CIC nanoGUNE

MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE

Activity Report

2021 · 2022


iCore

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1 Director's Message

Jose M. Pitarke
Director

Science is about advancing human knowledge. We scientists are constantly driven by the wish to understand how the world around us works and the wish to use this understanding to make predictions and unveil new challenges.

Nanoscience, in particular, has already yielded a number of important outcomes, like, for example, the development of new materials with novel properties, the possibility to accurately deliver drugs to specific cells or tissues in our body, the potential to address some of the world's most pressing environmental challenges, and new advances in computing and communication technologies. Furthermore, our ability to control matter at the nanoscale has enabled us to make substantial progress in the development of second-generation quantum technologies, which exploit some of the most extraordinary properties of matter like quantum superposition and entanglement. None of this would have been possible without an entangled combination of curiosity-driven fundamental science, industrial research, and experimental development.

At nanoGUNE, our mission is to carry out world-class nanoscience research for the competitive growth of the Basque Country; thus, we have been making a particular effort to combine fundamental research –the type of research whose applications are still unknown to us– with specific activities of industrial research and experimental development aimed at taking advantage of the opportunities that can be found, at any time, along the way. Hence, not only we publish our research outcome in journals of the highest impact, but we also pay special attention to the transfer of our knowledge and our technologies to industry and to the society in general. We carry out research under contract, we protect our new developments by patenting and licensing our ideas, and we also launch new technology-based startup companies in areas that are particularly competitive such as, for example, two-dimensional materials like graphene, bioeconomy, and personalized health.

In 2021, we were recognized, for a second time, as a Maria de Maeztu Center of Excellence for the period 2022-2025, a recognition given by the Spanish Ministry of Science and Innovation to centers that stand out for the international impact of their research activity. This new recognition, together with the invaluable support we have been receiving mainly from the Basque Government but also from other local institutions and the European Commission, has allowed us to continue carrying out, in the period 2021-2022, cutting-edge research in the areas of nanomagnetism, nanooptics, self-assembly, nanobiotechnology, nanodevices, electron microscopy, theory, nanomaterials, nanoimaging, and nanoengineering, which will now be reinforced with the opening of new research groups in the fields of nanomedicine and quantum technologies.

We were entrusted with the mission of performing cutting-edge nanoscience research in close collaboration with the international scientific community and with industry, and we can proudly say that we are fulfilling our mission. In order to stay there, at the top, in order to put the Basque Country at the forefront of nanoscience research, we need to keep doing a kind of novel research that will take us to unknown territories, still responding at all times to our commitment with society and with industry: the industry of the present and, above all, the industry of the future. This is the big challenge of the small.

At nanoGUNE, our mission is to carry out world-class nanoscience research for the competitive growth of the Basque Country

2 nanoGUNE in Numbers | 2021 2022

115 *
Employees

47 *
Guests and Undergraduates

10
Research groups

192
ISI publications

11 658
Citations

10.0
Average impact factor

73
Grants in place

74
Invited talks

44
Seminars

6
Patents submitted

6
Startups ongoing

630
Times in the media

6
Conferences & workshops organized

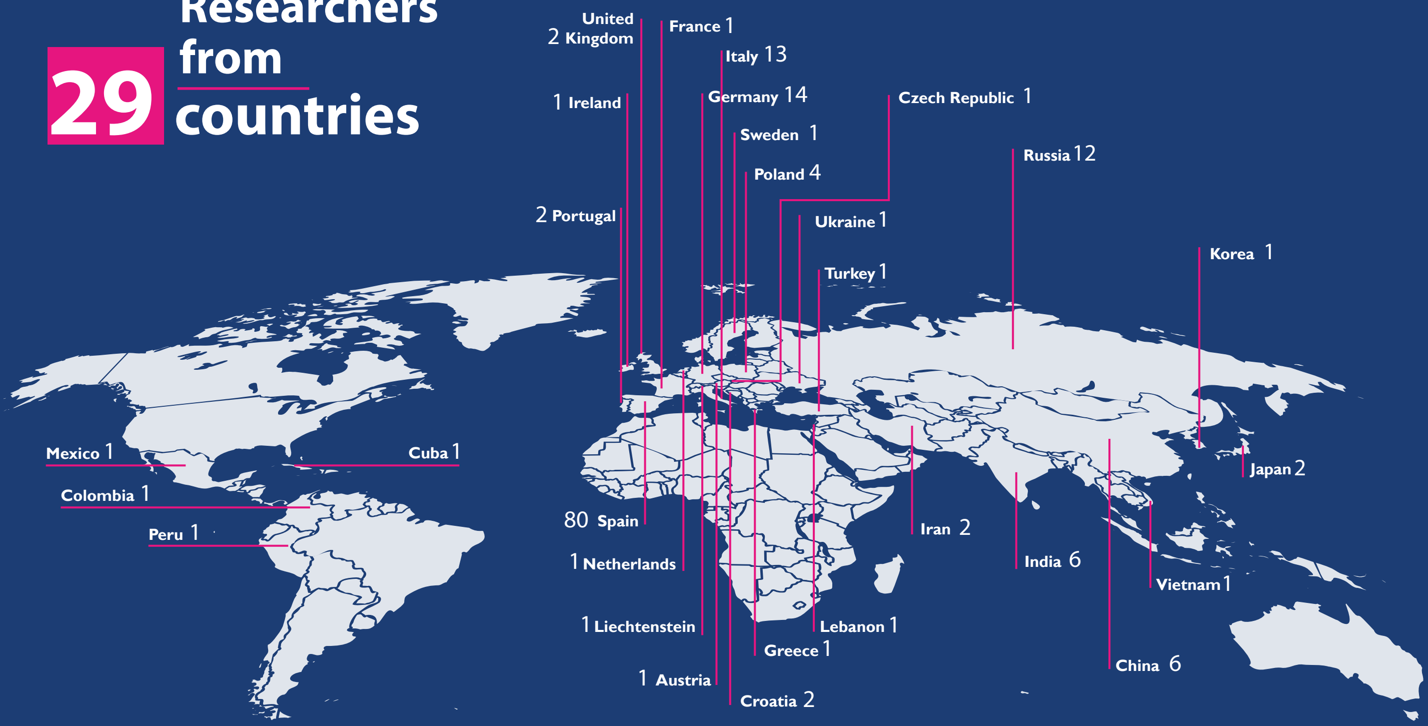
13 000
Participants in outreach activities

