres

Prof. Dario Anselmetti,
Universität Bielefeld, Germany

Prof. Maria Antònia Busquets,
Universitat de Barcelona, Spain

Prof. Elisabetta Ranucci,
Università degli Studi di Milano, Italy

Prof. José Manuel Bautista,
Universidad Complutense de Madrid, Spain

Dr. Matthias Rottmann,
Swiss Tropical and Public Health Institute, Basel, Switzerland

Prof. Robert Sinden,
Imperial College London, UK

Dr. Israel Molina,
Hospital Universitari Vall d'Hebron, Barcelona

Prof. José Luis Serrano,
Instituto de Nanociencia de Aragón, Zaragoza

Prof. Johan Engbersen,
University of Twente, The Netherlands

Dr. Eduardo Prata Vilanova,
Universidade Federal do Rio de Janeiro, Brazil

Prof. Maria Manconi,
Università di Cagliari, Sardinia, Italy

Dr. Krijn Paaijmans,
ISGlobal, Barcelona, Spain

Dr. Ellen Faszewski,
Wheelock College, Boston, USA

Prof. Bernard Degnan,
University of Brisbane, Australia

Dr. Francisco J. Muñoz,
Universitat Pompeu Fabra, Barcelona, Spain

Prof. Salvador Ventura,
Universitat Autònoma de Barcelona, Bellaterra, Spain

Dr. Juan José Valle-Delgado,
Aalto University, Helsinki, Finland

Prof. Mats Wahlgren,
Karolinska Institutet, Stockholm, Sweden

Dr. Fatima Nogueira,
Instituto de Higiene e Medicina Tropical, Lisboa, Portugal

Prof. Christian Grandfils,
University of Liège, Belgium

Singular Scientific Equipment and Techniques

Zeiss Primostar microscope.

Shake 'N' Stack (Thermo Hybaid) hybridization oven.

Rotatory evaporator RS 3000-V (Selecta).

Plasmodium falciparum cell cultures.

THE CELLULAR RESPONSES TO XENOBIOTCS GROUP (CEREX)

The Cellular Responses to Xenobiotcs Group (CEREX) is developing its research in the Department of Biochemistry and Physiology of the Faculty of Pharmacy and Food Sciences

The research activities of the group are focused in the development of in vitro methods to evaluate the cytotoxicity of nanoparticles and nanovesicles for drug delivery. The increase use of nanomaterials supposes a potential risk to the human health and it is necessary to ensure the safety of these materials before marketing.

There is an especial interest in the adaptation of the present methods to study the cytotoxicity of small particles given that their toxicity is affected by the exposition area. The potential interference of these particles with the classical cytotoxicity endpoints makes necessary the search of new endpoints. The present activity of the group is the search of assessment methods of the irritant and/or sensitization capacity of nanoparticles developed for transdermal drug delivery. The group obtain particles with higher loading efficiency and loading capacity and high biocompatibility as promising DNA vehicles to be used as non-viral gene delivery systems.

Another area of interest is the study nanoparticles interactions with erythrocytes and plasma proteins and the coagulation process. The potential photoprotective effect of nanovesicles are also studied

Members of the group

M.Pilar Vinardell Martínez-Hidalgo (Full Professor) Responsible
Montserrat Mitjans Arnal (Tenured Assistant Professor)
M. Carmen Morán Badenas (Tenured Assistant Professor)

SELECTED PUBLICATIONS

D.R. Nogueira-Librelotto, L.E. Scheeren, M.P. Vinardell, M. Mitjans and C.M. Rolim. ***Chitosan-tripolyphosphate nanoparticles functionalized with a pH-responsive amphiphile improved the in vitro antineoplastic effects of doxorubicin.*** *Colloids Surf B Biointerfaces. 2016 Nov 1;147:326-35.*

M.C. Morán, N. Rosell, G. Ruano, M.A. Busquets and M.P. Vinardell. ***Gelatin-based nanoparticles as DNA delivery systems: Synthesis, physicochemical and biocompatible characterization.*** *Colloids Surf B Biointerfaces. 2015 Oct 1;134:156-68.*

T. Baccarin, M. Mitjans, D. Ramos, E. Lemos-Senna and M.P. Vinardell. ***Photoprotection by Punica granatum seed oil nanoemulsion entrapping polyphenol-rich ethyl acetate fraction against UVB-induced DNA damage in human keratinocyte (HaCaT) cell line.*** *J Photochem Photobiol B. 2015 Dec;153:127-36.*

Collaborations

Departamento de Farmácia Industrial,
Universidade Federal de Santa Maria, Av. Roraima 1000, 97105-900 Santa Maria, RS, Brazil.

Departament de Fisicoquímica - Facultat de Farmàcia,
Universitat de Barcelona, Avda. Joan XXIII 27-31, 08028 Barcelona, Spain.

Institute for Advanced Chemistry of Catalonia, Spanish National Research Council (IQAC-CSIC) and CIBER de Bioingeniería, Biomateriales y Nanomedicina (CIBER-BBN),
Jordi Girona 18-26, 08034 Barcelona, Spain.

Institut de Ciència de Materials de Barcelona (ICMAB-CSIC),
Campus Universitari de Bellaterra, 08193, Cerdanyola del Vallès, Spain.

CONFORMATIONAL DISEASES GROUP

In the cell, the biological function is determined for the native protein fold. In this way, problems in the protein fold with the consequent apparition of misfolded species can disturb the essential cellular processes. Importantly, the protein misfolding entailing the polypeptide aggregation into amyloid structures have been associated with dozens of human diseases as Alzheimer, Parkinson or prion diseases. Interestingly, recent studies have shown that the amyloid aggregation process is not limited to disease-related proteins but appears to be a generic property of the proteins in both eukaryotic and prokaryotic cells. The possibility that the amyloid formation is a universal and omnipresent process shared for all life organisms entails important consequences in biology.

Following the research started in the last few years, I plan my current research in two main blocks, both of them focused in conformational diseases. On one hand, screening of new drugs for conformational diseases and on the other hand early detection of conformational diseases.

In the last few years I have focused much of my research in development of new screening methods to check potential inhibitors of the amyloid aggregation. Currently screening systems could be divided in in-silico, as pre-screening system; in-vitro, inexpensive but usually with low in-vivo reproducibility; and in-vivo using transgenic animals usually mouse, expensive and slow. Recently we have developed new in-cellulo (in-vitro in cell-based), fast and inexpensive methods using bacteria as a model track the amyloid aggregation and assay the inhibition capacity of anti-amyloid compounds. These methods allow determine the inhibitory capacity of anti-amyloid compounds for a large range of conformational diseases, from neurodegenerative illness as Alzheimer's or Parkinson

SELECTED PUBLICATIONS

R. Sabate, F. Rousseau, J. Schymkowitz and S. Ventura. ***What makes a protein sequence a prion?*** *PLoS Comput Biol. 2015 Jan 8;11(1):e1004013.*

A. Daskalov, B. Habenstein, D. Martinez, A.J. Debets, R. Sabaté R, A. Loquet and S.J. Saupe. ***Signal transduction by a fungal NOD-like receptor based on propagation of a prion amyloid fold.*** *PLoS Biol. 2015 Feb 11;13(2):e1002059.*

R. Zambrano, O. Conchillo-Sole, V. Iglesias, R. Illa, F. Rousseau, J. Schymkowitz J, R. Sabate, X. Daura and S. Ventura. ***PrionW: a server to identify proteins containing glutamine/asparagine rich prion-like domains and their amyloid cores.*** *Nucleic Acids Res. 2015 Jul 1;43(W1):W331-7.*

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A. Daskalov, B. Habenstein B, R. Sabaté, M. Berbon, D. Martinez, S. Chaignepain, B. Coulary-Salin B, K. Hofmann, A. Loquet and S.J. Saupe. ***Identification of a novel cell death-inducing domain reveals that fungal amyloid-controlled programmed cell death is related to necroptosis.*** *Proc Natl Acad Sci U S A. 2016 Mar 8;113(10):2720-5.*

A. Espargaró, A. Medina, O. Di Pietro, D. Muñoz-Torrero and Sabate R. ***Ultra rapid in vivo screening for anti-Alzheimer anti-amyloid drugs.*** *Sci Rep. 2016 Mar 22;6:23349.*

diseases and prion diseases to non-neurological neurological ones as type 2 diabetes (Figure 1).

Starting a new line in nanomaterial field, we are developing a new method for the early detection of conformational diseases based in the detection of specific protein in several conformation stages. This method originally designed for Parkinson's diseases could be redesigned to early detection of other unrelated conformational diseases as Alzheimer's diseases or prion diseases.

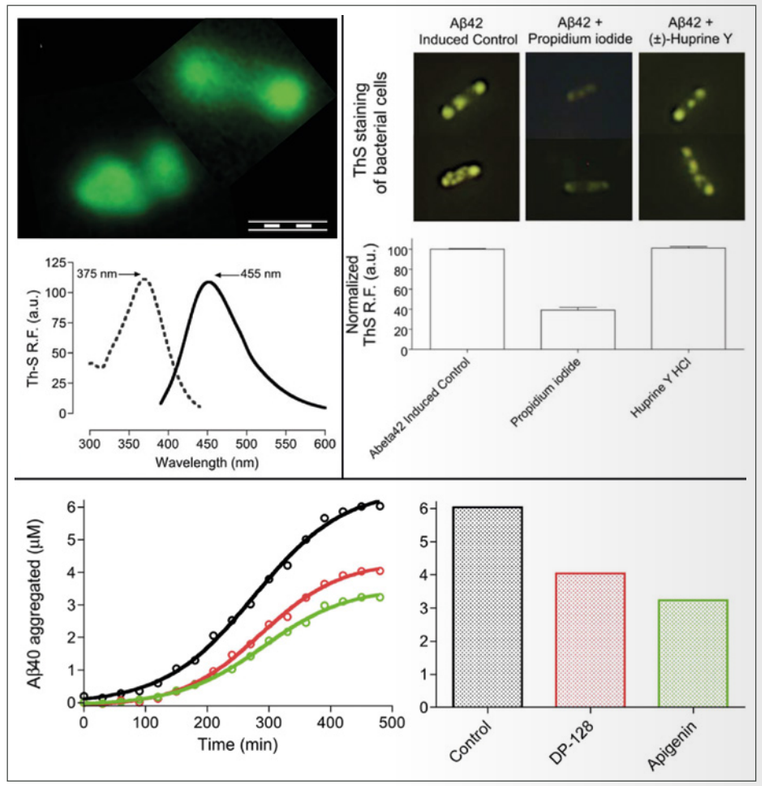

Figure 1. Amyloid aggregation. (Left-upper panel) Th-S staining of bacterial cells overexpressing Aβ42 peptide. (Up) Optical fluorescence microscopy images of bacterial cells overexpressing Aβ42 peptide stained with Th-S. The microscopy image under UV light shows the presence of amyloid-like IBs localized at the cellular poles. Scale bars 0.5 μm. (Down) Emission and excitation spectra of Th-S in the presence of bacterial cells overexpressing Aβ42 peptide. (Right-upper panel) Th-S staining of bacterial cells overexpressing Aβ42 peptide in the absence and in the presence of active (propidium) and inactive ((±)-huprine Y)) anti-aggregating compounds. (Up) Optical fluorescence microscopy images of bacterial cells overexpressing Aβ42 peptide stained with Th-S. (Down) Th-S relative fluorescence in the presence of bacterial cells overexpressing Aβ42 peptide. (Lower panel) Aβ40 amyloid concentration along the time-course kinetics and amyloid concentration at end-point of the time-course. In black, red and green, in the absence (control) and presence of 10 μM DP-128 and apigenin, respectively.

Members of the group

Raimon Sabaté (PI)
Alba Espargaró (Postdoc)

Collaborations

- Principal investigator: **Dr. Sven J Saupe**
  Institute: **Institut de Biochimie et Génétique Cellulaires**
  Subject: **Prions and cell death in fungal**

- Principal Investigator: **Prof. Angelo Carotti**
  Institute: **Dipartimento di Farmacia - Scienze del Farmaco. Università degli Studi di Bari Aldo Moro**
  Subject: **Anti-tau drugs**

- Principal Investigator: **Dr. Diego Muñoz-Torrero**
  Institute: **Laboratory of Pharmaceutical Chemistry. School of Pharmacy. Institute of Biomedicine (IBUB). University of Barcelona**
  Subject: **Anti-amyloid drugs**

- Principal Investigator: **Dr. Patrick Gámez**
  Institute: **Department of Inorganic and Organic Chemistry University of Barcelona. ICREA.**
  Subject: **Anti-amyloid peptides. Metallotherapy**

- Principal Investigator: **Prof. Joan Estelrich**
  Institute: **Physical Chemistry Department. Faculty of Pharmacy. University of Barcelona**
  Subject: **Liposomes**

- Principal Investigator: **Prof. Francisco Javier Luque**
  Institute: **Department of Nutrition. School of Pharmacy. Institute of Biomedicine. University of Barcelona**
  Subject: **Computational studies of amyloid interactions**

- Principal Investigator: **Dr. Jaime Kulisevsky**
  Institute: **Movement Disorders Unit. Neurology Department. Hospital de la Santa Creu i Sant Pau**
  Subject: **Early detection of Parkinson**

2.3. NANOPHARMACOTHERAPY (NPHARMA)

This area aims to develop nanostructured systems for controlled drug release and to the improvement of drug therapeutic efficiency when administered on targets to treat diseases such as Alzheimer. A reduction of toxicity on healthy tissues and cancer therapy is also sought.

NPharma resaerch area comprehends the following research lines:

A. Nanostructured Systems for controlled drug release. Nanocapsules.
B. Nanoestructured systems interaction with biological strucures.
C. Bioavailability, toxicity and therapeutic efficiency of nanostructured systems.
D. Non-viral vectors. Gene therapy. Pharmacogenomics and nutrigenomics.
E. Molecular internalisation. Molecular marking. Detoxification.

NPharma area is composed of the following research groups:

COLLOIDAL GROUP

The properties of magnetic nanoparticles by themselves or incorporated into different vehicles such as liposomes or emulsions has allowed the development of agents suitable for therapy and diagnosis, the so called theranostic nanoparticles. Therefore, the aim of the Colloids group is mainly focused in the design and synthesis of superparamagnetic iron oxide nanoparticles (SPIONs) coated through a layer-by-layer approach with polymers; magnetoliposomes (MLs) and nanoemulsion (NEs). These nanosystems (NSs) are characterized by determining their size (DLS, TEM, HRTEM); size distribution (DLS); charge (ζ potential); lipid (Steward-Marshall) and/or iron content (ICP; Kiwada). The potential of the NSs as therapeutic agents is related to their ability to entrap both hydrophobic and hydrophilic molecules and, last but not least, their tunable surface (Figure 1). Surface modification enables, in theory, the NSs targeting towards cells rich in specific receptors. Thus, we have functionalized MLs and NEs with peptide fragments (RGD and penetratin) and studied their cytotoxicity and internalization into 3T3 or Hela cells as well as their stability in physiological media. On another hand, the ability of MLs as T2 contrast agents in Magnetic Resonance Imaging (MRI) has been checked. For this purpose, MLs of different lipid composition were analyzed to evaluate the influence of length as well as acyl chain saturation in such parameter.

SELECTED PUBLICATIONS

B. Kwasigroch, E. Escribano, M.C. Morán, J. Queralt, M.A Busquets and J. Estelrich. ***Oil-in-water nanoemulsions are suitable for carrying hydrophobic compounds: Indomethacin as a model of anti-inflammatory drug.*** *Int. J. Pharm. 515. 749–756. (2016) http://dx.doi:0.1016/j.ijpharm.2016.11.016 0378-5173*

R. Martínez-González, J. Estelrich and M.A. Busquets. ***Liposomes Loaded with Hydrophobic Iron Oxide Nanoparticles: Suitable T2 Contrast Agents for MRI.*** *Int. J. Mol. Sci. 17, 1209 (14 pp). (2016).*

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Therefore research is summarized in the following main research lines:

1. **Synthesis and physicochemical characterization of superparamagnetic iron oxide nanoparticles.**

2. **Nanosystems for theranostic applications:**
   From the development towards the in vivo applications.

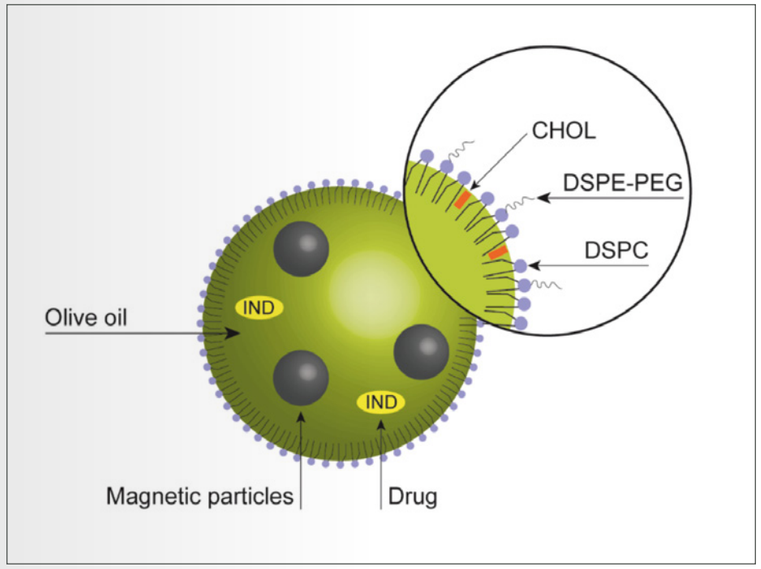

Figure 1. Scheme of functionalized magnetic nanoemulsions encapsulating indomethacin.

Members of the group

Joan Estelrich Latràs (Full Professor)
M. Antonia Busquets Viñas (Professor)

Collaborations

The Group is collaborating with other members of the IN²UB belonging to the Departments of Biochemistry and Physiology; Pharmacy, Pharmaceutical Technology and Physical Chemistry of the Faculty of Pharmacy. In addition, several collaborations have been stablished with groups of the Institute for Bioengineering of Catalonia Centre; Hospital Clínic de Barcelona and the Biomolecular NMR group (Parc Científic de Barcelona, UB).

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J. Castelló, M. Gallardo, M.A. Busquets and J. Estelrich. ***Chitosan (or alginate)-coated iron oxide nanoparticles: A comparative study.*** *Colloids Surf. A: Physicochem. Eng. Aspects. 468. 151–158. (2015)*

J. Estelrich, M.J Sánchez-Martín and M.A. Busquets. ***Nanoparticles in magnetic resonance imaging: from simple to dual contrast agents.*** *Int. J. Nanomedicine. 10.1727 – 1741. (2015)*

J. Estelrich, E. Escribano, J. Queralt and M.A. Busquets. ***Iron oxide nanoparticles for magnetically-guided and magnetically-responsive drug delivery.*** *Int. J. Mol. Sci. 16. 8070-8101 (2015)*

SELECTED PUBLICATIONS

G. Bener, A.J. Félix, C. Sánchez de Diego, I. Pascual Fabregat, C.J. Ciudad and V. Noé. ***Silencing of CD47 and SIRPα by Polypurine reverse Hoogsteen hairpins to promote MCF-7 breast cancer cells death by PMA-differentiated THP-1 cells.*** *BMC Immunol. 2016 Sep 26;17(1):32.*

A. Solé, C.J. Ciudad, L.A. Chasin and V. Noé. ***Correction of point mutations at the endogenous locus of the dihydrofolate reductase gene using repair-PolyPurine Reverse Hoogsteen hairpins in mammalian cells.*** *Biochem Pharmacol. 2016 Jun 15;110-111:16-24.*

X. Villalobos, L. Rodríguez, A. Solé, C. Lliberós, N. Mencia, C.J. Ciudad and V. Noé. ***Effect of Polypurine Reverse Hoogsteen Hairpins on Relevant Cancer Target Genes in Different Human Cell Lines.*** *Nucleic Acid Ther. 2015 Aug;25(4):198-208.*

L. Rodríguez, X. Villalobos, A. Solé, C. Lliberós, C.J. Ciudad and V. Noé. ***Improved design of PPRHs for gene silencing.*** *Mol Pharm. 2015 Mar 2;12(3):867-77.*

CANCER THERAPY

Our research is focused in the design and improvement of new therapies for cancer treatment. In this direction we have developped in our laboratory a new strategy: Polypurine reverse Hoogsteen hairpins (PPRHs).