12
PhD theses accomplished

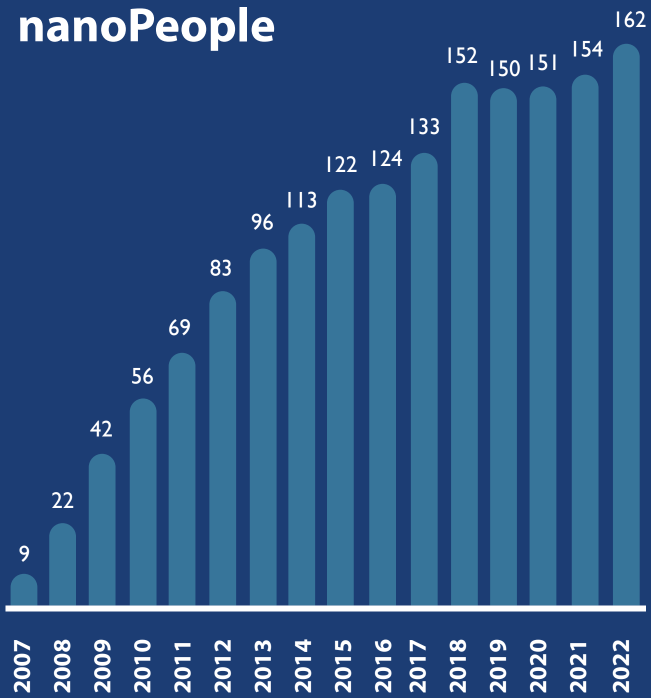
45 *
PhD theses ongoing

* *On 31 December 2022*

29 Researchers from countries



nanoPeople



96 MEN WOMEN 66

	Total	Men	Women
Director	1	1	0
Senior Scientists	12	12	0
Research Fellows	6	4	2
Post-docs	30	17	13
Pre-docs	39	22	17
Specialists	4	3	1
Technical Team	13	9	4
Management & Services	10	2	8
Master Students	3	2	1
Undergraduates	6	4	2
Guest Researchers	38	20	18

nanoGUNE personnel (including students and guests) on 31 December 2022


90

3 Research Activity

Research Groups

Nanomagnetism

OUR PRIMARY GOAL IS TO CONDUCT WORLD-CLASS FUNDAMENTAL AND APPLIED RESEARCH ON MAGNETISM AND MAGNETO-OPTICS AT THE NANOSCALE

MAGNETO-PLASMONICS

We conduct investigations of advanced magneto-optical and magneto-plasmonic effects and their utilization for fundamental and applied purposes.

- ***We have shown*** *that a plasmon nanoantenna can be used to achieve the deterministic ultrafast all-optical magnetization switching at the nanoscale in a thin film [Nanoscale, 2021], and we have proposed the concept of a hybrid magneto-plasmonic nanopore membrane for single-molecule detection [Applied Physics Letters, 2021].*

NANOSTRUCTURED MAGNETIC METAMATERIALS

We use an efficient, fast, and non-invasive plasmon-assisted heating of nanomagnets to optically control the length and time scales of the thermal excitation of assemblies of interacting nanostructures implementing magnetic metamaterials.

- ***We have shown*** *that plasmon-assisted heating enables deeper studies of emergent excitations in artificial spin ice systems [New Journal of Physics, 2021], and we have opened a clear path to their use as opto-thermally activated nanomagnet circuits for ultralow-power computation [Physical Review Applied, 2022].*

EXCHANGE-GRADED MAGNETIC MATERIALS

We utilize the ability to modify exchange coupling strength in magnetic alloys by precise modifications of alloy compositions at the nanoscale to explore magnetic properties that cannot be achieved with uniform materials.

- ***We have demonstrated*** *that ferromagnetic phase transitions can be most relevantly modified by means of exchange-graded functional layers, which can be utilized for hysteresis-free magnetization reversal in anisotropic materials [Physical Review Applied, 2021], extended temperature regions of constant coercivity [Physical Review Applied, 2022], and tunable critical exponents [Physical Review Letters, 2021].*

ELLIPSOMETRIC MAGNETO-OPTICAL MEASUREMENTS

We are establishing several experimental approaches to retrieve the complete available information of a light reflection experiment while being extremely sensitive to small magneto-optical effects.

- ***We have shown*** *that it is possible to identify and isolate the magneto-optical contribution of an embedded sub-surface layer, even if this layer is only 1 nm thick and the magneto-optical signal overall is being dominated by the surrounding material [Journal of Physics D, 2021].*

HIGHLIGHTS

EU Projects

We participate in the Marie Skłodowska-Curie Doctoral Network called DYNAMO. The objective of this project is to reach single- molecule capturing and tweezing functionality in a solid-state nanopore. This will pave the way to fascinating new discoveries into the fundamental structures of biomolecules and the interaction among them.

Patent application

On 2021, our patent application describing an ultrasensitive "Method for extracting a transverse magneto-optic effect signal" was granted and the European Patent EP 3734313B1 was issued. This methodology does not only enable an unprecedentedly precise measurement of the transverse magneto-optic Kerr effect, but also the determination of purely optical material properties by means of an ellipsometric measurement scheme.

Group members

Andreas Berger

Research Director
Group Leader

Paolo Vavassori

Ikerbasque Research Professor
Group Coleader

Post-docs

Lorenzo Fallarino
Terunori Kaihara

Pre-docs

Carmen Martín
Matteo Menniti
Mikel Quintana
Pablo Rodríguez
Ramon Webber

Technician

César Rufo

Undergraduates

Jaime López, University of the Basque Country

Adrián Meléndez, University of the Basque Country

Irene Prieto, University of Seville

Guest Researchers

for at least one month

Mikel Anzola,
Pre-doc at BCMaterials - Spain

Fernando J. Bonetto,
Researcher at CONICET - Argentina

Claudio J. Bonin,
Researcher at CONICET - Argentina

Naëmi Leo,
Post-doc at INA - Spain

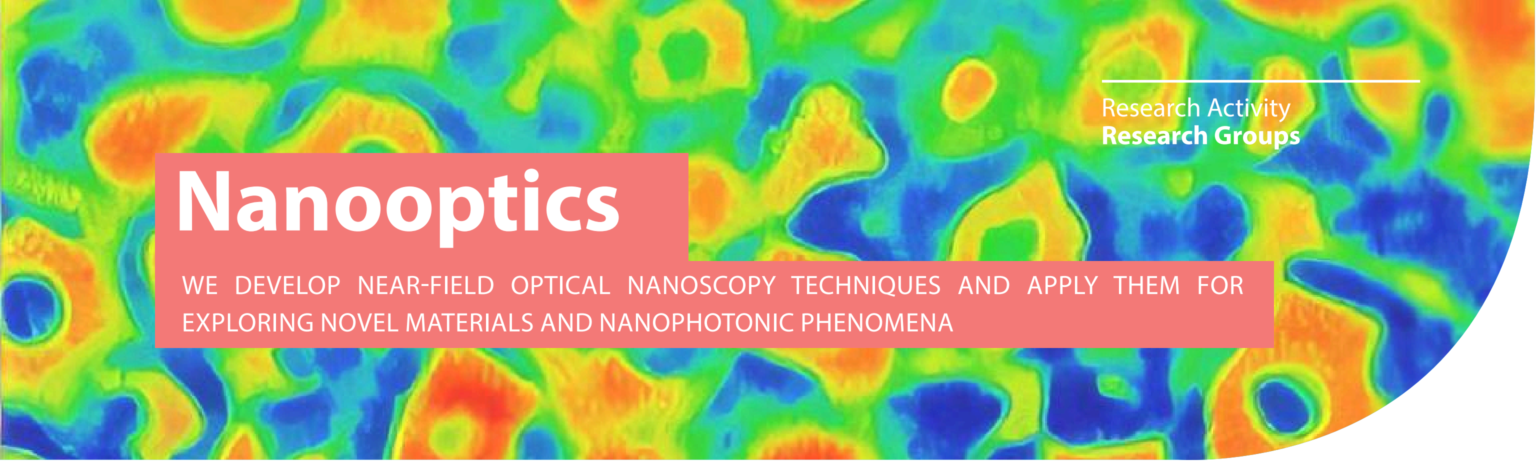
Alberto López-Ortega,
Lecturer at UPNA - Spain

Nicolò Maccaferri,
Assistant Professor at Umeå University - Sweden

José M. Porro,
Ikerbasque Fellow at BCMaterials - Spain

Emanuela Scardapane,
Pre-doc at Naples University - Italy

Aritz Villar,
Pre-doc at BCMaterials - Spain



Nanooptics

WE DEVELOP NEAR-FIELD OPTICAL NANOSCOPY TECHNIQUES AND APPLY THEM FOR EXPLORING NOVEL MATERIALS AND NANOPHOTONIC PHENOMENA

INSTRUMENTAL DEVELOPMENTS

We continuously improve and expand our near-field techniques (s-SNOM and nano-FTIR) for unprecedented nanoscale imaging and spectroscopy in the visible to terahertz frequency range.

- ***We have eliminated*** *illumination artefacts by a simple signal processing step, thus critically strengthening the analytical capabilities of our technique [Nanophotonics, 2022].*

- ***We have developed*** *a setup for infrared nanoimaging and spectroscopy in liquid environment [Nano Letters, 2021].*

MATERIALS CHARACTERIZATION

We apply our near-field techniques for the nanoscale mapping of chemical composition, mobile carrier concentration, and optoelectronic properties in two-dimensional (2D) and three-dimensional (3D) materials, as well as in electronic and optical nanodevices.