Polypurine reverse Hoogsteen hairpins (PPRHs) are non-modified DNA molecules formed by two antiparallel polypurine strands linked by a pentathymidine loop that allows the formation of intramolecular reverse Hoogsteen bonds between both strands. Previously in our laboratory it was demonstrated that these hairpins bind to their polypyrimidine target in a dsDNA via Watson-Crick bonds, displacing the polypurine strand of the target duplex. The effect of PPRHs in cells and their mechanism of action were first described using PPRHs designed against the template and coding strands of the dhfr gene. A PPRH against survivin was further validated in a xenograft tumor model, establishing the proof of principle for the use of PPRHs as a therapeutic tool. To improve the PPRHs effect, the influence of the length was studied obtaining a higher efficiency with longer molecules. To decrease the possible off-target effect, when a purine interruption is found in the pyrimidine target, the PPRH sequence should contain the complementary base opposite to the interruption. Furthermore, the stability of PPRHs is higher than that of siRNAs, as evidenced by the longer half-life of the former in different types of serum and in PC3 cells. PPRHs do not induce the levels of the transcription factors nor the proinflammatory cytokines involved in the Toll-like Receptor pathway and they do not trigger the formation of the inflammasome complex. PPRHs can be used as therapeutic tools to target genes related to cancer progression, resistance to drugs or immunotherapy approaches.

Furthermore, we have described the design and use of repair-PPRHs and editing-PPRHs as a new methodology either to correct a point mutation or to edit a genomic fragment of the dihydrofolate reductase gene in Chinese Hamster Ovary (CHO) cells. Repair-PPRHs are formed by a PPRH core, following the Reverse Hoogsteen bonds rules, covalently connected to a repair tail, which is homologous to the mutated region of the dsDNA except for the repaired nucleotide. Several point mutations in the endogenous dhfr gene have been successfully repaired in mammalian cells using repair-PPRHs, including a deletion, an insertion, and single and double substitutions in different regions of the gene. All repaired colonies showed high levels of DHFR protein and activity, and the corrected nucleotide was confirmed in all DNA sequences. Editing-PPRHs are formed by a PPRH core, covalently connected to a sequence tail homologous to the upstream and downstream regions of the DNA fragment to be edited. All edited colonies showed high levels of DHFR protein and activity, and the edition was confirmed in all DNA sequences.

Members of the group

Carlos Ciudad Gómez (Full Professor)
Verònica Noé Mata (Assistant Professor)
Anna Solé (PhD Student)
Xènia Villalobos (PhD Student)

Collaborations with other research groups

Prof. Lawrence Chasin, Columbia University, NY, on the molecular biology of the dhfr gene and presently on point mutants of this gene

Dra. Patrizia Alberti, Université de Paris Descartes (Département Régulation-Développement-Diversité Moléculaire), on the study of the possible “G-quadruplex” structures formed by PPRHs

Dra. Sonia Trigueros, Co-Director of the Oxford Martin Programe on Nanotechnology, (Intitute of Nanoscience for Medicine, Department of Physics, University of Oxford) on the study of gold nanoparticles for PPRH delivery.

RESEARCH GROUP QUÍMICA BIO-INORGÀNICA (QBI)

Cancer and neurodegenerative diseases (such as Alzheimer’s disease —AD— or Parkinson´s disease —PD—) represent critical Health issues of the twenty-first century. Our main goals are aimed at applying new nanotechnology-based research strategies for the development of efficient therapeutic tools against these important disorders.

The development of efficient and selective anticancer drugs is of paramount importance for Society because this disease (cancer represents a broad group of various diseases) remains a serious concern since successful approaches for its effective treatment are still limited. The development of drugs based on coordination compounds (metal complexes) offers the possibility of great structural versatility (as they are generated from the combination of different metal ion(s) with distinct ligand(s)), compared to purely organic molecules. In that context, the main objectives of our current investigation consist in:

SELECTED PUBLICATIONS

A. Presa, L. Barrios, J. Cirera, L. Korrodi-Gregório, R. Pérez-Tomás, S. J. Teat, and P. Gamez. ***Non-Switching 1,2-Dithienylethene-Based Diplatinum(II) Complex Showing High Cytotoxicity.*** *Inorg. Chem. 2016, 55, 5356-5364.*

A.B. Caballero, L. Terol-Ordaz, A. Espargaró, G. Vázquez, E. Nicolás, R. Sabaté and P. Gamez. Histidine-rich ***Oligopeptides to Lessen Copper-Mediated Amyloid-β Toxicity.*** *Chem. Eur. J. 2016, 22, 7268-7280.*

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I. Gamba, I. Salvadó, R. F. Brissos, P. Gamez, J.M. Brea, M.I. Loza, M.E. Vázquez and M. Vázquez López ***High-Affinity Sequence-Selective DNA binding by Iridium(III) polypyridyl organometallopeptides.*** *Chem. Commun. 2016, 52, 1234-1237.*

J. Grau, R. F. Brissos, J. Salinas-Uber, A.B. Caballero, A. Caubet, O. Roubeau, L. Korrodi-Gregório, R. Pérez-Tomás and P. Gamez ***Effect of potential supramolecular-bond promoters on the DNA-interacting abilities of copper-terpyridine compounds.*** *Dalton Trans. 2015, 44, 16061-16072.*

A. Presa, R. F. Brissos, A.B. Caballero, I. Borilovic, L. Korrodi-Gregório, R. Pérez-Tomás, O. Roubeau and P. Gamez. ***Photoswitching the Cytotoxic Properties of Platinum(II) Compounds.*** *Angew. Chem. Int. Ed. 2015, 54, 4561-4565.*

- the design and preparation of novel metallodrugs using different approaches, namely the generation of (i) small, highly cytotoxic metal-based molecules (ii) metallosupramolecules targeting particular DNA structures, e.g. three-way junctions or G-quadruplexes (cancer-cell-selective agents) and (iii) photoswitchable metal complexes based on the photo-modification of the ligands (an unprecedented approach in photoactivated chemotherapy —PACT—, which is currently metal centred).

- the development of drug-delivery systems with targeting properties: functionalizable nano-objects for the nanoencapsulation of potential drugs; nanoparticles as drug carriers.

Neurodegenerative diseases are slowly progressive neurological disorders, in which neurodegeneration is believed to progress for 20 to 30 years before clinical onset. Affected brains usually suffer from metal-ion homeostasis (metallostasis), which gives rise to amyloidosis and oxidative stress, which are common associated signs of such pathology. To date, there are no known *effective treatments for* AD or PD.

In the case of AD, our objectives are to design and prepare selective (fluorescent) peptide-based copper chelators and conjugating them to emissive nanoparticles (gold nanoparticles, quantum dots, etc...). Such peptide-decorated nanoparticles allow the detection of copper and its brain location (fluorescent probe), and the re-establishment of normal metallo-trafficiking, therefore reducing oxidative stress (Metal Protein Attenuating Compound); these nanocompounds therefore act as AD theragnostic (therapy + diagnosis) agents.

For PD, we are currently designing diagnosis systems based on the combination of appropriately functionalized non-magnetic and magnetic nanoparticles.

Members of the group

Patrick Gamez Enamorado (Adjunct lecturer and ICREA Researcher)
Amparo Caubet Marín (Professor)
Ana Belén Caballero (Postdoc)

2.4. NANOMAGNETISM, NANOELECTRONICS AND NANOPHOTONICS (NELECTROMAGΦ)

The main objective of this area is the development of new systems for storage and processing of information at the nanoscopic scale, which is at the core of future technologies of information processing. It is also devoted to the study of new phenomena related to the nanometric size, since the interaction of electric, magnetic and optical properties in a nanosystem enables the design of innovative devices of application in the fields of healthcare, sustainable energy, healthy food and security.

NElectroMagϕ area comprehends the following research lines:

A. Magnetic nanoparticles and molecular magnets.
B. Dynamic processes in nanomagnetism. Microwave interaction.
C. Magnetic electronics.
D. NEMS (Nanoelectromechanical Systems).
E. Nanodevices, nanosensors and electronic nanosystems, optoelectronics and photonics. Photonic Crystals.

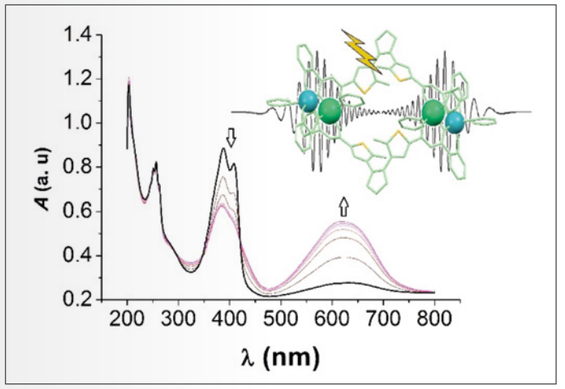
NElectroMagΦ gropus are the following:

GROUP OF MAGNETISM AND FUNCTIONAL MOLECULES

The **Group of Magnetism and Functional Molecules** (GMMF; https://www.gmmf-ub.com/) is devoted to the design and synthesis of functional molecules and of nanostructured materials for their implementation as nanodevices in spintronic applications. The main themes of interest are summarized in the following:

1. Quantum Computing

The GMMF is among the few groups of chemical synthesis actively working to advance the proposal of using the molecular spin as the technology for implementing Quantum Computing (Chem. Soc. Rev. 2012, 41, 537–546). Recent progress involves the preparation of prototypes of photoactivated √SWAP quantum gates, featuring two [CuNi] qubits, which exhibit quantum coherence of their spin states.



SELECTED PUBLICATIONS

M. Darawsheh, L.A. Barrios, O. Roubeau, S.J. Teat and G. Aromi. ***Guest-, Light- and Thermally-ModulatedSpin Crossover in [FeII2] Supramolecular Helicates.*** *Chem. Eur. J. 2016, 22, 8635-8645.*

C.M. Beavers, J. Sánchez Costa, G.A. Craig, G. Mínguez Espallargas, A. Orera, O. Roubeau and G. Aromí. ***Snapshots of a solid-state transformation: coexistence of three phases trapped in one crystal.*** *Chem. Sci., 2016, 7, 2907-2915.*

R. Diaz-Torres, M. Menelaou, O. Roubeau, A. Sorrenti, G. Brandariz-de Pedro, E.C. Sañudo, S. Teat, J. Fraxedas, E. Ruiz and N. Aliaga. ***Multiscale Study of Mononuclear CoII SMMs based on Curcuminoid Ligands.*** *Chem. Sci., 2016, 7, 2793-2803.*

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V. Fernàndez-Altable, M. Dalmases, A. Falqui, A. Casu, P. Torruella, S. Estradé, F. Peiró and A. Figuerola. ***Au-Assisted Growth of Anisotropic and Epitaxial CdSe Colloidal Nanocrystals via in Situ Dismantling of Quantum Dots.*** *Chem. Mater. 2015, 27, 1656–1664.*

V. Velasco, D. Aguila, L.A. Barrios, I. Borilovic, O. Roubeau, J. Ribas-Ariño, M. Fumanal, S.J. Teat, and G. Aromí. ***New coordination features; a bridging pyridine and the forced shortest non-covalent distance between two CO_3^{2-} species.*** *Chem. Sci., 2015, 6, 123-131.*

2. Switching Molecular Materials

Several properties are exploited in the group for implementing molecular switches. One of the most promising is the so-called spin crossover, which toggles reversibly the magnetic state of molecular materials with concomitant changes to many other physical properties by means of external stimuli (eg J. Am. Chem. Soc. 2014, 136, 3869–3874).

3. Multifunctional Molecules

A promising avenue for accessing molecular devices is the design of multi-responsive molecules, capable to respond to different stimuli and to display more than one property or function. We develop molecules combining properties such as interesting magnetic properties (slow relaxation of the magnetization, spin crossover, etc), optical properties (photo-switching, luminescence, the LIESST effect, etc.) or recognizing molecular guests.

4. Molecules on Surfaces

The implementation of molecular devices in Nanotechnology depends most often on the capacity of immobilizing molecules on surfaces and addressing them. Our group is engaged on several programs aiming at studying the functional properties on surfaces, specially the magnetic behavior.

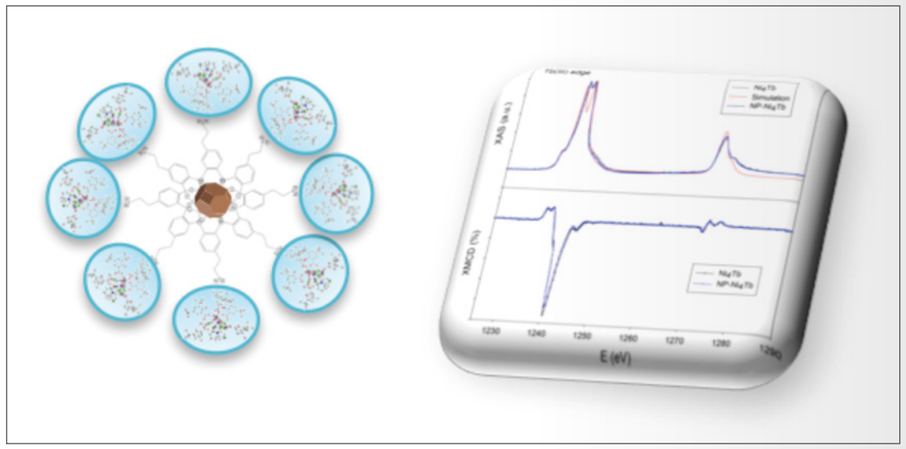
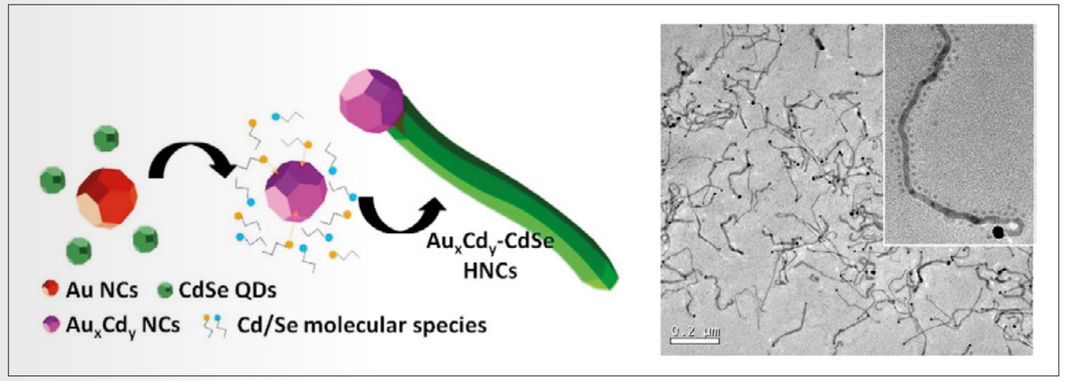


Figure 1. Hybrid SMM-nanoparticle systems: element specific XMCD.

5. Energy Conversion

We use the bottom-up approach to prepare composite nanostructures for various purposes. One of them is the conversion of solar energy into an electric potential. One methosd used is colloidal chemistry as a synthetic tool to obtain homogeneous and compositionally complex novel nanostructured systems. For example, we have studied the Au-assisted growth of anisotropic CdSe colloidal nanocrystals, and investigated the solid state reaction mechanism hidden behind their formation.



Members of the group

Guillem Aromí Bedmar
(Tenured Assistant Professor)

Albert Figuerola Silvestre
(Tenured Assistant Professor)

Eva Carolina Sañudo
(Tenure-Track Lecturer)

Verónica Velasco Amigó
(Adjunt Lecture)

Marta Estrader Bofarull
(Postdoc)

Ivana Borilovic (PhD Student)

Mariona Dalmases Solé
(PhD Student)

Collaborations

The group has an extensive net of collaborations. Among the most significant are:

Instituto de Materiales de Aragón
Prof. Fernando Luis, Dr. Olivier Roubeau
Universidad de Zaragoza (Spain)

Advanced Light Source
Prof. Simon J. Teat
Lawrence Berkeley National Laboratory (USA)

Department of Nanochemistry
Prof. Alberto Casu
IIT (Italy)

Institut für Nanotechnologie
Prof. Wolfgang Wernsdorfer
KIT (Germany)

Singular Scientific Equipment and Techniques

Microwave reactor

Glove Box (controlled atmosphere) for sample preparation and chemical synthesis

X-Ray Diffractometer for single crystal structural determinations

SELECTED PUBLICATIONS

C. Moya, O. Iglesias-Freire, N. Pérez, X. Batlle, A. Labarta and A. Asenjo. ***Direct imaging of the magnetic polarity and reversal mechanism in individual Fe(3_x)O4 nanoparticles.*** *Nanoscale. 7. 8110-8114. (2015)*

A. Fraile Rodríguez, A.C. Basaran, R. Morales, M. Kovylina, J.Llobet, X. Borrisé, M. A. Marcus, A. Scholl, I. K. Schuller, X. Batlle and A. Labarta. ***Manipulation of competing ferromagnetic and antiferromagnetic domains in exchange-biased nanostructures.*** *Physical Review B. 92.174417 (2015).*

R. Morales, A.C. Basaran, J.E. Villegas, D. Navas, N. Soriano, B. Mora, C. Redondo, X. Batlle and I.K. Schuller. ***Exchange-bias phenomenon: The role of the ferromagnetic spin structure.*** *Physical Review Letters. 104. 097202 (2015).*

C. Moya, O. Iglesias-Freire, X. Batlle, A. Labarta and A. Asenjo. ***Superparamagnetic versus blocked states in aggregates of $Fe_{3-x}O_4$ nanoparticles studied by MFM.*** *Nanoscale 7. 17764-17770. (2015).*

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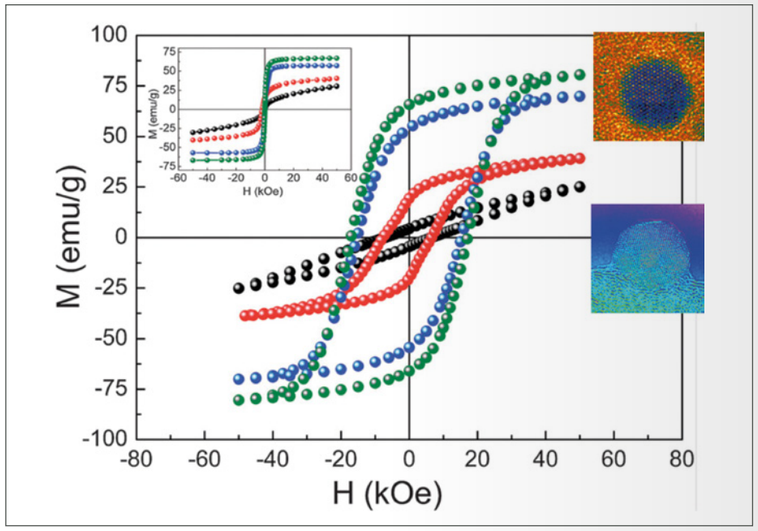
GROUP OF MAGNETIC NANOMATERIALS

1. Magnetic nanoparticles

We have studied the effect on both the magnetic and crystal structures of MFe_2O_4 (with M= Co,Fe) nanoparticles (NPs) of the concentration of some reactants present along the high-temperature decomposition of organic precursors that is the general synthesis method used in literature.

We present two results:

The structural and magnetic properties of three samples of 8 nm Co-ferrite NPs synthesized by the decomposition of metal-organic precursors have been compared by varying the amount of 1,2-hexadecanediol present in the reaction mixture. Tough all three samples had very similar stoichiometry and distribution of particle sizes, and they were all even nominally single-phase $CoFe_2O_4$ according to the conventional methods of chemical and structural characterization performed, they have shown strongly sample-dependent magnetic properties, ranging from bulk-like ferrimagnetism to glassy magnetic behavior. We have demonstrated that the presence of crystallite domains associated with crystallographic defects throughout the particles leads to highly-frustrated ferrimagnetic cores that were responsible for the glassy phenomenology - largely spoiling the magnetic performance of the NPs, while only samples almost free of structural imperfections showed bulk-like magnetic properties. It is thus suggested that care should be taken when analyzing the magnetic behavior of ferrimagnetic transition metal oxide nanoparticles since most of the reported large variability of magnetic properties and 'spin glass-like' phenomenology may be just due to the poor crystallinity of the particles yielded by some conventional methods of preparation.



Hysteresis loops at 5 K for Cobalt ferrite NPs with different crystal quality. Samples are as follows: R1: black spheres, R1a: red spheres, R1b: blue spheres and R1c: green spheres. Inset: hysteresis loops at 300 K with the same color code.

The magnetization reversal in single, isolated $Fe_{3-x}O_4$ NPs and small clusters has been studied by means of variable-field magnetic force microscopy. We have directly observed the domain configurations in cubic, isolated $Fe_{3-x}O_4$ NPs with an average lateral size of 25-30 nm and high crystal quality. Single domain structures were shown, whose orientation and polarity result from both the magnetocrystalline easy axes of the particles and previous magnetic history. As the main result, we have been able to observe directly the orientation of the easy axes in individual ferrimagnetic nanoparticles. Furthermore, experimental evidence of a magnetization reversal mediated by coherent rotation of the particle spins has been obtained in those isolated NPs that has also been supported by micromagnetic OOMF calculations.

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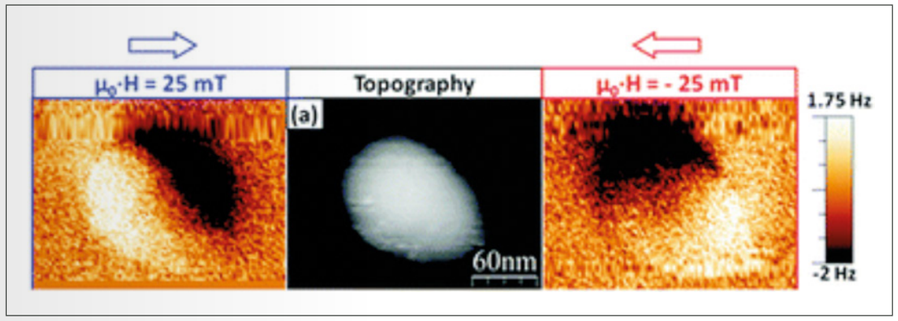
H. Bakkali, M. Domínguez, X. Batlle and A. Labarta. ***Universality of the electrical transport in granular metals. Scientific Reports.*** *6. 29676-1/29676-8. (2016).*

M. Kovylina, N. Alayo, A. Conde-Rubio, X. Borrisé, J. Bausells, G. Hibbard, A. Labarta, X. Batlle and F. Pérez-Murano. ***Au cylindrical nanocup: A geometrically, tunable optical nanoresonator.*** *Applied Physics Letters. 107.033102-1/033102-5. (2015).*



The domain polarity. Topographic (center) and MFM images (left & right) for 25 nm $Fe_{3-x}O_4$ NP in the presence of in-plane magnetic fields with opposite directions.

References

1. C. Moya, *et al.* Phys. Chem. Chem. Phys., 2015,17, 27373.
2. C. Moya, *et al.* Phys. Chem. Chem. Phys., 2015,17, 13143.
3. C. Moya, *et al.* J. Phys. Chem. C 2015, 119, 24142.
4. C. Moya, *et al.* Nanoscale, 2015,7, 8110.

Collaborations

Prof. M.P. Morales and **Dr. A. Asenjo**
ICMM-CSIC (Madrid)

Dr. Óscar Iglesias-Freire
Nanoscience and SPM Group, McGill University, Montreal,Canada.

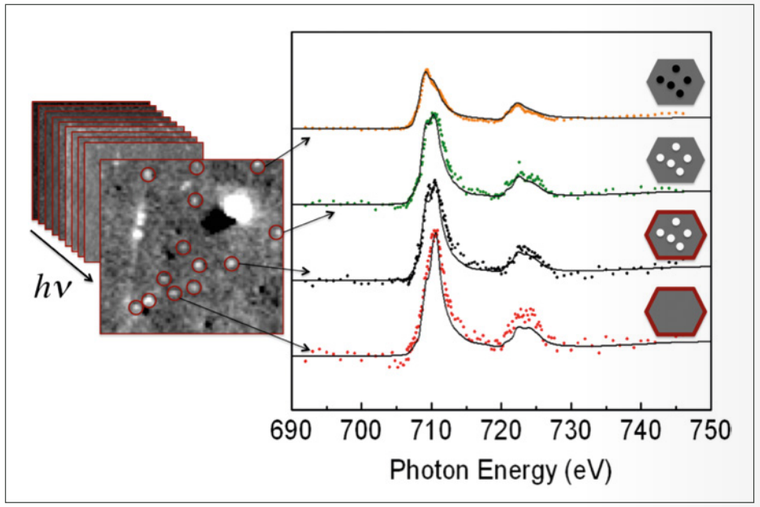
Singular Equipment

Synthesis lab.

2. Exchange bias and x-ray spectro-microscopy on individual magnetic nanostrucutres

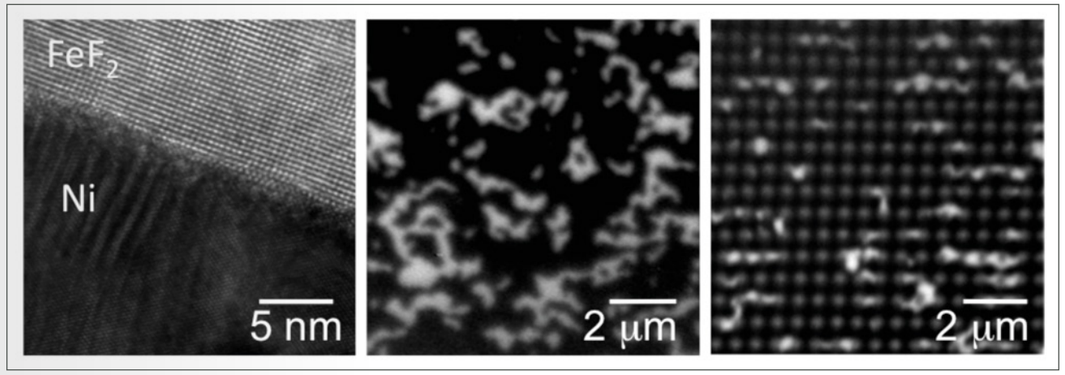
a. Probing the variability in oxidation states of magnetite nanoparticles by single-particle spectroscopy

Study of electronic and chemical properties of a variety of ensembles of size- and shape-selected Fe_3O_4 nanoparticles with single particle sensitivity by means of synchrotron-based X-ray photoemission electron microscopy. The local X-ray absorption spectra reveal that the oxidation states and the amount and type of cations within the individual nanoparticles can show a striking local variability even when the average structural and magnetic parameters of monodisperse ensembles appear to be compatible with those of conventional homogeneous magnetite nanoparticles. Our results show the key role played by the oleic acid concentration in the reaction mixture on the formation and compositional homogeneity within individual nanoparticles. This work underlines the importance of combining both advanced synthesis techniques and complementary single-particle investigations to improve the understanding and control over the electronic and magnetic phenomena at the nanoscale.



b) Manipulation of hybrid magnetic nanostructures through exchange bias and interfacial strain

We use synchrotron X-ray photoemission electron microscopy to analyze the spin configurations of model exchange biased Ni/FeF_2 nanostructures and Ni/V_2O_3 nanostructures. For the Ni/FeF_2 case, we show that a progressive spatial confinement of the bilayers, either through FM thickness variation or via antidot patterning the whole FM/AF heterostructure, actively controls the domain configuration of uncompensated spins in the AF. The final spin structure is determined by the balance between the competing FM and AF magnetic energies. The underlying mechanism of the AF domain formation in Ni/FeF_2 may be generic to other magnetic systems with complex non-collinear FM/AF spin structures.



For the Ni/V_2O_3 bilayers, we find that the SPT in V_2O_3 induces nucleation of reversed Ni domains, and their fraction grows monotonically with the predominance of one of the coexisting structural phases. The changes in domain structure are fully reversible over the narrow temperature window of the SPT. A local distribution of transition temperatures is found across the sample. The lateral domain correlation length allows us to discern the SPT character.

References

Arantxa Fraile Rodríguez, Ali C. Basaran, Rafael Morales, Miroslavna Kovylina, Jordi Llobet, Xavier Borrisé, Matthew A. Marcus, Andreas Scholl, Ivan K. Schuller, Xavier Batlle, and Amílcar Labarta. *Manipulation of competing ferromagnetic and antiferromagnetic domains in exchange-biased nanostructures.* Physical Review B 92, 174417 (2015).

Ramírez, J.G.; de la Venta, J.; Wang, S.; Saerbeck, T.; Basaran, A.C.; Batlle, X.; Schuller, I.K. *Collective mode splitting in hybrid heterostructures.* Physical Review B. 93, 214113 (2016)

Morales, R.; Basaran, A.C.; Villegas, J.E.; Navas, D.; Soriano, N.; Mora, B.; Redondo, C.; Batlle, X.; Schuller,I.K. *Exchange-bias phenomenon: The role of the ferromagnetic spin strucutre.* Physical Review Letters. 104, 097202 (2015)

Collaborations

Dr. A. Scholl
Advanced Light Source, LBNL, USA

Dr. Ali Basaran, Dr. J. Gabriel Ramírez, Mr. Ilya Valmianski, Prof. Ivan K. Schuller
University of California San Diego (UCSD), USA

Dr. F. Kronast
Helmoholtz-Zentrum Berlin, Germany

Dr. C. Piamonteze
Swiss Light Source. Switzerland

Dr. Rafael Morales
Universidad del País Vasco

Singular Equipment

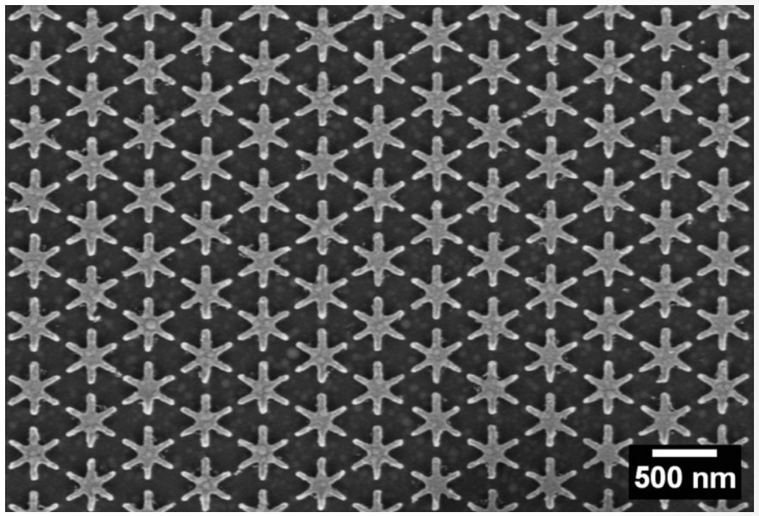
Access to large-scale facilities: Synchrotron radiation lab:

- UE49_PGM SPEEM. BESSY (Helmholtz Zentrum Berlin).
- 11.0.1 beamline (PEEM3). Advanced Light Source. LBNL. US Department of Energy.
- SIM and X-Treme beamline. Swiss Light Source.
- BOREAS beamline. ALBA.

3. Plasmonics

Concerning plasmonic nanostructures, we have been working in two different lines. First, we continued our studies in cylindrical metallic nanostructures (nanocups), in particular. In the optimization of the geometrical parameters and the use of a Si substrate a metal-insulator-metal stack on top to enhance their plasmonics response. Also, first measurements for SERS were performed.

On the other sized, we started studying hexagonal and triangular lattices of plasmonics nanostructures. Finite Difference Time Domain (FDTD) simulations show, for certain lattices, narrow peaks and very high absorption in the visible part of the spectrum that could be of interest for SERS. Samples have been fabricated by e-beam lithography and first measurements show good agreement with simulations.



SEM image of Au stars

References

Kovylina, M.; Alayo, N.; Conde-Rubio, A.; Borrisé, X.; Bausells, J.; Hibbard, G.; Labarta, A.; Batlle, X.; Pérez-Murano, F.
Au cylindrical nanocup: A geometrically, tunable optical nanoresonator
Applied Physics Letters 107, 033102 (2015).

Collaborations

Prof. F. Pérez-Murano
IMB-CNB-CSIC.

Dr. G. D. Hibbard
Universidad de Toronto. Canadá.

Prof. Harald Giessen
Physics Institute de la Universidad de Stuttgart.

Singular Equipment

Access to nanofabrication techniques: Electron Beam Lithography, Focus Ion Beam, Nano-imprint Lithography, Reactive Ion Etching, Metallization, Atomic Layer Deposition

Deposition techniques: sputtering and electron beam evaporation

Optical properties: optical absorption, SNOM, non-linear optics

Numerical simulations by Finite Difference Time Domain (FDTD)

4. Monte Carlo simulations

Current research activity based on theoretical models and computer simulations has been conducted along the following research lines: 1) microscopic characterization of the reversal mechanisms of individual magnetic nanoparticles with peculiar morphologies like hollow structures, showing the different dynamic behavior of inner and outer surface spins, and core/shell structures, studying exchange bias effects; 2) influence of dipolar interactions on nanoparticle assemblies, proposing a scheme based on the analysis of relaxation curves to quantify their strength; 3) biomedical applications of hyperthermia, ongoing research to study the effects of clustering, chaining and interactions.

Impact article

“Exchange Bias Effects in Iron Oxide Based Nanoparticle Systems”

M.-H. Phan, Javier Alonso, Hafsa Kurshid, Paula Lampen-Kelley, Sayan Chandra, Kristen Stojak Repa, Zohre Nemati, Raja Das, Oscar Iglesias, Hariharan Srikanth

Nanomaterials (Topic Review) 6, 221 (2016)

Collaborations

Drs. Nuno J. O. Silva and **V. Amaral**
Univ. Porto y CICECO (Aveiro, Portugal

Profs. Hari Srikanth and **Manh-Huong Phan**
Univ. South Florida (USF, EEUU)

Dr. Johans Restrepo
Univ. Antioquia (Medellín, Colombia)

Prof. Saurav Giri
Indian Association for the Cultivation of Science (IACS), Kolkata (India)

Prof. Hamid Kachkachi
Université de Perpignan, Perpignan (Francia)

Prof. Kalliopi Trohidou
Institute of Materials Science - NCSR Demokritos (Atenas, Grecia)

Members of the group

Amílcar Labarta Rodríguez (Full Professor)
Xavier Batlle Gelabert (Full Professor)
Òscar Iglesias Clotas (Tenured Assistant Professor)
Montserrat García del Muro (Tenured Assistant Professor)
Arantxa Fraile Rodríguez (Tenured Assistant Professor)
Carlos Moya Alvarez (Postdoc)
Ana Conde Rubio (PhD Student)
Mariona Escoda Torroella (PhD Student)

SELECTED PUBLICATIONS

J. Ibanez, S. Hernández, J. López-Vidrier, D. Hiller, S. Gutsch, M. Zacharias, A. Segura, J. Valenta and B. Garrido. ***Optical emission from SiO2-embedded silicon nanocrystals: A high-pressure Raman and photoluminescence study.*** *Physical Review B 92, 035432 (2015).*

M. Dalmases, M. Ibáñez, P. Torruella, V. Fernàndez-Altable, L. López-Conesa, D. Cadavid, L. Piveteau, M. Nachtegaal, J. Llorca, M.L. Ruiz-González, S. Estradé, F. Peiró, M.V. Kovalenko, A. Cabot and A. Figuerola. ***Synthesis and Thermoelectric Properties of Noble Metal Ternary Chalcogenide Systems of Ag-Au-Se in the forms of Alloyed Nanoparticles and Colloidal Nanoheterostructures.*** *Chemistry of Materials, 28 (19), pp. 7017-7028 (2016).*

J. López-Vidrier, Y. Berencén, S. Hernández, B. Mundet, S. Gutsch, J. Laube, D. Hiller, P. Löper, M. Schnabel, S. Janz, M. Zacharias and B. Garrido. ***Structural parameters effect on the electrical and electroluminescence properties of silicon nanocrystals/SiO_2 superlattices.*** *Nanotechnology 26, 185704 (2016).*

>>>>>

MIND (MICRO-NANOTECNOLOGIES I NANOSCÒPIES PER DISPOSITIUS ELECTRÒNICS I FOTÒNICS)

Micro-and Nanotechnology Electronic and Photonic Devices (MIND) research activities are structured in the following areas:

1. Printed electronics
2. Micro and nanotechnologies
3. Nanoscopies
4. Optoelectronics and photonic devices

The activities and most relevant results are described as follows:

1. Printed electronics

As a result of a research which aims to provide flexible and wearable nanosensors, the group has gained a remarkable know-how in printed electronics.

The main techniques have been Inkjet Printing, electrospray, 3D Printing

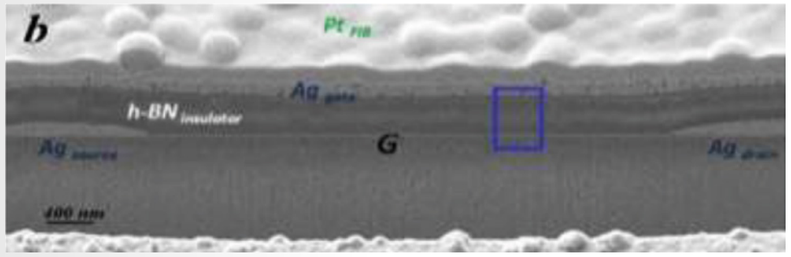
(robocasting and DLP) and tape casting. In the case of Inkjet Printing, which has been set-up, currently there are two printer: Dimatix and Xennia. As Electropray concerns there is a electrospinner / electrospray YFLOW. Concerning 3D printing, the is a robocasting (or direct-writing) plus a thread extruder (BCN3D).

The group also has other techniques such as spin-coating or drop-coating.

Related to Printed Electronics the group has been working on different approaches:

Formulating nanomaterials-based conductive inks (Ag), high-K (HFO) and 2D (Graphene, BN) for advanced devices (TFT ReRAMS)

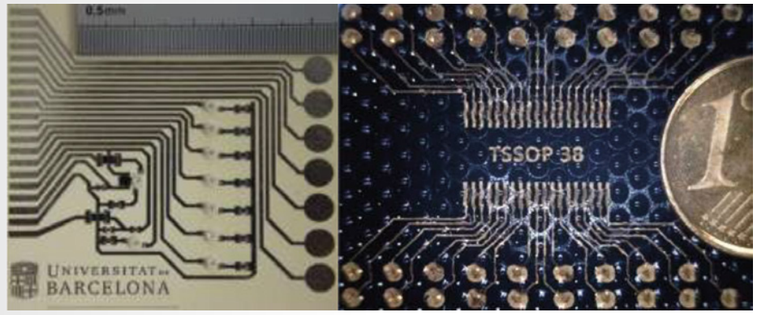
Printed electronics, especially Inkjet printing, is characterized by a strong application development which in recent years has been much faster than the availability of functional materials inks. In the group we have developed some unique inks for very specific applications. We have developed, for example, an Hafnium oxide ink based on its nanoparticles. This material is a high dielectric provision. It can be used in high frequency, high-K so-called. We have been able to apply this ink both into MIM capacities and Memristors ReRAMS. We have also developed 2D materials inks such as graphene and boron nitride. These materials are particularly interesting for development of more complex systems such as thin transistors (TFTs) on flexible materials.



FE-SEM image of a FIM Prim transistor section (TFT) printed source and drain of silver, boron nitride insulating and graphene semiconductor.

Hybrid Printed Electronics

A special effort has been made to combine the development of printed electronics with other standard electronic components, such as those based on SMD encapsulated. To reach this gaol it has been analyzed a welding system based on the very ink in which inks are made, getting great results on mechanical adhesion and contact resistance.



Left: impression of a hybrid circuit with various sensors and SMD LEDs on paper.
Right: print of a circuit on rough glass to solder a SMD package.

Polymeric Surfaces Modification

Other aspect in which we are also working is on surface modification of polymer impressions for various electronic applications (sensors, solar cells) or even for bioelectronics (biosensors). PDOT printed polymers, PDOT: PSS, polystyrene or others, (in collaboration with other groups) changes are made by periodic surface techniques such as LIPS (laser induced periodic structures) or nano-imprinting.