- ***We have demonstrated*** *cross-sectional chemical nanoimaging of composite polymer nanoparticles [Macromolecules, 2021].*

- ***We have verified*** *an inhomogeneous charge carrier distribution in organic-ion intercalated MoS_2. [Advanced Functional Materials, 2022].*

PLASMONICS AND PHONONICS

We explore plasmon and phonon polaritons in 2D and 3D materials for the development of ultracompact nanophotonic devices, e.g., for molecular sensing.

- ***We have applied nano-FTIR spectroscopy,*** *thus demonstrating a nanoscale vibrational strong coupling between phonon polaritons and organic molecules [Nature Photonics, 2021; Nature Communications, 2022].*

- ***THz nanoscopy has allowed us to reveal*** *polaritons in the topological insulator Bi_2Se_3, which are formed by the coupling of THz radiation to optical phonons and various charge carriers [Nature Communications, 2022].*

- ***We have demonstrated*** *the evolution from weak to ultrastrong phonon-photon coupling with the use of boron-nitride layers in a microcavity [Nature Communications, 2021].*

HIGHLIGHTS

EU Projects

The GRAPHENE CORE 3 is the fourth project within the EC-financed parts of the Graphene Flagship. Funded by the European Commission in 2013, the Graphene Flagship facilitates cooperation between its partners (nearly 170 academic and industrial partners in 22 countries), thus accelerating the timeline for industry acceptance of graphene technologies and other 2D materials, with applications everywhere from energy and transport to electronics and biomedicine.

ENSEMBLE PHASE II. We participate in the creation and strategic growth of a Center of Excellence (ENSEMBLE3) that is located in Poland and focuses on research excellence and innovation in the area of crystal-growth based technologies, novel functional materials with innovative electromagnetic properties, and applications in nanophotonics, optoelectronics, and medicine.

Industrial collaboration

ATTOCUBE AG. In collaboration with the Nanoscale Analytics department of the German company Attocube AG (formerly neaspec GmbH), our cutting-edge near-field nanoscopy developments have been implemented into the neaSCOPE product line that nowadays can be found worldwide in state-of-the-art nanoscale analytics laboratories.

Group members

Rainer Hillenbrand

Ikerbasque Research Professor
Group Leader

Research Fellows

Martin Schnell,
Ikerbasque Fellow

Post-docs

Eugenio Calandrini
Shu Chen
Monika Goikoetxea
Iris Niehues
Philippe Roelli
Edoardo Vicentini

Technician

Carlos Crespo

Master

Blanca Martin, Bordeaux University

Pre-docs

Francisco J. Alfaro
Andrei Bylinkin
Irene Dolado
Iker Herrero
Jan Krpensky
Carlos A. Maciel
Florina L. Marxer
Lars Mester
Divya Virmani

Guest Researchers

for at least one month

Kateryna Domina,
Pre-doc at DIPC - Spain

Victor Krivenkov,
Post-doc at CFM - Spain

Alexey Nikitin,
Ikerbasque Associate at DIPC - Spain

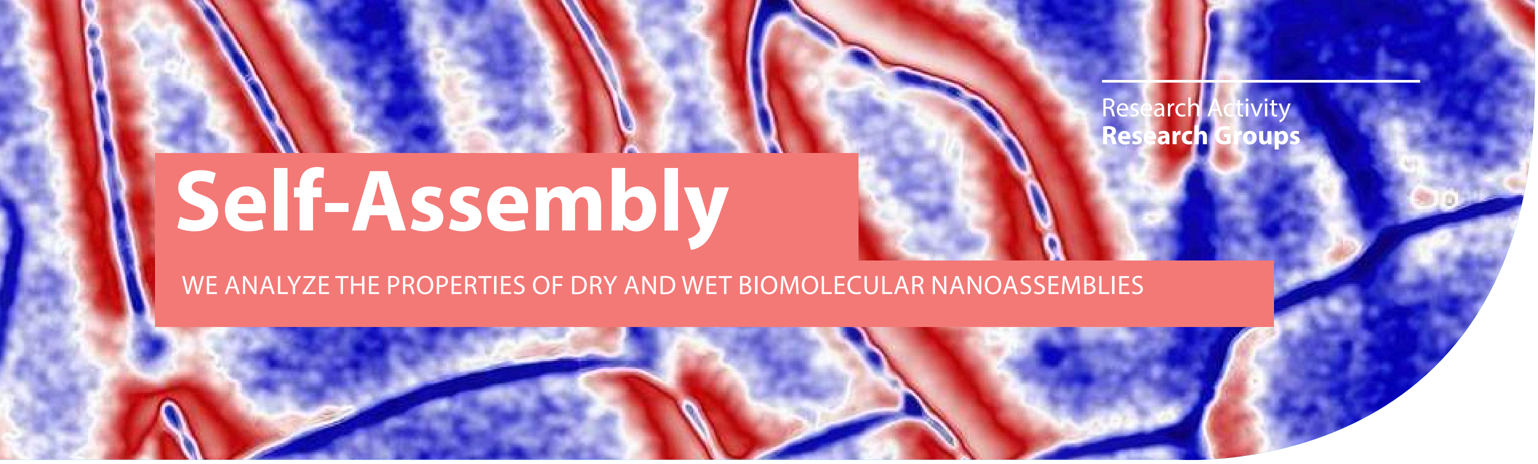
Adam Olejniczak,
Post-doc at CFM - Spain

Isabel Pascual,
Pre-doc at CFM - Spain

Marita Wagner,
Pre-doc at biomaGUNE - Spain

Daniel Wigger,
Post-doc at Trinity College - Ireland

Zebo Zheng,
Associate Professor at Sun Yat-Sen University - China



Self-Assembly

WE ANALYZE THE PROPERTIES OF DRY AND WET BIOMOLECULAR NANOASSEMBLIES

SELF-ASSEMBLING BIOMOLECULES

We investigate how biomolecules arrange at the nanoscale.

- ***We have found*** *how the influenza virus "spike" haemagglutinin prevents damage by drying the viral lipid envelope [BBA Advances, 2022].*

WATER AT THE NANOSCALE

We investigate the wetting of biomolecular surfaces.

- ***We have demonstrated*** *the imaging of droplets of supercooled water on a copper surface and on myoglobin with an electron microscope [Scientific Reports, 2022].*

ELECTROSPINNING, ELECTROWRITING, AND 3D PRINTING

We develop the novaspider tool towards applications in nanomedicine.

- ***We have written*** *microscale patterns of polymers and composites for their use as cell scaffolds (novaspider.com).*

HIGHLIGHTS

A new tool

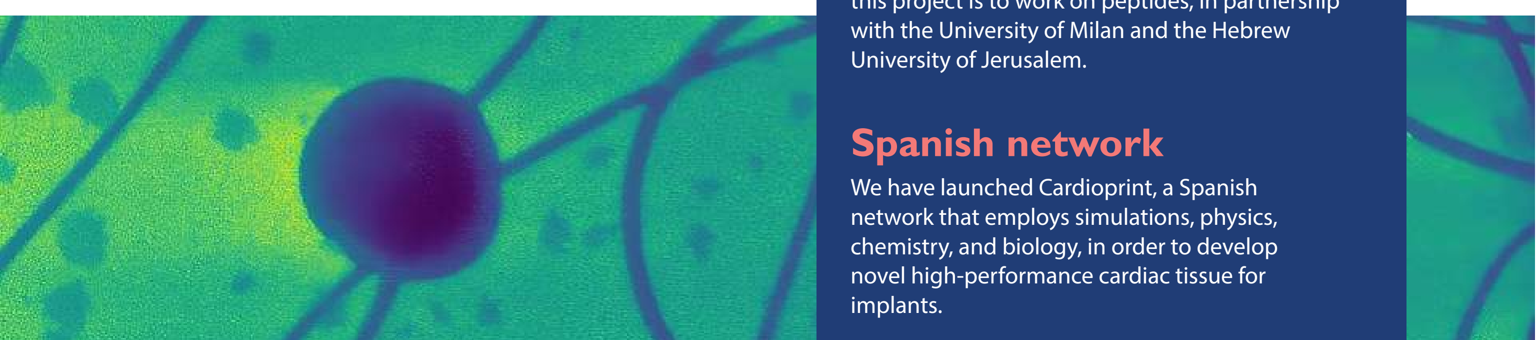
The novaspider additive manufacturing tool, which we have developed and patented at nanoGUNE, now counts on printing and spinning cartridges, which can easily be exchanged. This permits writing and depositing two or more substances, so the produced structure can be adapted to living cells and their ideal environment.

EU Project

We participate in the Marie Skłodowska-Curie Doctoral Network NANOREMEDI. The objective of this project is to work on peptides, in partnership with the University of Milan and the Hebrew University of Jerusalem.

Spanish network

We have launched Cardioprint, a Spanish network that employs simulations, physics, chemistry, and biology, in order to develop novel high-performance cardiac tissue for implants.



Group members

Alexander Bittner

Ikerbasque Research Professor
Group Leader

Research Fellows

Ibon Santiago,
Gipuzkoa Fellow

Technicians

Aitziber Eleta
Ion Moreno
Maider Rekondo

Pre-docs

Maiara A. Iriarte

Post-docs

Mohammad Amini
Evangelos Georgilis
Diana Soukarie

Guest Researchers

for at least one month

Jorge H. Melillo,
Pre-doc at CFM - Spain

Undergraduates

Josu Gómez, University of the Basque Country
Unai Montejo, University of the Basque Country
Lluis Nocete, Autonomous University of Barcelona
Ignacio Unanue, University of Navarre
Judith Zubia, University of Mondragon

Nanobiotechnology

WE FOCUS ON THE STUDY OF PROTEIN AND CELL MECHANICS

MECHANOBIOLOGY

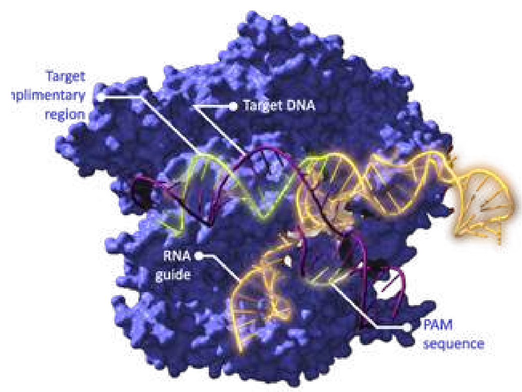
We investigate the mechanical response of proteins in a diversity of biological settings, with special attention to proteins involved in bacterial infections.

__We have worked__ with Engrailed Homeodomain (EnHD), cardiac titin, and an anti-phagocytic protein cloak of plague bacteria, showing the importance of the role of mechanical forces in biological settings.