2D and 3D Printing Combination

In collaboration with the CIM center we are developing a hybrid printer capable of printing ceramic or plastic in 3D using DLP (direct light processing) and in 2D Inkjet Printing.

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J. Samà, S. Barth, G. Domènech-Gil, J.D. Prades, N. López, O. Casals, I. Gràcia, C. Cané and A. Romano-Rodríguez. ***Site-selectively grown SnO_2 NWs networks on micromembranes for efficient ammonia sensing in humid conditions.*** *Sensors and Actuators B-Chemical 232, 402-409. (2016).*

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

2. Sensing microsystems based on micro and nanotechnologies

We are working on the development of micro and nanosystems in the following main topics:

Detection of pollutants

We have been working on the synthesis of materials based on metal oxides for the manufacture of sensors gas. To do this, progress has been made in the synthesis of new nanomaterials as Ga_2O_3 nanowires, In_2O_3 and mixed oxide-$IN_{2-x}Ga_xO_3$ and microoctahedres of In_2O_3, using a microwave tank chemical vapour (CVD). The results of gas sensing devices based on these materials have shown that they are all of mixed oxides there is no report in the literature microoctahedres the case and there is only one method of synthesis are different and may prove obtained here.

Following the research on gas sensing in 2012 it began a new form of synthesis Technical University of Vienna consistent growth of nanomaterials directly on the microplataform sensors, electrodes containing the heater surface and buried. Optimized synthesis, ensuring an efficiency of 90% growth (number of microplataforms not degrade after growth) and has expanded the range of materials grown, are now SnO_2, WO_3, ZnO and Ge. 2 articles have been published that demonstrated the sensitivity, robustness and viability the sensors. At the moment research is moving in the line of combining different materials microplataforms on the same chip with the idea of making nano-noses electroncis (nano enose).

Since 2014, the group is also working on the development of very low consumption gas sensors (sub-microwatts) and specificity improved under the project ERC Starting Grant “BetterSense.” To achieve these benefits, we combines blue LED technology at low consum with organic surface functionalization. The group maintains a very narrow collaboration with the University Technical Braunschweig, which has specific facilities for the production of these type of LED.

As a result of these developments, it has recently started an ERC Proof-of-Concept project (“GasApp”) for the implementation and feasibility study to detect gases with high specificity means of detecting changes colour (instead of conventional power measurement).

Detection of circulating cancer cells (CTC) by Fluidic Chip

In the frame of TECNOSpring program, it has been designed, simulated, fabricated and tested a modular fluidic system to detect circulating cancer cells (CTC) in blood flow, which has the peculiarity that can distinguish “normal” cells by means of the different electrical behaviour, allowing their detection directly from impedance measurements without the need to mark the cells. This system shows high capacity, enabling detection of up to 100 cells per second. This project is developed with the collaboration of manufacturing Technical University of Denmark and IBEC. Progress is being made in combining this microsystem with other micro parts, which would allow to directly work with blood samples to be purified by this micro modular and should be able to detect 5 CTCs in 7.5ml, which is considered to bethe threshold above which there may be metastasis.

Nanosystems to detect mechanical stresses in tissues

We are working on the design, simulation, manufacturing and test of a nanosystem based on nanopillars that can be deformed, to measure the mechanical stresses that is generated in living biological tissues as a result of the tumour generation and spreading or as a result of wound healing in these tissues. The deflexion of these nanopillars (from 40-200nm of diameter and 3 m high) should be used as the readout of the tensions to be measured. It has been already tested the biocompatibility of this system, since it does not affect the viability of the HeLa cell line tested.

Integrated super-resolution optical microscopy

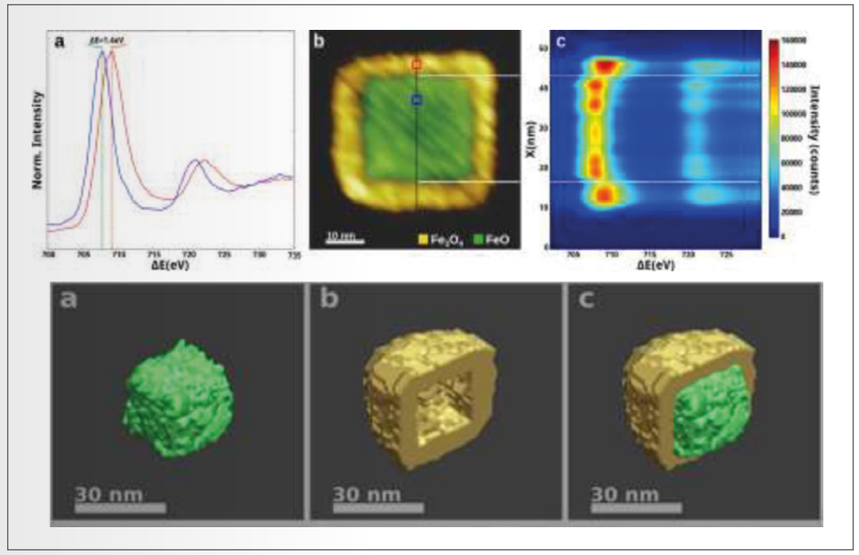
In collaboration the SIC group of our department (Dep. Engineering: Section of electronic), we are coordinating the FET Open project called “ChipScore” which aims at creating a new type of chip-sized optical microscope with high resolution capabilities, to see extremely small structures such as viruses, DNA molecules or the inside of cells, in real time and without the disadvantages of the current high resolution techniques. The project ChipScope will be conducted between January 2017 and December 2020, led by the University of Barcelona and with the participation of the Braunschweig University of Technology (Germany), the University of Rome Tor Vergata, the company Expert Ymaging (Barcelona), the Austrian University of Technology, the Medical University of Vienna and the Swiss Foundation for Research in Microtechnology.

3. Nanoscopies

In this field, the group has been focused on different research lines:

Methodologic

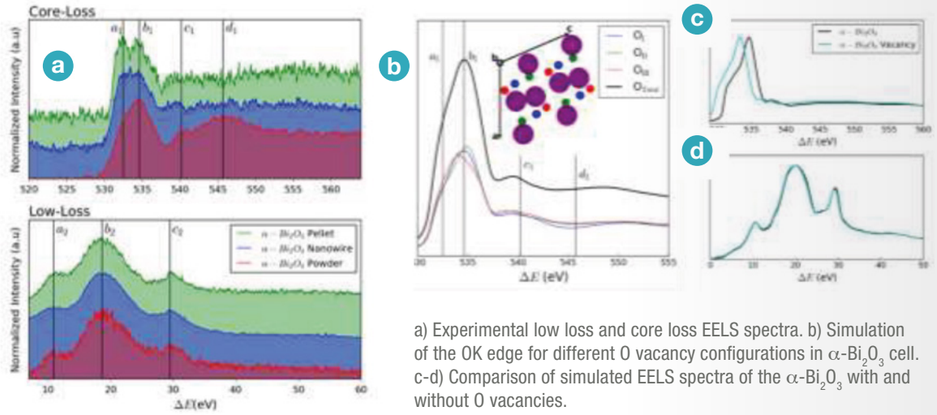
Combination of tomography and energy loss spectroscopy for the 3D reconstruction of oxidation states in transition metals.



3D reconstruction of Fe2 + (a) and Fe3 + (b) components and overlapping the two (c) confirming the core-shekll structure of the nanocubes.

Theoretical

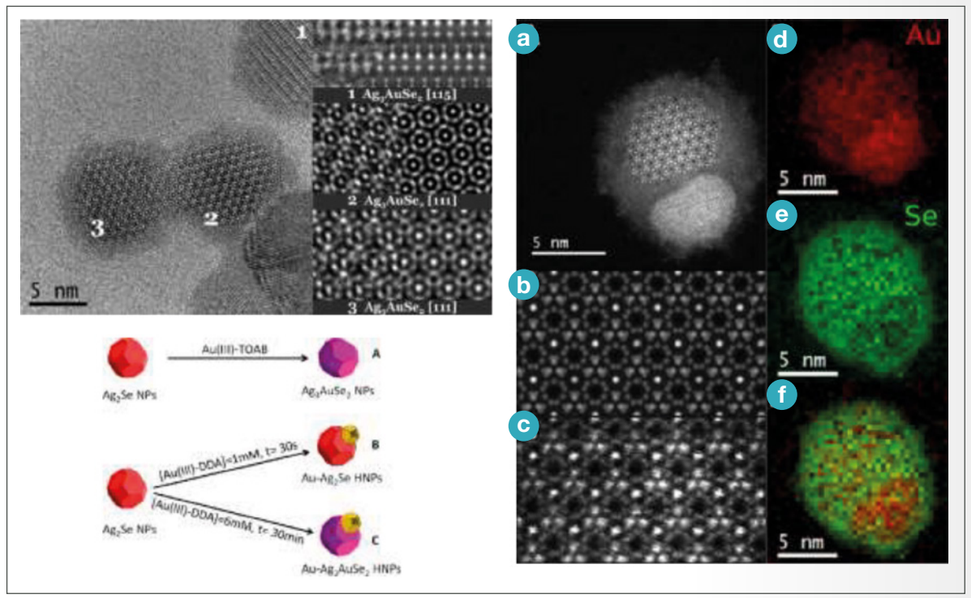
EELS spectroscopy simulation from first principles. We have developed knowhow in the simulation of EELS data through density functional theory (Density Functional Theory, DFT), to determine the properties of the material from the loss function.



a) Experimental low loss and core loss EELS spectra. b) Simulation of the OK edge for different O vacancy configurations in α-Bi_2O_3 cell. c-d) Comparison of simulated EELS spectra of the α-Bi_2O_3 with and without O vacancies.

Materials Science Application

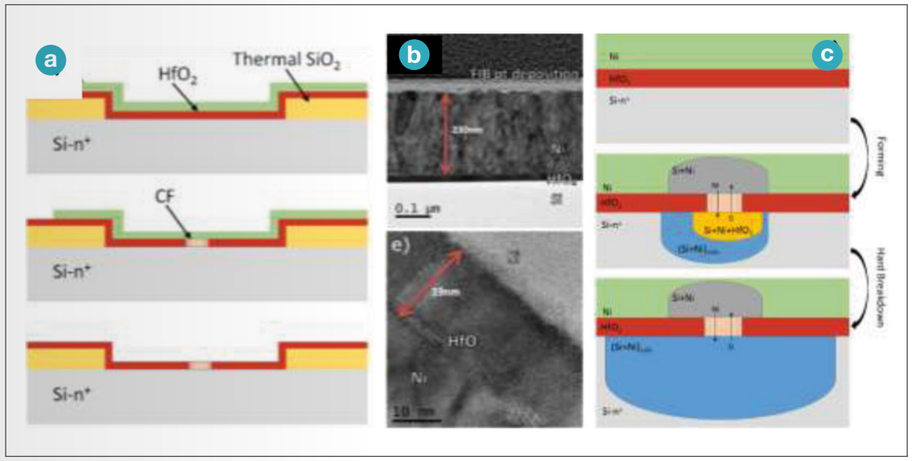
The combination of observation methods with advanced aberration corrected electron microscopes (high resolution, HAADF-STEM, Tomography, EELS) has allowed us an accurate characterization of functional nanostructures with applications in biomedicine, energy and optoelectronics.



(Left) HAADF images of AgAuSe nanoparticles and corresponding simulations. (Right): a) Au-dimer hybrid Ag3AuSe2. Simulations b) and image (c) of the fischesserite structure along the [111] zone axis. d-f) Se and Au signals maps. In collaboration with Dr. Albert Figuerola (UB) and Dr. Andreu Cabot (IREC).

Instrumentals

Application of in-situ electrical measurements to detect the formation mechanisms of the conductive filaments in Memristors filament with metal-insulator-semiconductor (MIS) structure.



Scheme of the MIS structure and the elimination of the Ni electrode. b) TEM images of the control sample c) Conductive filament formation scheme according EELS analysis. (in collaboration with F. Campabadal (CNM - CSIC).

4. Optoelectronics and photonics

Silicon photonics and optoelectronics are part of the science and technology that promote development of devices that manipulate light in a compatible way with nano- and microelectronics technology. Thus, photons and electrons, silicon and integration are the main actors of this field.

The research activities in this area are focused on the following lines:

Materials with optoelectronic and photonics properties: design, manufacture and characterization

Doping metal oxides with rare earth (RE) has attracted much attention for its use in telecommunications (using Er) or in emitters in the visible range (such as Ce, Eu and Tb). Making. Use of delta-doping technique can achieve deposition of alternating layers and RE subnanométrics oxide thickness, allowing better dopant activation within the matrix oxide.

In addition to the characterization of the material, in recent years we have also focused on the manufacture of active layers using the technique of electron beam evaporation. Studies performed in Transmission electron microscopy confirm the multi-layer structure.

Design and manufacture of advanced devices compatible CMOS

Using nanostructured oxides drivers we have designed, fabricated and characterized new powered devices silicon (CMOS): i) light sources (LEDs and lasers); ii) waveguides and interferometers assets (optical amplifiers, optical switches, optical logic gates); iii) Detectors (PIN, APD) miniaturitzables. As an innovative device, our research is focusing on manufacturing and characterization Memristors devices. These devices have resistance attributed to changes generating patterned nanowires along the material, depending on the voltage applied. Reversibility. This process enables these devices as an electronic memory (ReRAM). In particular, oxinitrurs Si-Al (Sialon) offer the possibility to obtain active layers with good electrical properties that can be implemented through ReRAM devices thanks to memristives properties. We have observed variations in the resistance of these layers over 5 orders of magnitude. Microscopy studies reveal accumulation of oxygen in the interface between the active layer and the upper electrode, suggesting an atomic diffusion of oxygen generating nanowires drivers.

Smart lighting generation

Finally, this research line is also working on the development of a smart lighting system based on LEDs technology able to light anywhere in the colorimetric diagram. This technology is of interest for those sectors in which intelligent light has a role such as museums, healthcare as circadian rhythm concerns… At this stage, we are creating an spin-off which in under a patent process.

Members of the group

Albert Cornet Calveras (Full Professor)
Blas Garrido Fernández (Full Professor)
Albert Romano Rodríguez (Professor)
Francisca Peiró Martínez (Professor)
Paolo Pellegrino (Tenured Assistant Professor)
Albert Cirera Hernández (Tenured Assistant Professor)
Juan Daniel Prades Garcia (Tenured Assistant Professor and ERC Starting grant)
Sergio Hernández Márquez (Tenured Assistant Professor)
Sònia Estradé Albiol (Tenure-Track Lecturer)
Lorenzo Calvo Barrio (Adjunct Lecturer)
Josep Manel Rebled Corselles (Adjunct Lecturer)
Alberto Eljarrat Ascunce (Adjunct Lecturer)
Cristian Fàbrega Gallego (Adjunct Lecturer)
Romén Rodríguez Trujillo (Adjunct Lecturer)
Francisco de P. Hernandez Ramirez (Adjunct Lecturer)
Aïda Varea Espelt (Adjunct Lecturer)
Olga Casals Guillén (Postdoc)
Luís López Conesa (PhD Student)
Oriol Monereo Cusco (PhD Student)
Giovanni Vescio (PhD Student)
Julià López Vidrier (PhD Student)
Pau Torruella Besa (PhD Student)
Gemma Martin Malpartida (PhD Student)
Josep Oriol Blazquez Gomez (PhD Student)
Catalina Coll Benejam (PhD Student)
Adrià Huguet Ferran (PhD Student)
Javier Blanco Portals (PhD Student)
Alexander Cabal Tato (PhD Student)
Ismael Gabaldon Saucedo (PhD Student)

LASER PROCESSING GROUP (MEMBER OF THE CAPES FINES I ENGINYERIA DE SUPERFÍCIES SGR)

The research activity of the Laser processing group is focused on the study and development of laser microfabrication techniques. Along the 2015-16 period our research has been focused on two main areas:

1. Laser microprinting of functional materials
2. Laser surface modification of transparent materials

1. Laser microprinting has been carried out through laser induced forward transfer (LIFT), a digital technique which makes possible the printing of complex materials through a jetting mechanism similar to that of inkjet printing, but with the advantage over that of allowing to print a much broader range of ink rheologies. Actually, LIFT does not present almost any limitation concerning the viscosity of the ink or the size of the loading particles. Taking advantage of these instances, we have mainly focused our research on LIFT on the transfer of materials that cannot be printed through more conventional techniques. Most of this work has been devoted to the manufacture of circuits for printed electronics devices and sensors. Thus, we succeeded on printing silver nanoparticle inks for the realization of interconnects, carbon nanofibers for gas sensors, and proteins for odor sensors, both on rigid and flexible substrates. However, printed electronics and sensors are not the only areas of application that we have worked on during this period. We have also used LIFT to print optical-grade polymers with an extremely high viscosity for the fabrication of tailored microlenses. Finally, and as a nice example of out-of-the-box thinking, we have inverted the process: printing small droplets of a transparent ink to be used as focusing liquid microlenses for nanopatterning applications.

2. Laser surface modification of transparent materials. In the previous report we already emphasized the importance of the correct focusing of the laser beam waist on the sample surface for the generation of very small features on transparent materials. Building upon that premise, we have improved the laser microfabrication system so that now it is possible to drill holes with an extremely good definition and high aspect ratio on diverse transparent polymers. This possibility appears to be very attractive in a number of applications, from the fabrication of highly accurate hole-through vias in electronic circuits to the standardization of procedures for leak detection systems.

SELECTED PUBLICATIONS

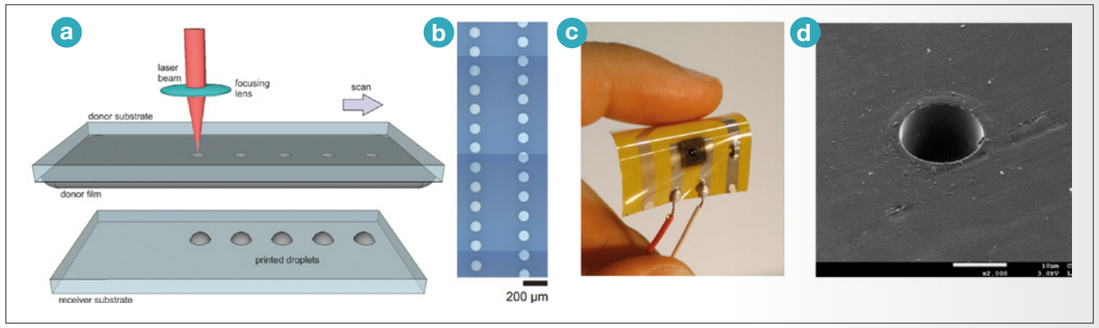
C. Florian, S. Piazza, A. Diaspro, P. Serra and M. Duocastella. ***Direct laser printing of tailored polymeric microlenses.*** *ACS Applied Materials and Interfaces. 8, 17028-17032 (2016)*

C. Florian, F. Caballero-Lucas, J.M. Fernández-Pradas, S. Ogier, L. Winchester, D. Karnakis, R. Geremia, R. Artigas and P. Serra. ***Printing of silver conductive lines through laser-induced forward transfer.*** *Applied Surface Science. 374, 265-270 (2016)*

M. Duocastella, C. Florian, P. Serra and A. Diaspro. ***Sub-wavelength Laser Nanopatterning using Droplet Lenses.*** *Scientific Reports. 5, 16199-1/9 (2015)*

C. Florian, F. Caballero-Lucas, J.M. Fernández-Pradas, S. Bosch, J.L. Morenza and P. Serra. ***Femtosecond laser surface ablation of polymethyl-methacrylate with position control through z-scan.*** *Journal of Physics D. 48, 335302-1/9 (2015)*

F. Di Pietrantonio, M. Benetti, D. Cannatà, E. Verona, A. Palla-Papavlu, J.M. Fernández-Pradas, P. Serra, M. Staiano and S. D'Auria. ***A surface acoustic wave bio-nose for detection of volatile odorant molecules.*** *Biosensors and Bioelectronics. 67, 516-523 (2015)*



a) Sketch of the principle of operation of the LIFT technique. b) Droplets of Ag conductive ink printed through LIFT on glass. c) Gas and temperature sensor printed through LIFT on a flexible polyimide substrate. The black pad corresponds to the gas sensing element: carbon nanofibers. d) Hole-through via on poly-lactic acid drilled through fs laser irradiation.