NANOBIOTECHNOLOGY

We work on the design of novel enzymes for biotechnological applications. Our research goes from the enzymatic design of new biomaterials to gene editing using ancestral CRISPR-Cas9 nucleases.

__We have reconstructed__ ancestors dating back 2.6 billion years of the well-known CRISPR-Cas system, and we have studied their evolution in time.



HIGHLIGHTS

EU Projects

We participate in the EU project FET Open Biocatalytic upgrading of natural biopolymers for reassembly as multipurpose materials (BIOUPGRADE), in order to develop new materials using biotechnology with novel enzymes and surface acting proteins.

Patents

In the period 2021-2022, we have filed four new patents, which have already been licensed for their exploitation.

Group members

Raúl Pérez-Jiménez

Ikerbasque Research Professor
Group Leader

Post-docs

Borja Alonso
Leire Barandiaran
Borja Fernández-D'Arlas
Ylenia M. Jabalera
Ane Quesada

Pre-docs

Alba Fernández
Irati Mitxelena
Antonio Reifs
Ane Rivas
Sara Samperio

Technician

María C. Villoslada

Guest Researchers

for at least one month

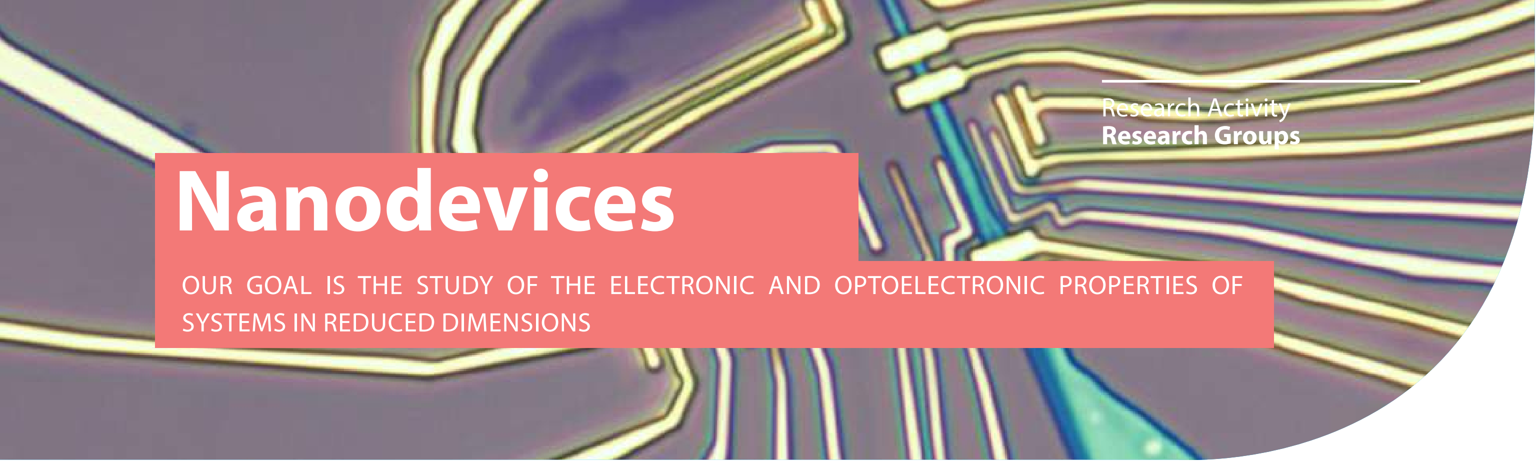
Nerea Barruetabeña,
Scientist at Evolgene - Spain

Raquel Olmos,
Pre-doc at UPV/EHU - Spain

Irene Ruiz,
Pre-doc at DIPC - Spain

Undergraduates

Halima Jraifi, Don Bosco Vocational Training
Maren Mugarza, Don Bosco Vocational Training
Pablo A. Rodríguez, University of Granada



Nanodevices

OUR GOAL IS THE STUDY OF THE ELECTRONIC AND OPTOELECTRONIC PROPERTIES OF SYSTEMS IN REDUCED DIMENSIONS

APPLIED SPINTRONICS

We use spin-based devices as an alternative computational architecture that combining memory and logic leads to a high energy efficiency.

- ***We have developed,*** *in the framework of a collaboration with Intel, a fully integrated magnetoelectric spin-orbit (MESO) device, which was presented in the prestigious conference IEDM 2021.*

- ***We have demonstrated*** *all-electrical spin-to-charge conversion in nanodevices with the topological material Bi_xSe_{1-x} [Nano Letters, 2022].*

SPINTRONICS IN LOW-DIMENSIONAL MATERIALS

Low dimensional (2D and 1D) van der Waals materials show broken symmetries and can be stuck in heterostructures, giving rise to proximity and non-linear effects that can be exploited in spintronics.

- ***We have demonstrated*** *the all-electrical generation, manipulation, and detection of spin polarization in chiral single-crystalline Tellurium nanowires [Nature Materials, 2022].*

- ***We have realized*** *at room temperature the electrical control of spin precession by exploiting the spin-orbit proximity in a graphene/WSe_2 heterostructure [Physical Review Letters, 2021].*

HYBRID FUNCTIONAL MATERIALS

We combine different classes of materials (molecules, 2D materials, metals, etc.) to manipulate their functionalities.