Members of the group

José Luís Morenza Gil (Full Professor)
Juan Marcos Fernández Pradas (Tenured Assistant Professor)
Pere Serra Coromina (Tenured Assistant Professor)
Francesc Caballero Lucas (PhD Student)
Pol Sopeña Martinez (PhD Student)
Adrian Patrascioiu (PhD Student)
Camilo Florian Baron (PhD Student)

Collaborations

Istituto Italiano di Tecnologia,
Nanophysics Group,Genoa, Italy
PI: Alberto Diaspro

Italian National Research Council (CNR)
Institute of Acoustics and Sensors “O.M. Corbino”, Rome, Italy
PI: Enrico Verona

Naval Research Laboratory, Materials Science and Technology Division, Washington DC, USA
PI: Alberto Piqué

National Institute for Lasers,Plasma, and Radiation Physics
Magurele, Romania
PI: Maria Dinescu

Oxford Lasers Ltd., Didcot, UK
PI: Dimitris Karnakis

Centre for Process Innovation Ltd., Cleveland, UK
PI: Simon Ogier

Sensofar-Tech S.L., Terrassa, Spain
PI: Roger Artigas

Singular Scientific Equipment

Materials processing: Laser microfabrication and marking setups; 5 laser sources: Nd:YAG and Yb:YKW (ns, fs, infrared, visible, ultraviolet).

Materials characterization: microscopy (optical, fluorescence, confocal, interferometry, AFM).

2.5. NANOSTRUCTURED MATERIALS (NMATERIALS)

The main aims of these lines are developing new nanostructured materials, which offer an improvement as far as the properties of already existing materials, are concerned.

NMaterials research area 5 encompasses the following research lines:

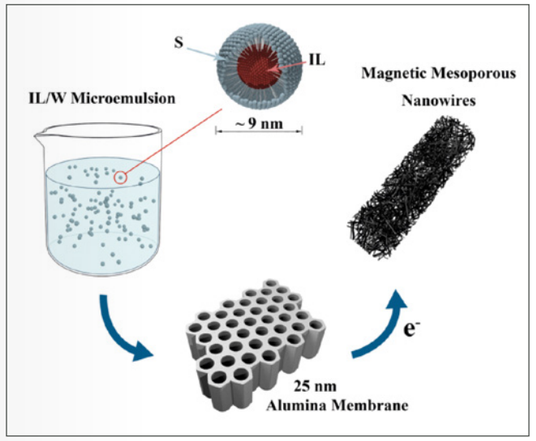
A. Synthesis, nanomanufacturing and nanomanipulation.
B. Thin layers, nanostructured multilayers and coatings.
C. Nanoparticles, gels, nanofibers, nanorods and nanotubes.
D. Nanoestructured metallic Oxydes.
E. Nanocompounds.
F. Mesoporous Materials and Nanopatterns.

NMaterials research area 5 is composed of the following research groups:

THIN-FILM AND NANOSTRUCTURES ELECTRODEPOSITION GROUP

The **Thin-film and Nanostructures Electrodeposition Group (Ge-CPN)** is working in the development, by using electrochemical techniques, of nanometric films on different substrates, supported micro and nanoparticles, nanowires and new structures of metals and alloys with magnetic or electrocatalytic properties.

Recently, we have developed a synthesis procedure to obtain mesoporous metallic nanostructures by means of templated electrodeposition to define the shape of nanorods and microemulsions containing ionic liquids to induce the formation of interconnected mesoporous structures (Figure).



Scheme of preparation of magnetic mesoporous nanorods. A. Serrà, X. Alcobé, J. Sort, J. Nogués and E. Vallés Journal of Materials Chemistry A 4 (2016) 15676-15687

SELECTED PUBLICATIONS

A. Serrà, E. Gómez and E. Vallés. ***Facile electrochemical synthesis, using microemulsions with ionic liquid, of highly mesoporous CoPt nanorods with enhanced electrocatalytic performance for clean energy.*** *International Journal of Hydrogen Energy 40 (2015) 8062-8070*

C. Gispert, A. Serrà, M.E. Alea, M. Rodrigues, E. Gómez, M. Mora, M. Ll. Sagristá, L. Pérez-García and E. Vallés. ***Electrochemical preparation and characterization of magnètic core-shell nanowires for biomedical Applications.*** *Electrochemistry Communications 63 (2016) 18-21*

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

A. Serrà, N. Gimeno, E. Gómez, M. Mora, M. Ll. Sagristá and E. Vallés. ***Magnetic mesoporous nanocarriers for drug-delivery with improved therapeutic efficacy.*** *Advanced Functional materials 26 (2016) 6601-6611*

A. Serrà, X. Alcobé, J. Sort, J. Nogués and E. Vallés. ***Highly eficient electrochemical and chemical hydrogenation of 4-nitrophenol using recyclable narrow mesoporous magnètic CoPt nanowires.*** *Journal of Materials Chemistry A 4 (2016) 15676-15687*

Mesoporous magnetic nanorods have been revealed excellent catalysts for clean energy production, localized remediation and biomedical applications. CoPt and CoNi-Pt core-shell mesoporous nanorods have been tested as catalysts for methanol and ethanol electro-oxidation in fuel cells and effective degradation of pollutants; because they have high surface areas, large pore volumes and high corrosion stability, with moderate proportions of platinum. Moreover, the magnetic catalysts can be easily recycled and reused.

CoNi-Au electrochemically synthesized nanorods have been tested for biomedical applications. The functionalized nanorods are promising vehicles for targeted drug delivery, under magnetic fields application. When, moreover, the nanorods are mesoporous present a highly effective area and a high drug loading capability.

Members of the group

Elisa Vallés Giménez (Professor)
Elvira Gómez Valentín (Professor)
Albert Serrà Ramos (PhD Student)
Joan Vilana Balastegui (PhD Student)

Collaborations

Dr. Josep Nogués (ICREA)
Catalan Institute of Nanoscience and nanotechnology (ICN2), CSIC, The Barcelona Institute of Science and Technology, Campus UAB

Dra Margarita Mora i **Dra Maria Lluïsa Sagristá**
Dpt. Bioquímica i Biologia Molecular, Facultat de Biologia, UB

Dra. Lluïsa Pérez Garcia, Dpt. Farmacologia, Toxicologia i Química Terapèutica, Facultat de Framàcia, UB

Dr. José Antonio Plaza i **Dr. Jaume Esteve**
Institut de Microelectrònica de Barcelona (IMB-CNM (CSIC), Campus UAB

Singular Scientific Equipment and Techniques

Equipment for electrochemical study of electrode processes, electrochemical synthesis and characterization of materials

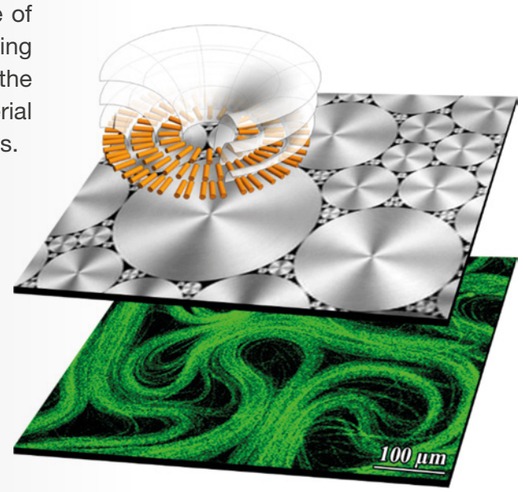
X-ray Fluorescence Equipment

SELF-ORGANIZED COMPLEXITY AND SELF-ASSEMBLED MATERIALS

The Self-organized Complexity and self-assembling Materials Group (SOC&SAM) performs basic research in the field of soft Nanotechnology. A significant part of our work is devoted to the study of composite systems in which anisotropic fluids (liquid crystals) are organized by contact with ordered surfactant monolayers or protein gels or by the presence of colloidal inclusions. We take advantage of the coupling of liquid crystals with external electric or magnetic fields to build responsive materials whose organization we can control.

In this context, we have developed a strategy to command the self-assembly and to drive ensembles of microscale solid or liquid inclusions in confined geometries. This is achieved by using non-linear electrophoresis mediated by a liquid crystal medium as driving force, and light-induced control of the local mesogen to steer the moving colloids. The developed strategy allows to study transitions between different forms of aggregation of colloidal ensembles, and to prepare a model system to explore the phenomena of clogging at the microscale.

In the context of active soft materials, we have studied the aqueous gel that forms in-vitro when the molecular motor protein kinesin is combined with self-assembled microtubules of the cytoskeleton protein tubulin. In the presence of ATP, and when depleted on an interface with an immiscible liquid, the system self-assembles into dynamic bundles with two-dimensional long-range orientational order. We have taken advantage of the coupling of this material with an oil interface to demonstrate that the dynamics of the active material can be controlled by exerting an influence on an anisotropic interface, either with a magnetic field or with intrinsic viscosity contrasts. Using microfluidic techniques, we prepare ensemble of microdroplets including the active gel to study the response of this material in confined geometries.



The organization of active bundles of tubulin (fluorescence confocal image, bottom) is influenced by the soft patterning at the interface with a smectic-A liquid crystal (reflection confocal image, top). The organization of oil molecules in layers (sketch) determines an anisotropic interfacial viscosity.

SELECTED PUBLICATIONS

S. Hernàndez-Navarro, P. Tierno, J. Ignés-Mullol and F. Sagués. ***Liquid-crystal enabled electrophoresis: Scenarios for driving and reconfigurable assembling of colloids.*** *The European Physical Journal Special Topics. 224, 1263 (2015).*

S. Hernàndez-Navarro, P. Tierno, J. Ignés-Mullol and F. Sagués. ***Nematic colloidal swarms assembled and transported on photosensitive surfaces.*** *IEEE transactions on nanobioscience. 14, 267 (2015).*

P. Guillamat, J. Ignés-Mullol and F. Sagués. ***Control of active liquid crystals with a magnetic field.*** *Proceedings of the National Academy of Sciences of the United States of America. 113, 5498 (2016).*

P. Guillamat, J. Ignés-Mullol, S. Shankar, M. C. Marchetti and F. Sagués. ***Probing the shear viscosity of an active nematic film.*** *Phys Rev E. 94, 060602 (2016).*

J. Ignés-Mullol, G. Poy and P. Oswald. ***Continuous Rotation of Achiral Nematic Liquid Crystal Droplets Driven by Heat Flux.*** *Phys Rev Lett. 117, 057801 (2016).*

Members of the group

Francesc Sagués Mestre (Full Professor)
Rosa Albalat Piñol (Professor)
Josep Claret Bonet (Professor)
Joan Antoni Farrera Piñol (Professor)
Jordi Ignés Mullol (Professor)
Pau Guillamat Bassedas (PhD Student)
Mohammad Tahghighi (PhD Student)

HOMOGENEOUS CATALYSIS GROUP

The activity of the Homogeneous Catalysis Group in the area of nanoscience is focused on the development of new systems based on nanoparticles (NPs). Two types of NPs have been developed and evaluated as catalysts in organic reactions. Their performance have also been compared to molecular systems.

One of the types is Pd and Ru NPs whose surface has been functionalised with chiral ligands in order to evaluate their activity in asymmetric catalysis.

An example of the synthetic methodology used to prepare such systems is depicted in the Figures 1 and 2 (ref 4).

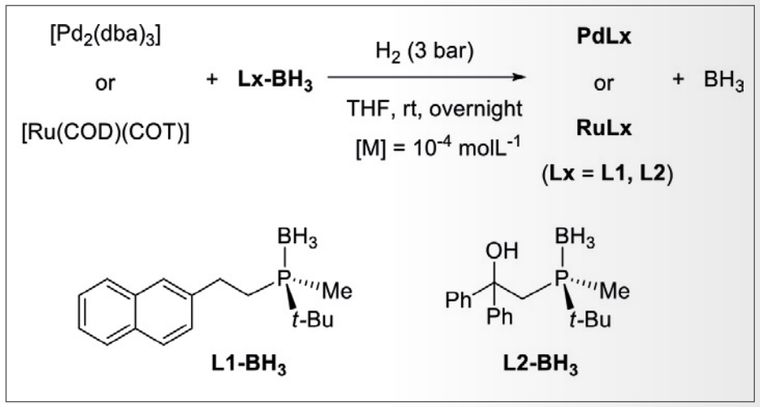


Figure 1. Synthesis of PdNPs (PdL1, PdL2) and RuNPs (RuL1, RuL2) by organometallic precursor decomposition methodology.

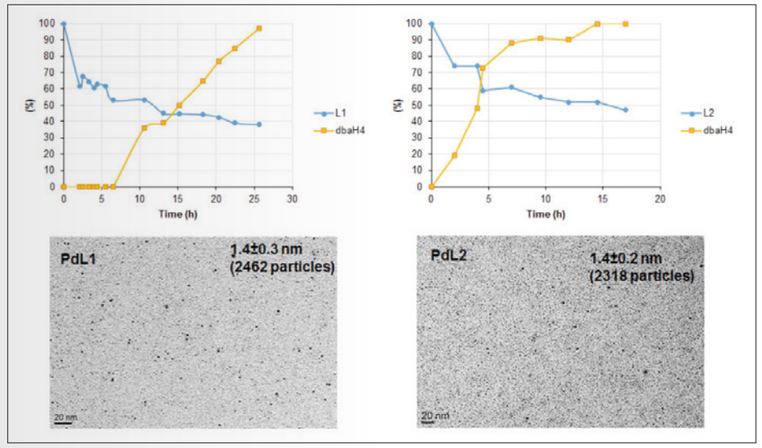


Figure 2. Graphical representations of the data corresponding to the consumption of ligand and decomposition of Pd precursor from the 1H NMR monitoring of the formation PdNPs with L1 and L2 (top); TEM images of PdL1 and PdL2 after total consumption of [$Pd_2(dba)_3$] (bottom).

The other type is Fe_3O_4 nanoparticles containing noble metals such as Pd deposited on their surface. These systems are interesting because the catalysts combine excellent reactivity with facile catalyst recovery and recyclability.

The synthetic methodology used to prepare this kind of NPs is depicted in Figure 3. Different aspects of their characterization are shown in Figures 4 and 5. An example of catalytic application in the Suzuki C-C cross-coupling reaction is also shown in Figure 3 (ref 1).

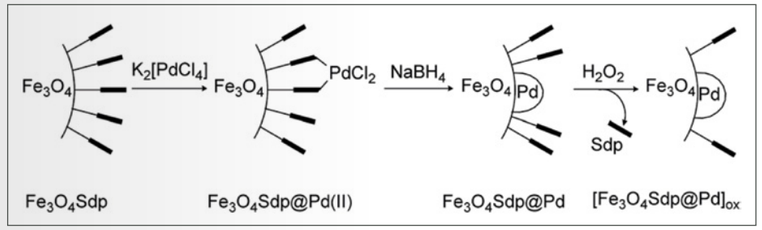
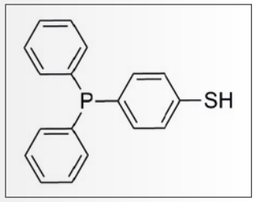


Figure 3. Synthesis of [Fe_3O_4Sdp@Pd]ox nanoparticles,

linker (Sdp) =



SELECTED PUBLICATIONS

A. Guarnizo, I. Angurell, M.D. Rossell, J. Llorca, G. Muller, M. Seco and O. Rossell.
4-mercaptophenyldiphenylphosphine as linker to immobilize Pd onto the surface of magnetite nanoparticles. Excellent catalytic efficiency of the system after partial linker removal.
RSC Advances. 5, 91340 – 91348. (2015).

M.D. Rossell, F.J. Caparrós, I. Angurell, G. Muller, J. Llorca, M. Seco and O. Rossell.
Magnetite-supported palladium single-atoms do not catalyse the hydrogenation of alkenes but small clusters do.
Catal. Sci. & Tech. 6, 4081 - 4085. (2016).

A. Guarnizo, I. Angurell, G. Muller, J. Llorca, M. Seco, O. Rossell and M.D. Rossell.
Highly water-dispersible magnetite-supported Pd nanoparticles and single atoms as excellent catalysts for Suzuki and hydrogenation reactions.
RSC Advances. 6, 68675 – 68684. (2016).

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E. Raluy, A. Grabulosa, P. Lavedan, C. Pradel, G. Muller, I. Favier and M. Gómez.
P-stereogenic phosphines for the stabilisation of metal nanoparticles. A surface state study. *Catalysts. 6, 213. (2016).*

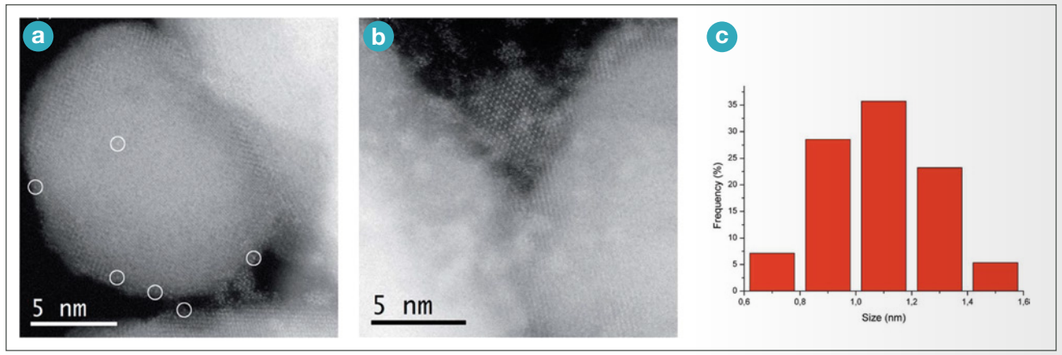

Figure 4. HAADF-STEM images of [Fe3O4Sdp@Pd]ox. (a) Palladium single atoms (white circles) on the magnetite support. (b) Pd nanoparticles are seen with enhanced contrast on the magnetite surface. (c) Histogram of the Pd particle size distribution.

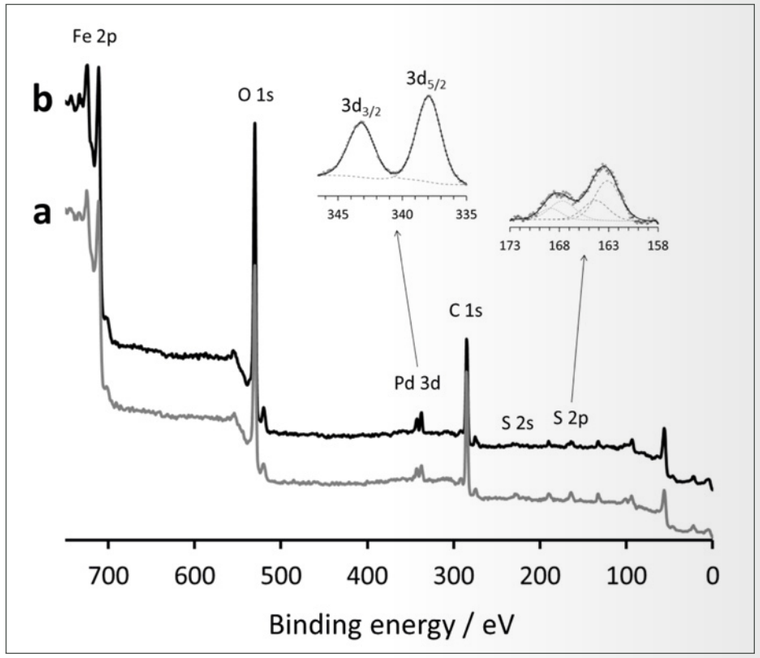

Figure 5. X-ray photoelectron spectra of samples Fe_3O_4Sdp@Pd (a) and [Fe_3O_4Sdp@Pd]ox (b). The insets show the Pd 3d and S 2p high resolution spectra of [Fe_3O_4Sdp@Pd]ox.

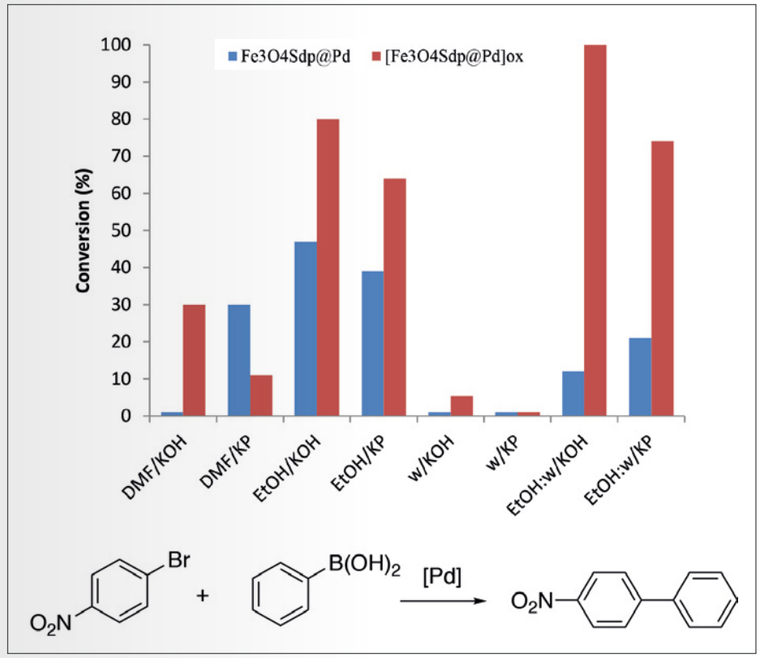

Figure 6. Comparison of the catalytic behaviour in the Suzuki-Miyaura cross-coupling reaction of both NPs catalysts using different solvents and bases. KP: K3PO4, w:water. Reaction conditions: 4 h, 65 ºC; phenylboronic acid (0.24 mmol, 1.2 eq), aryl halide (0.2 mmol, 1 eq), base (0.6 mmol, 3 eq), 5×10-3 eq Pd, 4 mL of solvent.

Members of the group

Guillermo Müller Jevenois (Full Professor)

Collaborations

Prof. Montserrat Gómez (Université de Toulouse 3 - Paul Sabatier)

Prof. Oriol Rossell (UB)

Singular Scientific Equipment and Techniques

Instalaciones para trabajo en atmosfera inerte.

Reactores y equipos para trabajo a presión (3 – 150 bar).

Cromatografía (GC, GC-MS, HPLC) con disponibilidad de columnas quirales.

SELECTED PUBLICATIONS

A. Gómez-Núñez, C. López, S. Alonso-Gil, P. Roura, P and A. Vilà. ***Study of a sol-gel precursor and its evolution towards ZnO.*** *Materials Chemistry and Physics. 162, 645-651. (2015).*

E. Vilella, O. Alonso, A. Vilà and A. Diéguez. ***Strategies for using GAPDs as tracker detectors in future linear colliders.*** *Nuclear Physics B-Proceedings Supplements. 273–275, 1 072-1078. (2015).*

A. Gómez-Núñez, S. Alonso-Gil, C. López and A. Vilà. ***Electronic and dynamic DFT studies on the substituent effects of aminoalcohol stabilizers in sol-gel ZnO precursor.*** *Physica Status Solidi (A). 213 (9), 2329-2335. (2016).*

A. Gómez-Núñez, P. Roura, C. López and A. Vilà. ***Comparison of the thermal decomposition processes of several aminoalcohol-based ZnO inks with one containing ethanolamine.*** *Applied Surface Science. 381, 48-53. (2016).*

INSTRUMENTATION SYSTEMS AND COMMUNICATIONS (SIC)

In the frame of Nanostructured Materials, we work since 2006 in printed electronics, developing our own inks to print conductors, semiconductors and isolants, mainly in the form of metal-oxides and polymers. The nanostructured films and devices obtained from our ecofriendly processes are nowadays focused on biocompatible optoelectronics and sensing applications.

The obtained experimental results are assessed by means of Quantum Mechanics calculations via Density Functional Theory and Molecular Dynamics. The polynucleation, degradation and decomposition processes of some of our inks have been described, bringing explanation of the physical changes observed and of the final materials obtained.

Another main research line of the group refers to harvesting and scavenging energy for low-power applications and self-powered devices. We work in the development of smart sensors and structural health monitoring, as well as in sustainable exploitation of marine renewable energy sources respectful with the environment.

Finally, bringing the limits of microelectronic technology the group is developping single-photon avalanche diode (SPAD) detectors for radiation and biomedical applications. Entirely-configurable easily-scalable low-cost fluorescence measurement systems aim to carry out fast diagnostic tests within a sort time span, allowing personalized medicine.

Members of the group

Anna Vilà Arbonés (Professor)
Christophe Serre (Tenured Assistant Professor)
Alberto Gomez Nunez (PhD Student)

Collaborations

Universitat de Girona (UdG), the Instituto de Microelectrónica de Barcelona-Centro Nacional de Microelectrónica (IMB-CNM), the LAAS-CNRS from Toulouse (France) and the College of Engineering, Mathematics and Physical Sciences from Exeter (UK).

Singular Scientific Equipment

Materials inkjet printer DIMATIX 2831

SUPRA AND NANOSTRUCTURED SYSTEMS

The Supra and Nanostructured Systems group is a young and recently created research group that is focused on the synthesis and applications of different type of structures containing mainly gold, palladium, platinum and ruthenium as metal atoms and different organic ancillary ligands. We have two main research lines: Supramolecular Chemistry and Nanoparticles. The work on Supramolecular Chemistry is centred on developing luminescent water-soluble systems able to give rise to the formation of gels, fibers, vesicles and other kind of supramolecular structures. These systems are based mainly on gold(I), with linear coordination, and that contains two different ligands coordinated to the metal atom, that contribute on the resulting assemblies. We are pioneers in this kind of supramolecules grown from discrete complexes. The resulting supramolecular aggregates rise from weak intermolecular interactions that can be the well-known and classical hydrogen bonds, pi-pi stacking,… together with the possibility of gold(I) atoms to interact with another metal unit giving rise to what is called aurophilic contacts. Moreover, the ancillary ligands are very important to modulate the solubility in different solvents (we are mainly interested in water at this moment) together with modulation of the resulting luminescent properties.

Applications as sensors, hydrogen production, liquid crystals, nanomaterials and biological properties are under study. European networks are decisive in some of the investigations carried out.

On the other hand, Nanoparticles of noble-metals (Pd, Au, Pt, Ru) are prepared and deposited on the surface of supporting materials, mainly magnetite, in order to study their catalytic behaviour in numerous processes, such as hydrogenation reactions, C-C coupling reactions and others. These studies are now being expanded to the formation of SACs (single atom catalyst) that generally are thought to be the best catalysts in terms of effectiveness and economy.

We have funding from the Spanish Government and also fundings based on European Union, such as Marie Curie contracts, active participation in diferent COST Actions, or projects for photophysical experiments at CLL-Laser Europe. Co-funded projects between Catalonian and European parties like those for attending to Alba Synchrotron should be also considered.

SELECTED PUBLICATIONS

E. Aguiló, R. Gavara, C. Baucells, M. Guitart, J.C. Lima, J. Llorca and L. Rodríguez. ***Tuning supramolecular aurophilic structures: the effect of counterion, positive charge and solvent.*** *Dalton Transactions. 45, 7328. (2016).*

M. Dalmases, E. Aguiló, J. Llorca, L. Rodríguez and A. Figuerola. ***Exploiting Metallophilicity for the Assembly of Inorganic Nanocrystals and Conjugated Organic Molecules.*** *Chem Phys Chem. 17, 2190. (2016).*

*R. Gavara, E. Aguiló, C. Fonseca Guerra, L. Rodríguez and J.C. Lima. T****hermodynamic Aspects of Aurophilic Hydrogelators.*** *Inorganic Chemistry. 54, 5195. (2015).*

L. Soler, A. Casanovas, A. Urrich, I. Angurell and J. Llorca. ***CO oxidation and COPrOx over preformed Au nanoparticles supported over nanoshaped CeO2.*** *Applied Catalysis B: Environmental. 197, 47. (2016).*

M. D. Rossell, F. J. Caparrós, I. Angurell, G. Muller, J. Llorca, M. Seco and O. Rossell. ***Magnetite-supported palladium single-atoms do not catalyse the hydrogenation of alkenes but small clusters do.*** *Catalysis Science and Technology. 6, 4081. (2016).*

Members of the group

Laura Rodríguez Raurell (Titular)
Inmaculada Angurell Purroy (Agregada Interina)
Francisco Javier Caparrós Rodríguez (Associat)

Collaborations

Our department

- Magnetism and Functional Molecules
  Dr. Albert Figuerola
- Bioorganometallic Chemistry
  Dr. Ramon Bosque
- Homogeneous Catalysis
  Prof. Guillermo Muller

Spanish Universities or Research Centers

Prof. Jordi Llorca (Universitat Politècnica de Catalunya, Barcelona)
Prof. Enrique García-España (Universitat de València)
Prof. Pau Ballester (ICIQ-Tarragona)
Prof. José Mª López de Luzuriaga (Universidad de La Rioja)

European Universities or Research Centers

Prof.João Carlos Lima
(Universidade Nova de Lisboa, Portugal) TEAM MEMBER
Prof. Antonella Dalla Cort (Università La Sapienza, Roma, Italy)
Prof. Kari Rissanen (University Jyväskylä, Jyväskyla, Finland)
Prof. Giulia Licini (Università Padova, Padova, Italy)
Dr. Marta Rossell (EMPA, Zurich, Switzerland)

Singular Equipment

Spectrofluorimeter to perform measurements for samples emitting at UV-vis and NIR in solution and in solid state, at room temperature, 77 K and variable temperature.

Fluorescence and Optical Microscopy including polarizers for analysing samples at different polarization light angles.

2.6. NANOENERGY: PRODUCTION, STORAGE AND ENVIRONMENT (NENERGY)

The main aim of this research line is the application of nanomaterials to energy production and storage in order to overcome efficiency and lifetime limits. The ultimate challenge is to make these technologies competitive enough in comparison with other methods that are more conventional and at present less environment-friendly.

Area 6 comprehends the following research lines:

A. Catalyic nanostructures for energy production. Fuel cells.
B. Nanomaterials for solar cells and photocatalytic processes.
C. Nanoestructured systems for energy storage.
D. Functional nanorods and nanothreads.
E. Nanosensors for pollution and gas detection.

NEnergy groups are the following:

CATALYSIS AND ADVANCED INORGANIC MATERIALS (MATCAT)

The research activities of the Catalytic Materials Group (MATCAT) have been focused on the design of tailored, nanostructured catalysts for different processes. The catalysts are prepared following different methods, which includes from sol-gel to molecular approaches and the use of different techniques as microwave and ultrasonic. The structural and physico-chemical characteristics of the materials are related to their catalytic behaviour to obtain appropriate relationship between structure and properties and allowing the preparation of new materials with advanced catalytic properties.

The two more active research lines in the period have been:

- Catalytic CO_2 conversion; processes to methane, methanol, higher oxygenates and CO_2-assisted reformation.

- H2 production; from biomass-derived resources and using reformation and photocatalytic methods.

SELECTED PUBLICATIONS

A.C. Sola, N. Homs and P. Ramirez de la Piscina. ***Photocatalytic H2 production from ethanol(aq) solutions: The effect of intermediate products.*** *International Journal of Hydrogen Energy. 41 (43), 19629-19636. (2016).*

L. Bednarczuk, P. Ramirez de la Piscina and N. Homs. ***Efficient CO2-regeneration of Ni/Y_2O_3-La_2O_3-ZrO_2 systems used in the ethanol steam reforming for hydrogen production.*** *International Journal of Hydrogen Energy. 41 (43), 19509-19517. (2016).*

R. Nafria, A. Genc, M. Ibanez, J. Arbiol, P. Ramirez de la Piscina, N. Homs and A. Cabot. ***-Cu Nanoparticles: Synthesis by Galvanic Replacement and Phase Rearrangement during Catalytic Activation.*** *Langmuir. 32(9), 2267-2276. (2016).*

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A.C. Sola, D. Garzon Sousa, J.; Arana, O. Gonzalez Diaz, J.M. Dona Rodriguez, P. Ramirez de la Piscina and N. Homs. ***Differences in the vapor phase photocatalytic degradation of ammonia and ethanol in the presence of water as a function of TiO2 characteristics and the presence of O2.*** *Catalysis Today. 266, 53-61. (2016).*

W. Cai, P. Ramirez de la Piscina, J. Toyir and N. Homs. ***CO_2 hydrogenation to methanol over CuZnGa catalysts prepared using microwave-assisted methods.*** *Catalysis Today. 242 (Part A), 193-199. (2015).*

Members of the group

Narcís Homs Martí (Full Professor)
Pilar Ramírez de la Piscina (Full Professor)
Joaquim Sales Cabré (Full Professor)
Alberto Cordoba Sola (Postdoc)
Sonia Rodriguez Abril (PhD Student)
Lukasz Bednarczuk (PhD Student)
Xianyun Liu (PhD Student)
Arturo Pajares Rojas (PhD Student)
Yan Wang (PhD Student)

International collaborations

Dr. Marcelo Maciel Pereira, UFRJ, Brazil

Dr. Elisabete Assaf, IQSC, USP, Brazil

Dr. Jamil Toyir, Fez, Morocco

Dr. Weijie Cai, Dalian, China

Singular Scientific Equipment

- Microwave and ultrasonic facilities for synthesis
- TG-DSC-microcalorimetry coupled to MS
- TPR/TPO/TPD analysis coupled to MS
- In-situ DRIFTS coupled to MS facility
- Thermal and photocatalytic reactors with on-line GC-MS analysis

DIOPMA (DISSENY I OPTIMITZACIÓ DE PROCESSOS I MATERIALS)

DIOPMA's research activity in the field of nanotechnology is divided into two areas:

1. Synthesis of nanostructured materials used for the manufacture of components (electrolyte and electrodes) of solid oxide fuel cells (SOFC) and superconductors by the method of combustion using polyacrylamide gels. In addition, synthesis of nanoparticles conventionally, by reduction in aqueous media using surfactant, and characterization of these nanoparticles by Transmission Electron Microscopy (TEM). Synthesis of Ni nanoparticles by magnetic separation is also performed.

2. Nanomechanical characterization, by nanoindentation technique, of various SOFC electrolytes, such as LSGM (perovskite lanthanum, strontium, gallium and magnesium). Furthermore, nanomechanical characterization of welding copper alloys, magnesium phosphate cements, steel oxide layers... Moreover, Mechanical properties (Young's modulus (E), hardness (H) and fracture toughness (KIC)) as well as the different fracture mechanisms activated during the indentation process, using bothe the Nanoindentation techniques and Atomic Force Microscopy (AFM).

SELECTED PUBLICATIONS

M. Morales, M.A. Laguna-Bercero, M.E. Navarro, F. Espiell and M. Segarra. ***The effect of anode support on the electrochemical performance of microtubular solid oxide fuel cells fabricated by gel-casting.*** *RSC Advances 5 (49), pp. 39350-39357. (2015)*

M. Morales, J. Formosa, E. Xuriguera, M. Niubo, M. Segarra and J.M. Chimenos. ***Elastic modulus of a chemically bonded phosphate ceramic formulated with low-grade magnesium oxide determined by Nanoindentation.*** *Ceramics International 41, pp. 12137-12146. (2015)*

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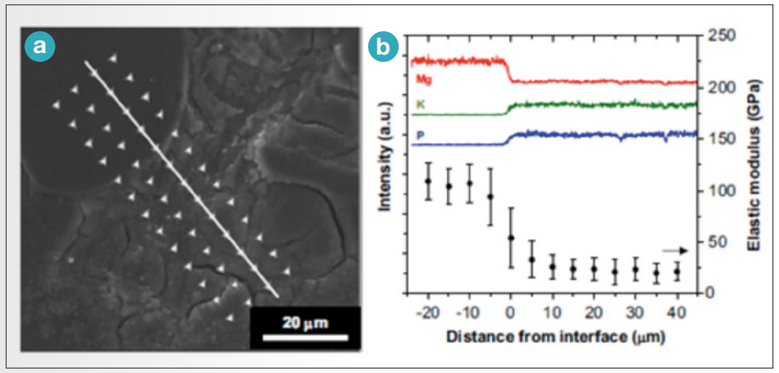
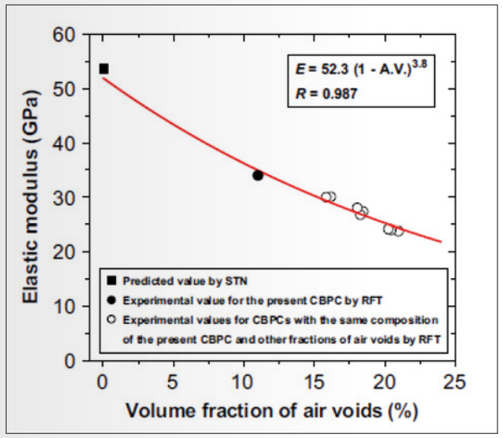


(a) SEM image of an indentation array close to K-struvite-periclase interface and i (b) chemical distribution obtained of EDX line scan and elastic modulus along an indentation array close to the K-struvite-periclase interface.



Prediction of the elastic modulus value Obtained by STN, without contribution of airvoids, and trend elastic modulus (determined by the resonance frequency test RFT) as a function os the air void content obtained for various CBPC's.