- *We have observed the emergence of spinterface effects at the interface between flakes of the prototypical 2D magnetic metal Fe_3GeTe_2 and thin films of Co-phthalocyanine [Advanced Materials, 2022].*

- ***We have demonstrated*** *that the chemical flexibility of layered hybrid organic-inorganic metal halide perovskites can be exploited to develop novel layered magnetic materials with tailored magnetic properties [Advanced Functional Materials, 2022].*

HIGHLIGHTS

EU Projects

We are coordinating the SPEAR project, selected as a Marie Sklodowska-Curie Innovative Training Network (ITN) by the European Commission. The project seeks to explore new materials for the next generation of computer memories and processors.

We participate in the SINFONIA and INTERFAST FET Open projects, in the MULTISPIN Flag ERA project, and in the FANTASTICOF EIC Pathfinder project.

Industrial collaboration

In collaboration with the multinational company Intel, we have been working on the development of a disruptive technology for the electronics of the future, the so-called MESO technology, a new technology that combines memory, interconnects, and logic requirements for future computing needs.

Fèlix Casanova, 2020 Intel outstanding research award

This award represents a recognition of research excellence as an essential motor for technological advances. Awarded in march 2021.

Group members

Luis E. Hueso
Ikerbasque Research Professor
Group Leader

Fèlix Casanova
Ikerbasque Research Professor
Group Coleader

Research Fellow

Marco Gobbi, La Caixa and Ikerbasque Fellow

Beatriz Martin, Ikerbasque Fellow

Post-docs

Tanweer Ahmed
Garen Avedissian
Diogo Castro-Vaz
Sara Catalano
Safeer Chenattukuzhiyil
Zhendong Chi
Wonyoung Choi
Sofia Ferreira-Teixeira
Juan M. Gómez
Xiaomin Guo
Josep Ingla
Junhyeon Jo
Yuan Peisen
Renu Rani
Haozhe Yang

Pre-docs

Montserrat X. Aguilar
Isabel C. Arango
Yaiza Asensio
Maria Barra
Francesco Calavalle
Eoin Dolan
Erlaitz Gómez
Inge Groen
Franz P. Herling
Jone Mencos
Nerea Ontoso
José M. Pereira
Mayank Sharma
Manuel Suárez
Daniel Tezze
Quang-Bao Tu

Master Students

Lucía Olano, University of the Basque Country

Lorea Sánchez, University of the Basque Country

Technician

Roger Llopis

SPEAR-ITN
Project Assistant

Elizabeth Goiri

Guest Researchers
for at least one month

Santiago Blanco,
Ikerbasque Associate at DIPC - Spain

David Caldevilla,
Pre-doc at CFM - Spain

Patricia Ferrer,
Pre-doc at Alicante University - Spain

Rishav Harsh,
Post-doc at CFM - Spain

Vahagn Mkhitaryan,
Post-doc at Purdue University - USA

Maider Ormaza,
Lecturer at UPV/EHU - Spain

María Ramos,
Post-doc at Alicante University - Spain

Witold R. Skowronski,
Research Assistant at AGH UST - Poland

Undergraduates

Luis Arriola, University of the Basque Country

Miren Etxalar, University of the Basque Country

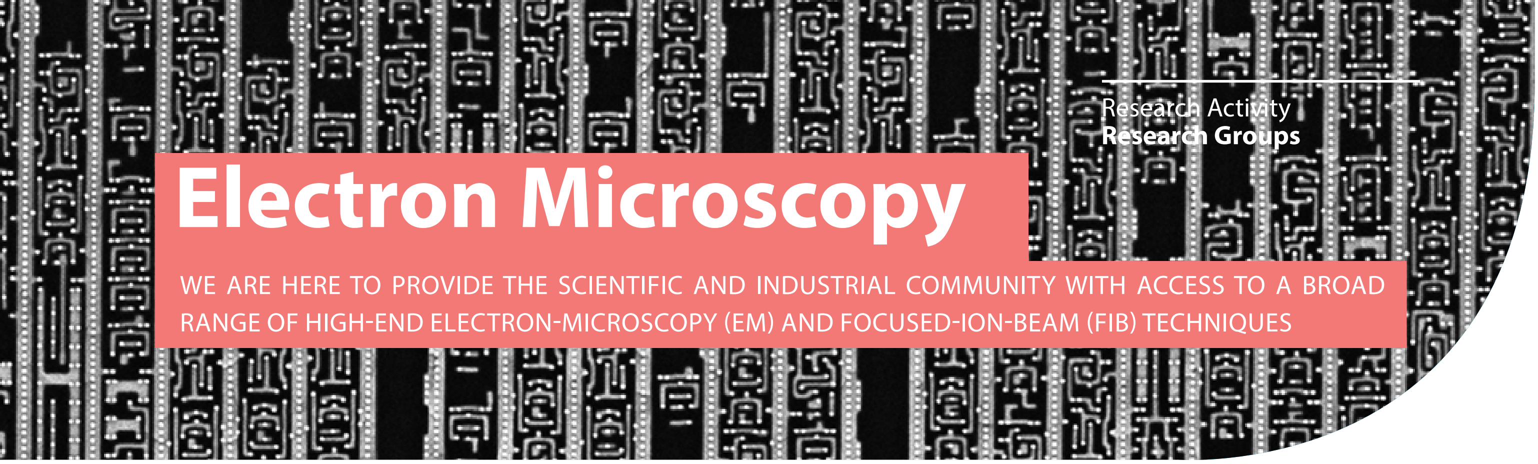
Kerman Gallego, University of the Basque

Eneko Íñiguez, University of the Basque Country

Asier Ortiz de Mendibil, University of the Basque Country

Asier Ribechini, University of the Basque Country

Lina Rohrer, University of Konstanz



Electron Microscopy

WE ARE HERE TO PROVIDE THE SCIENTIFIC AND INDUSTRIAL COMMUNITY WITH ACCESS TO A BROAD RANGE OF HIGH-END ELECTRON-MICROSCOPY (EM) AND FOCUSED-ION-BEAM (FIB) TECHNIQUES

LAB-IN-EM

We implement, develop, and maintain the broadest variety of EM techniques in response to the ever-growing needs of the scientific community.