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M. Morales and M. Segarra. ***Steam reforming and oxidative steam reforming of ethanol over La0.6Sr0.4Co03-δ perovskite as catalyst precursor for hydrogen production.*** *Applied Catalysis A: General 502, 15410, pp. 305-311. (2015).*

*M. Morales, F. Espiell and M. Segarra. I****mprovement of performance in low temperature solid oxide fuel cells operated on ethanol and air mixtures using Cu-ZnO-Al2O3 catalyst layer.*** *Journal of Power Sources 293, pp. 366-372. (2015)*

L. Pantoja-Suárez, M. Morales, J.L. Andújar, J. Esteve, M. Segarra and E. Bertran. ***Plackett-Burman experimental design for pulsed-DC-plasma deposition of DLC coatings.*** *Open Access. (2015)*

Members of the group

Mercè Segarra Rubí (Professor)
Elena Xuriguera Martín (Tenure-Track Lecture)

Collaborations

CIEFMA - Centro de Integridad Estructural y Fiabilidad de los Materiales (UPC)

ICMA - Instituto de Ciencia de Materiales de Aragón

FEMAN - Grupo de Física e Ingeniería de Materiales Amorfos y Nanoestructuras (UB)

Singular Scientific Equipment

Nanoindentaitor Nano Indenter XP (MTS) with CSM (Continuous Stiffness Measurement)

3. Our Groups and Researchers at a Glance

1. MODELLING AND SIMULATION OF SYSTEMS. PROPERTIES OF MATTER IN THE NANOSCALE

Coordinator: Martí Pi Pericay

- **Theoretical physics of Nanoscopic Systems**
  (Dep. Quantum Physics, Fac. Physics)

  Martí Pi Pericay (Full Professor)
  Manuel Barranco Gómez (Full Professor)
  Montserrat Guilleumas Morell (Professor)
  Ricardo Mayol Sánchez (Professor)
  Alberto Gallemi Camacho (PhD Student)

- **Materials: Phase transitions**
  (Dep. Condensed Matter Physics, Fac. Physics)

  Antoni Planes Vila (Full Professor)
  Lluís Mañosa Carrera (Full Professor)
  Teresa Castán Vidal (Full Professor)

- **Nanosystems Statistical Physics**
  (Dep. Condensed Matter Physics, Fac. Physics)

  Miguel Rubí Capaceti (Full Professor)

- **Nanosystems Statistical Physics-Complex Matter Group**
  (Dep. Condensed Matter Physics, Fac. Physics)

  Giancarlo Franzese (Professor)
  Carlos Calero Borrallo (Postdoc: BdP)
  Oriol Vilanova Gabarrón (PhD Student)

2. NANOBIOTECHNOLOGY

Coordinator: Jordi Borrell Hernández

- **Physics in Nanobiophysics**
  (Dep. Condensed Matter Physics, Fac. Physics)

  Aurora Hernandez Machado (Full Professor)

- **Non-linear Physics in Nanobiophysics-Magnetic Soft Matter Group**
  (Dep. Condensed Matter Physics, Fac. Physics)

  Pietro Tierno (RyC and ERC starting grant)
  Antonio Ortiz-Ambriz (Postdoc)
  Fernando Martinez-Pedrero (Postdoc)

- **Microbian Enzymes for Industrial Applications Group**
  (Dep. Genetics, Microbiology and Statistics, Fac. Biology)

  Francisco I. Javier Pastor Blasco (Full Professor)
  Pilar Díaz Lucea (Professor)
  Josefina Martínez Martínez (Professor)
  Susana Valenzuela Mayorga (Postdoc)

- **Nanomalaria Group**

  Xavier Fernández Busquets (Senior Researcher. IBEC-CRESIB)
  Santiago Imperial Ródenas (Professor. Dep. Biochemistry and Molecular Biology. Fac. Biology)
  Carlota Roca Martínez (PhD Student)

- **Biophysics and Bioengineering Unit**
  (Dep. Biomedicine, Fac. Medicine)

  Daniel Navajas Navarro (Full Professor)
  Ramon Farré Ventura (Full Professor)
  Pere Roca Cusachs (Tenure-Track Lecturer)

- **Intracellular Compartments and Membrane Trafficking**
  (Dep. Biomedicine, Fac. Medicine)

  Gustavo Egea Guri (Full Professor)

- **Biomolecule and small-system physics: Small Biosystems Lab**
  (Dep. Condensed Matter Physics, Fac. Physics)

  Fèlix Ritort Farran (Full Professor)
  Maria Mañosas (Postdoc)

- **BiOPT: Optical Trapping Lab - Biophotonics Group**
  (Dep. Applied Physics, Fac. Physics)

  Mario Montes Usategui (Professor)
  Estela Martín Badosa (Tenured Assistant Professor)
  Frederic Català Castro (PhD Student)
  Raul Bola Sampol (PhD Student)
  Dorian Treptow (PhD Student)
  Arnau Farré Flaquer (Collaborator)
  Ferran Marsà Samper (Collaborator)

- **Cellular responses to xenobiotics**
(Dep. Biochemistry and Physiology, Fac. Pharmacy)

  Mª Pilar Vinardell Martínez-Hidalgo (Full Professor)

  Montserrrat Mitjans Arnal (Tenured Assistant Professor)
  Mª del Carmen Moran Bádenas (Tenured Assistant Professor)

- **Genomics, Proteomics and Plant Metabolomics**
(Dep. Biology, Healthcare and the Environment, Fac. Pharmacy)
(Dep. Biochemistry and Physiology, Fac. Pharmacy)

  Antonio Fernàndez Tiburcio (Full Professor)
  Jaume Bastida Armengol (Professor)
  Francesc Viladomat Meya (Professor)
  Montserrat Arró Plans (Tenured Assistant Professor)
  Laura Torras Claveria (Adjunct Lecturer)

- **Peptides and Proteins: Physicochemical Studies**
(Dep. Pharmacy and Pharmaceutical Technology and Physical-Chemical, Fac. Pharmacy)

  M. Asunción Alsina Esteller (Full Professor)
  Victòria Girona Brumós (Full Professor)
  Josefina Prat Aixelà (Professor)
  Montserrat Pujol Cubells (Professor)
  Yolanda Cajal Visa (Professor)
  Montserrat Muñoz Juncosa (Tenured Assistant Professor)

- **Bioelectronics Unit and Nanobioeneering Lab**
(Dep. Engineering: Section of electronics, Fac. Physics)

  Josep Samitier Martí (Full Professor)

- **Bioelectrical Characterization at Nanoscale**
(Dep. Engineering: Section of electronics, Fac. Physics)

  Gabriel Gomila Lluch (Agregat)

- **Supramolecular Systems in Nanobiomedicine**
(Dep. Pharmacy and Pharmaceutical Technology and Physical-Chemical, Fac. Pharmacy)

  M. Ermitas Alcalde Pais (Full Professor)
  M. Lluïsa Pérez Garcia (Professor)
  Immaculada Dinarès Milà (Professor)
  Ana Mafalda Nunes Rodrigues (Postdoc)
  David Limon Magaña (PhD Student)
  Ezhil Amirthalingam (PhD Student)
  Maria Elisa Alea Reyes (PhD Student)
  Sandra Giraldo Clemente (PhD Student)

- **Nanostructure of Biomembranes Group**
(Dep. Pharmacy and Pharmaceutical Technology and Physical-Chemical, Fac. Pharmacy)

  Jordi Borrell Hernández (Professor)
  María Teresa Montero Barrientos (Professor)
  Òscar Domènech Cabrera (Tenure-Track Lecturer)
  Martha Leticia Vázquez González (Adjunct Lecturer)
  Adrià Botet Carreras (PhD Student)

- **Conformational Diseases Group**
(Dep. Pharmacy and Pharmaceutical Technology and Physical-Chemical, Fac. Pharmacy)

  Raimon Sabaté Lagunas (Postdoc: RyC)
  Alba Espargaró Colomé (Postdoc: JdC)

3. NANOPHARMACOTHERAPY

Coordinator M. José García Celma

- **Drug Development in Nanostructured Systems**
(Dep. Pharmacy and Pharmaceutical Technology and Physical-Chemical, Fac. Pharmacy)

  M. Luisa García López (Professor)
  M. Antonia Egea Gras (Professor)
  Marta Espina García (Professor)
  M. José García Celma (Professor)
  M. Àngels Salvadó Lladó (Professor)
  Genoveva Morral Ruiz (Adjunct Lecturer)
  Fidencia Gamisans Linares (Adjunct Lecturer)
  Marta Monge Azemar (Adjunct Lecturer)
  Mireia Mallandrich Miret (PhD Student)
  Elena Sanchez Lopez (Adjunct Lecturer)
  Ferran Roig Roig (PhD Student)
  Marcelle Silva de Abreu (PhD Student)

- **Drug Design and Response-evaluation within Pharmaceutical Nanostructured and self-ordered Systems Group**
(Dep. Pharmacy and Pharmaceutical Technology and Physical-Chemical, Fac. Pharmacy)

  Elvira Escribano Ferrer (Professor)
  Josep Queralt Regué (Professor)
  Jacinto Lauroba Viladrosa (Professor)
  Francesc Xavier García Sala (Adjunct Lecturer)

- **Colloids**
(Dep. Pharmacy and Pharmaceutical Technology and Physical-Chemical, Fac. Pharmacy)

  Joan Estelrich Latràs (Full Professor)
  M. Antonia Busquets Viñas (Professor)

- **Cancer therapy group**
(Dep. Biochemistry and Physiology, Fac. Pharmacy)

  Carlos Ciudad Gómez (Full Professor)
  Verònica Noé Mata (Assistant Professor)
  Alejandro Jiménez Félix (PhD Student)
  Miriam Marlene Medina (Colaborador)

- **Química Bio-Inorgànica (QBI) Research Group**
(Dep. Inorganic and Organic Chemistry, Fac. Chemistry)

  Patrick Gamez Enamorado (Adjunct lecturer and ICREA Researcher)
  Amparo Caubet Marín (Professor)
  Ana Belén Caballero (Postdoc: Marie Curie Fellowship)

- **Other IN²UB researchers who carry out research within the nanopharmacotherapy area in Dep. Pharmacy and Pharmaceutical Technology and Physical-Chemical, Fac. Pharmacy are:**

  Ana Calpena Campmany (Professor)
  J. Ignasi Oliva Gimeno (Professor)
  Julia Herrera Corominas (Professor)
  Mireia Oliva (Professor)
  Guadalupe Del Carmen Abrego Escobar (Collaborator)
  Helen Lissette Alvarado Bonilla (Adjunct Lecturer)
  Beatriz Clares Maveros (Collaborator)

4. NANOMAGNETISM, NANOELECTRONICS AND NANOPHOTONICS

Coordinator: Albert Romano Rodríguez

- **Magnetic Interactions and Molecular Magnetism**
(Dep. Inorganic and Organic Chemistry, Fac. Chemistry)

  Ramón Vicente Castillo (Full Professor)
  Albert Escuer Fité (Full Professor)
  Montserrat Corbella Cordomí (Professor)
  Carmen Díaz Gasa (Professor)
  Mohamed Salah El Fallah (Tenured Assistant Professor)

- **Magnetism and Functional Molecules Group (GMMF)**
(Dep. Inorganic and Organic Chemistry, Fac. Chemistry)

  Guillem Aromí Bedmar (Tenured Assistant Professor)
  Albert Figuerola Silvestre (Tenured Assistant Professor)
  Eva Carolina Sañudo (Tenure-Track Lecturer)
  Verónica Velasco Amigó (Adjunt Lecture)
  Mariona Dalmases Solé (PhD Student)
  Marta Estrader Bofarull (Postdoc: JdC)
  Ivana Borilovic (PhD Student)

- **Thin Layer Stuctures for Spintronics**
(Dep. Applied Physics, Fac. Physics)

  Manuel Varela Fernández (Full Professor)
  M. Victoria García-Cuenca Varona (Professor)
  César Ferrater Martorell (Professor)
  Mª Carmen Polo Trasancos (Professor)
  Alvaro Caballero Lorenzo (PhD Student)

- **Magnetism**
(Dep. Condensed Matter Physics, Fac. Physics)

  Javier Tejada Palacios (Full Professor)
  Antoni García Santiago (Tenured Assistant Professor)
  Joan Manel Hernández Ferràs (Tenured Assistant Professor)

- **Micro-nanotecnologies and nanoscopies for electronics and photonic devices (MIND)**
(Dep. Engineering: Section of electronics, Fac. Physics)

  Albert Cornet Calveras (Full Professor)
  Blas Garrido Fernández (Full Professor)
  Albert Romano Rodríguez (Professor)
  Francisca Peiró Martínez (Professor)
  Paolo Pellegrino (Tenured Assistant Professor)
  Albert Cirera Hernández (Tenured Assistant Professor)
  Juan Daniel Prades Garcia (Tenured Assistant Professor and ERC Starting grant) dprades(at) el.ub.es
  Sergio Hernández Márquez (Tenured Assistant Professor)
  Sònia Estradé Albiol (Tenure-Track Lecturer)
  Lorenzo Calvo Barrio (Adjunct Lecturer)
  Josep Manel Rebled Corselles (Adjunct Lecturer)
  Alberto Eljarrat Ascunce (Adjunct Lecturer)
  Cristian Fàbrega Gallego (Adjunct Lecturer)
  Romén Rodríguez Trujillo (Adjunct Lecturer)
  Francisco de P. Hernandez Ramirez (Adjunct Lecturer)
  Aïda Varea Espelt (Adjunct Lecturer)
  Olga Casals Guillén (Postdoc)
  Luís López Conesa (PhD Student)
  Oriol Monereo Cusco (PhD Student)
  Giovanni Vescio (PhD Student)
  Julià López Vidrier (PhD Student)
  Pau Torruella Besa (PhD Student)
  Gemma Martin Malpartida (PhD Student)
  Josep Oriol Blazquez Gomez (PhD Student)
  Catalina Coll Benejam (PhD Student)
  Adrià Huguet Ferran (PhD Student)
  Javier Blanco Portals (PhD Student)
  Alexander Cabal Tato (PhD Student)
  Ismael Gabaldon Saucedo (PhD Student)

- **Organic Materials Unit**
(Dep.Inorganic and Organic Chemistry, Fac. Chemisty)

  Francisco López Calahorra (Full Professor)
  Dolors Velasco Castrillo (Professor)
  Marta Reig Canyelles (PhD Student)
  Alba Cuadrado Santolaria (PhD Student)
  Roger Bujaldón Carbó (Master Student)

- **Magnetic Nanomaterials Group**
(Dep. Condensed Matter Physics, Fac. Physics)

  Amílcar Labarta Rodríguez (Full Professor)
  Xavier Batlle Gelabert (Full Professor)
  Òscar Iglesias Clotas (Tenured Assistant Professor)
  Montserrat García del Muro Solans (Tenured Assistant Professor)
  Arantxa Fraile Rodríguez (Tenured Assistant Professor)
  Carlos Moya Alvarez (Postdoc)
  Ana Conde Rubio (PhD Student)
  Mariona Escoda Torroella (PhD Student)

- **Bioelectrochemistry and Nanotechnology Group**
(Dep. Materials Science and Physical Chemistry, Fac. Chemisty)

  Fausto Sanz Carrasco (Full Professor)

- **Laser Processing Group (member of the Capes Fines i Enginyeria de Superfícies SGR)**
(Dep. Física Aplicada, Fac. Física)

  José Luís Morenza Gil (Full Professor)
  Juan Marcos Fernández Pradas (Tenured Assistant Professor)
  Pere Serra Coromina (Tenured Assistant Professor)
  Francesc Caballero Lucas (PhD Student)
  Pol Sopeña Martinez (PhD Student)

5. NANOSTRUCTURED MATERIALS

Coordinator Enric Bertran Serra

- **Thin-film and Nanostructure electrodeposition group**
(Dep. Materials Science and Physical Chemistry, Fac. Chemistry)

  Elisa Vallés Giménez (Professor)
  Elvira Gómez Valentín (Professor)
  Albert Serrà Ramos (PhD Student)
  Joan Vilana Balastegui (PhD Student)

- **Homogeneous Catalysis**
(Dep. Inorganic and Organic Chemistry, Fac. Chemistry)

  Guillermo Müller Jevenois (Full Professor)
  Montserrat Gómez Simón (Collaborator - UPS Toulose)

- **Phyisics and Engineering of amorphous materials and Nanostructures. FEMAN**
(Dep. Applied Physics, Fac. Physics)

  Enric Bertran Serra (Full Professor)
  José Luis Andújar Bella (Professor)
  Adolf Canillas Biosca (Professor)
  Esther Pascual Miralles (Professor)
  Roger Amade Rovira (Adjunct Lecturer)
  Oriol Arteaga Barriel (Postdocs)
  Shahzad Hussain (Postdocs)
  Stefanos Chaitoglou (Postdoc)
  Edgar Julian Cabrera Magaña (PhD Student)
  Arevik Musheghyan Avetisyan (PhD Student)

- **Engineering of colloidal systems**
(Dep. Chemical Engineering and Analytical Chemistry, Fac. Chemsitry)

  José María Gutiérrez González (Professor)
  Alicia Maestro Garriga (Tenured Assistant Professor)

- **Surface Engineering. Thin-layer Lab**
(Dep. Applied Physics, Fac. Physics)

  Joan Esteve Pujol (Full Professor)
  Arturo Lousa Rodríguez (Professor)

- **Self-organized complexity and self-assembling materials (SOC&SAM)**
(Dep. Materials Science and Physical Chemistry, Fac. Chemistry)

  Francesc Sagués Mestre (Full Professor)
  Rosa Albalat Piñol (Professor)
  Josep Claret Bonet (Professor)
  Joan Antoni Farrera Piñol (Professor)
  Jordi Ignés Mullol (Professor)
  Pau Guillamat Bassedas (PhD Student)
  Mohammad Tahghighi (PhD Student)

- **Instrumentation Systems and Communications (SIC)**
(Dep. Engineering: Section of electronics, Fac. Physics)

  Anna Vilà Arbonés (Professor)
  Christophe Serre (Tenured Assistant Professor)
  Alberto Gomez Nunez (PhD Student)

- **Supra and Nanostructured Systems Group**
Dep. Inorganic and Organic Chemistry, Fac. Chemistry

  Laura Rodríguez Raurell (Titular)
  Inmaculada Angurell Purroy (Agregada Interina)
  Francisco Javier Caparrós Rodríguez (Associat)

6. NANOENERGY: PRODUCTION, STORAGE AND ENVIRONMENT

Coordinator: Narcís Homs Martí

- **Design and improvement of Processes and Materials (DIOPMA)**
(Dep. Materials Science and Physical Chemistry, Fac. Chemistry)

  Mercè Segarra Rubí (Professor)
  Elena Xuriguera Martín (Tenure-Track Lecture)

- **M2E-Nanoenergy and Electronic Materials**
(Dep. Engineering: Section of electronics, Fac. Physics)

  Joan Ramon Morante Lleonart (Full Professor)
  Alejandro Pérez Rodríguez (Full Professor)
  Franc Güell Vilà (Professor)

- **Solar and Photovoltaic Energy Group**
(Dep. Applied Physics, Fac. Physics)

  Jordi Andreu Batallé (Professor)
  Joan Bertomeu Balagueró (Professor)
  José Miguel Asensi López (Tenured Assistant Professor)

- **Catalysis and Advanced Inorganic Materials (MATCAT)**
(Dep. Inorganic and Organic Chemistry, Fac. Chemistry)

  Narcís Homs Martí (Full Professor)
  Pilar Ramírez de la Piscina (Full Professor)
  Alberto Cordoba Sola (Postdoc)
  Sonia Rodriguez Abril (PhD Student)
  Xianyun Liu (PhD Student)
  Arturo Pajares Rojas (PhD Student)
  Yan Wang (PhD Student)

RyC: Ramon y Cajal program
JdC: Juan de la Cierva program

4. Calls, Events, Media and Outreach Activities

With the aim to enhance and strength internal collaborations between IN²UB researchers, promoting transversal research among the 6 different areas of knowledge in IN2UB, different strategies and actions have been developed during 2015-2016 period.

CALLS

On 2015 IN²UB has opened the first call, called: *"Ajut a la Recerca Transversal"*. The aim is to give financial support to a transversal project between at least two groups, from different areas in IN2UB. The targets of this action are Doctors from IN²UB, who have not been yet Principal Investigator/s (IP/s), so that they will lead this project. On 2016, two *"Ajut a la Recerca Transversal"* have been awarded. Applications submitted are avaluated by a Scientific Committee in the IN²UB Governing Board.

Moreover, IN²UB aims to give financial support to its Students, either at the begging or end of their Master or Thesis in the Master or Doctoral in Nanoscience Programs. These grants have been published in the frame of *"beques de col·laboració amb IN²UB"*, which have been publish by Beques de Col.laboració Administration from UB. A total of 10 *"beques de col·laboració amb IN²UB"* have been given.

EVENTS

- A monothematic session on *"Nanoparticles"* on July 2015. *"Nanoparticle"* as a key word is broadly used for IN²UB researchers. During this session, researchers from IN²UB presented their expertise in this field: from production to application and toxicology. In this session, **Dr. Sonia Trigueros**, Co-Director OMS Institute of Nanoscience for Medicine, from Oxford University, gave a short presentation on *"Nanoparticle and Toxicology"*. This monothematic session set up the transversal collaboration between two different groups from IN²UB: the group of Physics and Engineering of amorphous materials and Nanostructures, FEMAN (Dep. Applied Physics and Optics, Fac. Physics) lead by **Dr. Enric Bertran Serra**; and the group of Cancer therapy group (Dep. Biochemistry and Molecular Biology, Fac. Pharmacy) lead by **Dr. Carlos Ciudad Gómez**. The aim of this collaboration is to put their knowhow together in order to develop more efficient drug delivery nanoparticles to treat cancer.

- A Workshop for IN²UB Researchers on November 2015. Dr. **Jordi Alberch**, Vice-Rector for Research, Innovation and Transfer participated on the inauguration of this Workshop. During that workshop, the 6 coordinators from the 6 research areas in IN²UB gave a presentation about the research being developed in each area. The aim was to know exactly who is doing what and how in order to start new collaborations and share knowledge and knowhow.

- A BioAFM Workshop, entitled "*Membranes-cellular Mechanics Workshop"*, was organized the 18th March 2016 at the Paranimf at Medical School UB. The aim was to put together brand new research and knowledge in the field of Cellular Mechanics, which is known to play a crucial role in the cell homeostasis including proliferation, motility, and differentiation.

IN²UB invited the following researchers:

Dr. Manfred Radmacher from Biophysics Institute at Bremen University (Germany)

Dr. Lewis Francis from Institute of Life Sciences at Swansea University Medical School (UK)

Dr. Pierre-Emmanuel Milhiet from Single Molecule Biophysics Department at CBS/CNRS/INSERM (Montpellier, France)

Dr. Gabriel Gomila from Bioelectrical Characterization at Nanoscale at IBEC (Spain)

Dr. Daniel Navajas from Cellular and Respiratory Biomechanics Group at IBEC (Spain)

Finally, **Dr. Christian Bippes** from Nanosurf, a Swiss-based high-tech company providing scanning probe microscopes to customers around the globe introduced us its Artidis project, which has been delineated for cancer diagnostics, based on the AFM (Atomic Force Microscopy) technique.

- A roundtable on *Nanoparticles* topic was organized the 30th March 2016 at Faculty of Physics. **Dr. Sonia Trigueros** (Co-Director OMS Institute of Nanoscience for Medicine, from Oxford University) has been invited by IN²UB and gave a plenary session on its expertise field: "Nanoparticle and Toxicology". Moreover, **Dr. Miquel Borràs**, full professor from Dep. Pharmacology and Therapeutic Chemistry (Toxicology Unit), Fac. Pharmacy (UB), who is an expert on toxicology, has also talked. After these two conferences, a session of questions has been opened in order to discuss and share experience on this research field and to set up the basses of new collaborations.

Several research groups of the IN²UB have organized seminars and talks of general interest to the IN²UB community:

- *Liquid Crystals: Displays and Beyond*, by **Dr. Oleg Lavrentovich, A Trustees** Research Professor at Kent State University (USA). May 2015.
- *Perpendicular Magnetic Anisotropy: From Ultralow Power Spintronics to Cancer Therapy*, by **Prof. Russell Cowburn**, Cavendish Laboratory, University of Cambridge (UK). IEEE Magnetics Society Distinguished Lecturers 2015. September 2015.
- *High-Speed Atomic Force Microscopy: Watching Dynamic Membrane Processes at High Spatio-Temporal Resolution,* by. **Dr. Simon Scheuring**. Research Director INSERM-Marseille (France). October 2015.

- *El porqué de la física: Más allá de bombas y hoyos negros.* Nanociencia, by. **Prof. Ivan K. Schuller**. Centre for Advanced Nanoscience. University of California San Diego. La Jolla (USA). November 2015.
- *Seminar about HORIZON 2020 Program. By* **Oficina de Projectes Internacionals de Recerca (OPIR-UB)**. May 2016 at Faculty of Physics.
- *Seminar about Open Access. By* **Dr. Ignasi Labastida**, CRAI-UB. June 2016 at Faculty of Pharmacy.
- *Presentation of new lines of action from Fundació Bosch i Gimpera to encourage transfer of the knowledge, technology and innovation*. By. **Jordi Naval**, Director General Fundació Bosch i Gimpera. June 2016 at Faculty of Chemistry.
- *Effects of Fe oxide nanoparticle size and structure on reactivity and bioavailability.* By **Prof. Patricia Maurice** from Dept. of Civil and Environmental Engineering and Earth Sciences, University of Notre Dame (USA). November 2016 at Faculty of Physics.
- *Magnetics + Mechanics + Nanoscale = Electromagnetics Future*. By **IEEE Magnetics Society Distinguished Lecturer 2016 Professor Greg P. Carman** (Director, Translational Applications of Nanoscale Multiferroic Systems TANMS, Mechanical and Aerospace Engineering Department, UCLA). November 2016 at Faculty of Physics.
- *The Magnetism of Oxides.* By **IEEE Magnetics Society Distinguished Lecturer 2016 Professor Josep Fontcuberta**. (Full research professor at Institut de Ciència de Materials de Barcelona (ICMAB-CSIC)). November 2016 at Faculty of Physics.

In addition, the IN²UB has cofounded and given support, among others, to the following congresses organized by IN²UB members:

- **European Materials Research Society (E-MRS) Fall Meeting 2015**. Symposium on "Molecular Materials for Quantum Computing". Warsaw University of Technology, September 2015. http://www.european-mrs.com/meetings/2015-fall
- **Sociedad Española de Catálisis (SECAT) Congress**. Barcelona, July 2015. http://www.ub.edu/secat2015/
- **Congrés XXV Sitges Conference on Statistical Mechanics**. Barcelona in June 6th-10th, 2016.
- **Congrés Formula VIII**. Barcelona July 4th-7th, 2016

Since July 2009, the IN²UB is part of the scientific cluster SECPhO (Southern European Cluster of Photonics and Optics). The IN²UB collaborates with the costs and activities of the cluster through an annual fee and, when needed, funds attendance to specialized conferences by the cluster members belonging to the IN²UB. For further details about the SECPHO Cluster, please check http://www.secpho.net/secpho/index.jsp

MEDIA

IN²UB has been announced in the Biotech Supplement from La Vanguardia (17th September 2015) with the aim to make IN²UB more visible.

BIOTECNOLOGÍA SIGLO XXI

2015

NANOCIENCIAS EN BIOTECNOLOGÍA

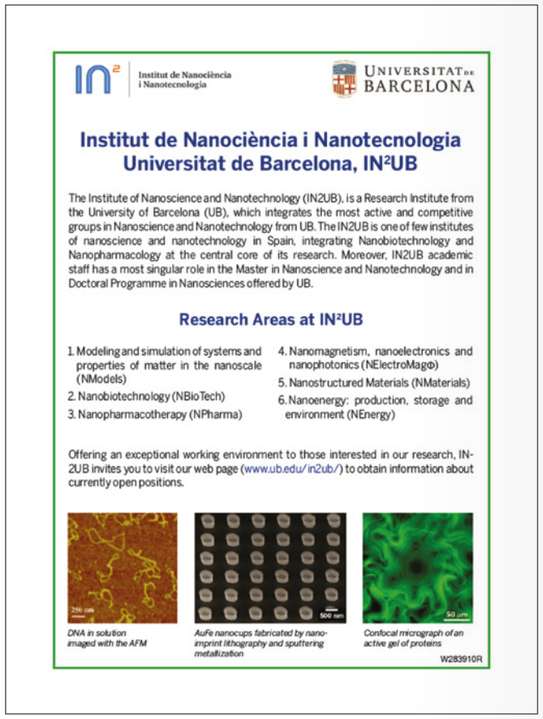
Con la voluntad de impulsar las actividades de investigación y difundirlas entre la sociedad, y con la intención de coordinar las actividades que llevan a cabo diferentes grupos de investigación en nanociencia, la Universitat de Barcelona creó en el año 2006 el *Institut de Nanociència i Nanotecnologia* (IN2UB). El instituto quiere contribuir al progreso de la ciencia y la innovación y estimular, a su vez, la competitividad del sector empresarial. Los investigadores que integran el IN2UB provienen de disciplinas muy diferentes, como la física, la química, la farmacia, la bioquímica o la medicina, porque la voluntad del IN2UB es fomentar al máximo la colaboración entre diferentes grupos y centros de investigación, tanto a nivel nacional como a nivel internacional, y contribuir de este modo a potenciar las actividades interdisciplinares de investigación básica y aplicada. Los principales objetivos del IN2UB son:

- Generar las sinergias adecuadas entre los investigadores mediante el fomento de actividades interdisciplinares que permitan abordar nuevos proyectos en la frontera del conocimiento;
- Favorecer la relación entre los investigadores y las empresas interesadas en las diferentes aplicaciones de las nanotecnologías, impulsando la realización de proyectos conjuntos, orientados a satisfacer la demanda tecnológica del sector empresarial.

INFO

Universitat de Barcelona
Institut de Nanociència i Nanotecnologia (IN2UB).
Av. Joan XXIII, S/N
08028 Barcelona
Tel.: 93 403 59 85
in2ub@ub.edu

IN²UB has been announced, as print advertising, in the Spotlight on Catalonia 2016 in Nature.



Institut de Nanociència i Nanotecnologia

Universitat de Barcelona

Institut de Nanociència i Nanotecnologia Universitat de Barcelona, IN²UB

The Institute of Nanoscience and Nanotechnology (IN2UB), is a Research Institute from the University of Barcelona (UB), which integrates the most active and competitive groups in Nanoscience and Nanotechnology from UB. The IN2UB is one of few institutes of nanoscience and nanotechnology in Spain, integrating Nanobiotechnology and Nanopharmacology at the central core of its research. Moreover, IN2UB academic staff has a most singular role in the Master in Nanoscience and Nanotechnology and in Doctoral Programme in Nanosciences offered by UB.

Research Areas at IN²UB

1. Modeling and simulation of systems and properties of matter in the nanoscale (NModels)
2. Nanobiotechnology (NBioTech)
3. Nanopharmacotherapy (NPharma)
4. Nanomagnetism, nanoelectronics and nanophotonics (NElectroMagΦ)
5. Nanostructured Materials (NMaterials)
6. Nanoenergy: production, storage and environment (NEnergy)

Offering an exceptional working environment to those interested in our research, IN-2UB invites you to visit our web page (www.ub.edu/in2ub/) to obtain information about currently open positions.

DNA in solution imaged with the AFM

AuFe nanocups fabricated by nanoimprint lithography and sputtering metallization

Confocal micrograph of an active gel of proteins

W283910R

OUTREACH ACTIVITIES

In 2014, IN²UB toghether with other UB institutes, founded the dissemination unit for nanotechnologies (Nanodivulga; http://www.ub.edu/laubdivulga/nanodiv) aimed at bringing nanotechnology to society from different approaches and at promoting educational tools and guidelines for assessing and monitoring a responsible nanotechnology development. During 2015-2016, IN²UB has been actively involved in **Nanoeduca Project (NANODIVULGA UB)**. In this sense, IN²UB has acquired a Nanoeduca Kit to do nanoscience divulgation among teachers from secondary schools. During this July 2015, researchers from IN²UB have taken part into the **Summer Nanoschool**. This initiative, organized by CCiTUB and Nanoeduca with the collaboration of IN²UB, was a one-week workshop about nanoscience and nanotechnology for high school students in which they can visit the facilities and laboratories from IN²UB and CCiTUB. The aim of the NanoSchool is to familiarize the students with the techniques and equipment commonly used in nanoscience in order to help define the students' research final project. Together with CCiTUB and Nanodivulga UB, IN²UB has participated at **Festival 10alamenos9.es**, which aims to share the importance and impact of nanoscience and nanotechnology with society. This project has been supported by FECYT 2015 call.

Together with CCiTUB and Nanodivulga UB, a workshop on **Nanosecurity and Occupational Hazard** was organized the 29th February 2016 at Faculty of Physics. During this one-day session, a demo was performed in which IN²UB researchers were able to manage with laboratory good practices.

5. PhD defended

2015

2015

- Title: *Integración de la tecnología cerámica multicapa.*
  Author: **Francisco Manuel Ramos Pérez.**
  Director: **Albert Cirera Hernández.**

- Title: *A Novel Sensor Concept for Selective and Self-Powered Gas Detection.*
  Author: **Martin W. G. Hoffmann.**
  Director: **Juan Daniel Prades García, Franscisco Hernández Ramírez.**

- Title: *A network-based approach to cell metabolism: from structure to ﬂux balances.*
  Author: **Oriol Güell Riera.**
  Director: **M. Ángeles Serrano, Francesc Sagués.**

- Title: *Ritmos circadianos en la permeación dérmica y absorción transdérmica de melatonina.*
  Author: **Ana Flo Sierra.**
  Director: **Trinitat Cambras, Ana C. Calpena.**

- Title: *Colloidal dispersions in fluid fedia: Electric, Magnetic and Light Control.*
  Author: **Sergi Hernàndez Navarro**.
  Director: **Jordi Ignés Mullol, Pietro Tierno.**

- Title: *Asociación de Pranoprofeno a sistemas nanoestructurados para administración tópica.*
  Author: **Guadalupe Abrego Escobar.**
  Director: **Ana C. Calpena Campmany, Mª Luisa García López.**

- Title: *Electron transport in low-dimensional systems: optoelectronic device simulations.*
  Author: **Sergio Illera Robles.**
  Director: **Albert Cirera Hernández, Joan Daniel Prades Garcia.**

- Title: *Novel light management techniques for thin film solar cells: Nanotextured substrates and transparent conducting upconverters.*
  Author: **Marta Lluscà i Jané.**
  Director: **Joan Bertomeu, Aldrin Antony.**

- Title: *Quantum dynamics of physicochemical processes in superfluid 4He nanodroplets.*
  Author: **Vilà, A.**
  Director: **González, M., Mayol, R.**

- Title: *Estudio de catalizadores basados en Pt/TiO2 en la fotoproducción de H2 y otros productos valorizados a partir de etanol.*
  Author: **Alberto Córdoba Sola.**
  Director: **Pilar Ramirez de la Piscina, Narcís Homs.**

- Title: *Comprehensive analysis of Pseudomonas aeruginosa oleate-diol synthase activity.*
  Author: **Mónica Estupiñan Romero.**
  Director: **Ángeles Manresa Presas, Pilar Diaz Lucea.**

- Title: *Estudio biofarmacéutico de triterpenos pentacíclicos antiinflamatorios vehiculizados en sistemas nanoestructurados para aplicación tópica.*
  Author: **Helen Lissette Alvarado Bonilla.**
  Director: **María Luisa García López, Ana Cristina Calpena Campmany.**

- Title: *Quantitative Methods for Electron Energy Loss Spectroscopy.*
  Author: **Alberto Eljarrat.**
  Director: **Francesca Peiró, Sònia Estradé.**

- Title: *Advanced TEM Imaging Tools For Materials Science.*
  Author: **Lluís López Conesa.**
  Director: **Francesca Peiró, Sònia Estradé.**

- Title: *Synthesis and Characterization of Engineered Carbon-based Nanoparticles by Arc-discharge Plasma.*
  Author: **Mohammad Reza Sanaee.**
  Director: **Enric Bertran Serra.**

- Title: *Desarrollo y cartacterización de liposomas para aplicación tópica de fármacos.*
  Author: **Martha Letícia Vázquez González.**
  Director: **Jordi Borrell Hernández, Ana C. Calpena Capmany.**

- Title: *Silicon nanocrystal superlattices for light-emitting and photovoltaic devices.*
  Author: **Julià López Vidrier.**
  Director: **Prof. Blas Garrido Fernández, Dr. Sergi Hernández Márquez.**

- Title: *Polypurine Reverse Hoogsteen Hairpins as a gene therapy tool: in vitro development and in vivo validation.*
  Author: **Laura Rodríguez Gallego.**
  Director: **Carlos J. Ciudad, Veronica Noe.**

- Title: *Polypurine Reverse Hoogsteen hairpins: stability, lack of immunogenicity and gene-silencing in cancer therapy.* Author: **Xenia Villalobos Alberú.**
  Director: **Verónica Noé Mata, Carlos Ciudad Gómez.**

- Title: *Nutrigenomic approach to study the potential role of walnut polyphenols and their human metabolites in cancer prevention and treatment.*
  Author: **Claudia Alejandra Sánchez González.**
  Director: **Verónica Noé Mata, Maria Izquierdo-Pulido.**

- Title: *Estudio de la permeación ex vivo e in vivo de antidepresivos tricíclicos en tejido biológico. Estudio de la actividad anestésica y analgésica.*
  Author: **Álvaro Gimeno Sandig.**
  Director: **Ana C. Calpena Campmany, Concepción Peraire Guitart.**

- Title: *Nuevas implicaciones de la hipoxia intermitente en un modelo animal de apneas del sueño.*
  Author: **Marta Torres Lopez.**
  Director: **Ramon Farre Ventura, Josep M. Montserrat Canal.**

2015

- Title: *Técnica de Presión Negativa Esparatoria en los Trastornos Respitatorios del Sueño en niños y adolescentes.*
  Author: **Helena Larramona Carrera.**
  Director: **Ramon Farre Ventura, Josep M. Montserrat Canal.**

- Title: *Research on the alkaloids of Amaryllidaceae plants: genera Lycoris and Hippeastrum.*
  Author: **Ying Guo.**
  Director: **Jaume Bastida Armengol, Francesc Viladomat Meya.**

- Title: *Structure versus magnetism in magnetic nanoparticles.*
  Author: **Carlos Moya Álvarez.**
  Director: **Amilcar Labarta Rodriguez.**

- Title: *Magnetic deflagrations in Mn12-ac and Nd5Ge3.*
  Author: **Diego Villuendas Pellicero.**
  Director: **Joan Manel hernàndez Ferràs.**

2016

- Title: *Cellular responses to intermittent hypoxia: A lab-on-a-chip approach.*
  Author: **Noelia Campillo.**
  Director: **Navajas D, Almendros I.**

- Title: *Compostos polinuclears de manganès mimètics d'enzims redox. Inserció en suports mesoestructurats. Estudi de les propietats magnètiques i catalítiques.*
  Author: **Beltzane Garcia i Cirera.**
  Director: **Montserrat Corbella Cordomí.**

- Title: *Correction of point mutations at the endogenous locus of the mammalian dihydrofolate reductase gene using Polypurine reverse Hoogsteen hairpins.*
  Author: **Anna Solé Ferré.**
  Director: **Verónica Noé Mata, Carlos Ciudad Gómez.**

- Title: *Creixement i estructura local de capes primes epitaxials de BaZrxTi1-xO3.*
  Author: **Jofre Ventura Altozano.**
  Director: **Manuel Varela Fernández.**

- Title: *Desarrollo, obtención y optimización de sustratos metálicos texturados base cobre biaxialment para aplicaciones de alto valor tecnológico.*
  Author: **José Antonio Padilla.**
  Director: **Mercè Segarra, Elena Xuriguera.**

- Title: *Design and synthesis of photoswitchable coordination complexes.*
  Author: **Jorge Salinas Uber.**
  Director: **Guillem Aromí.**

- Title: *Diseño de Ligandos Beta-Dicetona y sus Agregados Metálicos Funcionales.*
  Author: **Verónica Velasco Amigó.**
  Director: **Guillem Aromí.**

2016

- Title: *Enzimas modificadoras de la pared celular vegetal. Celulasas de interés biotecnológico papelero.*
  Author: **Liliana Cerda-Mejía.**
  Director: **Francisco Ignacio Javier Pastor Blasco.**

- Title: *Estudios de absorción y disposición de naringenina y quercetina. Estudios preclínicos.* Author: **Naiara Orrego Lagarón.** Director: **Elvira Escribano Ferrer, Rosa Mª Lamuela Raventós.**

- Title: *Formación y caracterización de nanosistemas terapéuticos con alginato.*
  Author: **Pablo Bonilla Valladares.**
  Director: **María José García Celma.**

- Title: *Funcionalización de superficies con ligandos para su interacción específica con avidina y estreptavidina.*
  Author: **Ivan Canal Barcala.**
  Director: **Joan-Antoni Farrera Piñol.**

- Title: *Gas sensors based on carbon nanofibers: a low power consumption approach.* Author: **Oriol Monereo.** Director: **Dr. J. Daniel Prades García, Dr. Albert Cirera Hernández.**

- Title: *Growth and characterization of new multiferroics.*
  Author: **Emerson Coy.**
  Director: **Manuel Varela Fernández.**

- Title: *Growth study and characterization of single layer graphene structures deposited on copper substrate by chemical vapor deposition.*
  Author: **Stefanos Chaitoglou**.
  Director: **Bertran Serra E., Andújar Bella J.L.**

- Title: *Hidrogels i materials porosos d'àcid hialurònic entrecreuat com a sistemes d'alliberament de fàrmacs.*
  Author: **Ferran Roig Roig.**
  Director: **García-Celma, M.J., Esquena, J.**

- Title: *Hygroscopic properties of single bacterial cells and endospores studied by Electrostatic Force Microscopy.*
  Author: **Marc van der Hofstad.**
  Director: **Gabriel Gomila Lluch.**

- Title: *Inkjet and Screen Printing for Electronic Applications.*
  Author: **Beatriz Medina Rodríguez.**
  Director: **Albert Cirera Hernández.**

- Title: *Laser direct-writing for microfabrication.*
  Author: **Camilo Florian Baron.**
  Director: **Pere Serra Coromina, Juan Marcos Fernández Pradas.**

- Title: *Multi-scale lung tissue mechanics in a mouse model of Marfan syndrome.*
  Author: **Juan José Uriarte Díaz.**
  Director: **Ramon Farre Ventura, Daniel Navajas Navarro.**

2016

- Title: *Nanopartículas de Carprofen para diferentes vías de administración.*
  Author: **Alexander Parra Coca.**
  Director: **Ana C. Calpena Campmany, Mª Luisa García López.**

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Institut de Nanociència i Nanotecnologia

Av Joan XXIII s/n, 08028 Barcelona

phone: 93 403 59 85

email: in2ub@ub.edu

www.ub.edu/in2ub

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