METALS AND ALLOYS

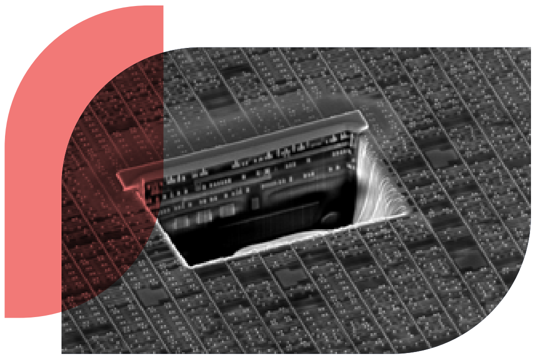
The utilization of the unique properties of nanostructured metals may pave a new way to a sustainable and eco-friendly metal industry.

We have found *that the commonly used AISI 1045 steel triples its strength when grain sizes go below 100 nm [Scientific Reports, 2022].*

LIQUID PHASE TEM

Using a multilateral approach –simulations, experiment, and development–, we are aiming for turning Liquid Phase Transmission EM into a quantitative technique.

We have revealed *the bottlenecks of the existing nanofluidic systems and have designed a setup with characteristic parameters enhanced by two orders of magnitude.*



HIGHLIGHTS

External Service

The combination of high-end equipment and a highly-qualified personnel at our laboratory ensures a reliable and industrially relevant external scientific service resulting in a substantial annual income from the private sector.

Cryo-FIB for biomedical and energy-related research

We have been awarded a 1.5 million euros grant from the Spanish Ministry of Science and Innovation to acquire a uniquely configured FIB instrument, which will allow us to open two principally new research lines: cryo-FIB fabrication for biological samples and battery research. With its unique combination of high-throughput plasma FIB, cryo cooling, and Time-of-Flight Secondary Ion Mass Spectrometry (ToF-SIMS), the new tool will open earlier unthinkable research possibilities in the biomedical and energy sectors.

Group members

Andrey Chuvilin

Ikerbasque Research Professor
Group Leader

Post-docs

Bentejui Medina
Aelita Nikulina

Pre-docs

Giuseppe De Salvo
Stefan Merkens

Specialist

Evgenii Modin

Technician

Christopher Tollan

Master Student

Pedro García-Ruiz,
University of Malaga

Undergraduate

Noé Duarte, University of Seville

Guest Researchers

for at least one month

Iurii Ivanov,
Chief Technician at IIT - Italy

Joscha Kruse,
Pre-doc at DIPC - Spain

Theory

OUR MAIN AIM IS FURTHERING THE UNDERSTANDING AND KNOWLEDGE OF NANOSYSTEMS BY MEANS OF COMPUTATIONAL SIMULATION AND PHYSICAL MODELS BASED ON FUNDAMENTAL QUANTUM PHYSICS

QUANTUM PROCESSES

We study non-equilibrium quantum processes related to radiation damage.

- ***We have developed*** *a new theory to describe the electronic stopping power of nuclear projectiles exploiting a symmetry in space-time [Physical Review Research, 2020; Physical Review B, 2022; Physical Review Research, 2022].*

- ***We have developed*** *a quantitative calibration of the effect of electron projectiles in water for the modeling of radiation damage in living tissue in radiotherapy [Royal Society Open Science, 2022].*

SIMULATION METHODS

We develop new methodologies for an efficient simulation of matter from first principles.

- ***We have developed*** *algorithms for the exploitation of exascale computers for first-principles simulations of condensed matter, and we have further developed SIESTA, which is widely used worldwide, within the EU Center of Excellence MAX and within the European initiative Electronic Structure Library we are leading.*

- ***We have carried*** *out formal developments for the evolution equations of hybrid quantum-classical systems based differential geometry [Physical Review Research, 2021; SciPost Physics, 2022].*

HIGHLIGHTS

EU Centre of Excellence

The EU Consortium MAX composed of several research and High-Performance-Computing (HPC) centers has been renewed with the aim of driving exascale computing in the context of first-principles condensed matter simulations.

MAX DRIVING THE EXASCALE TRANSITION

Group members

Emilio Artacho

Ikerbasque Research Professor
Group Leader

Research Fellows

Pablo Aguado,
Gipuzkoa Fellow

Karolina Z. Milowska,
Ikerbasque Fellow

Post-docs

Anna Kimmel
Natalia Koval
Irina Lebedeva
Daniel Muñoz
Yavar Taghipour

Pre-docs

Iker Ortiz de Luzuriaga
María Godin
Nuria Santervás

Undergraduates

Aimar Aguado, University of the Basque Country

Mikel Ballarena, University of the Basque Country

Jone Narbaiza, University of the Basque Country

Mónica Tapia, University of Granada

Unai Uriarte, University of the Basque Country

Guest Researchers

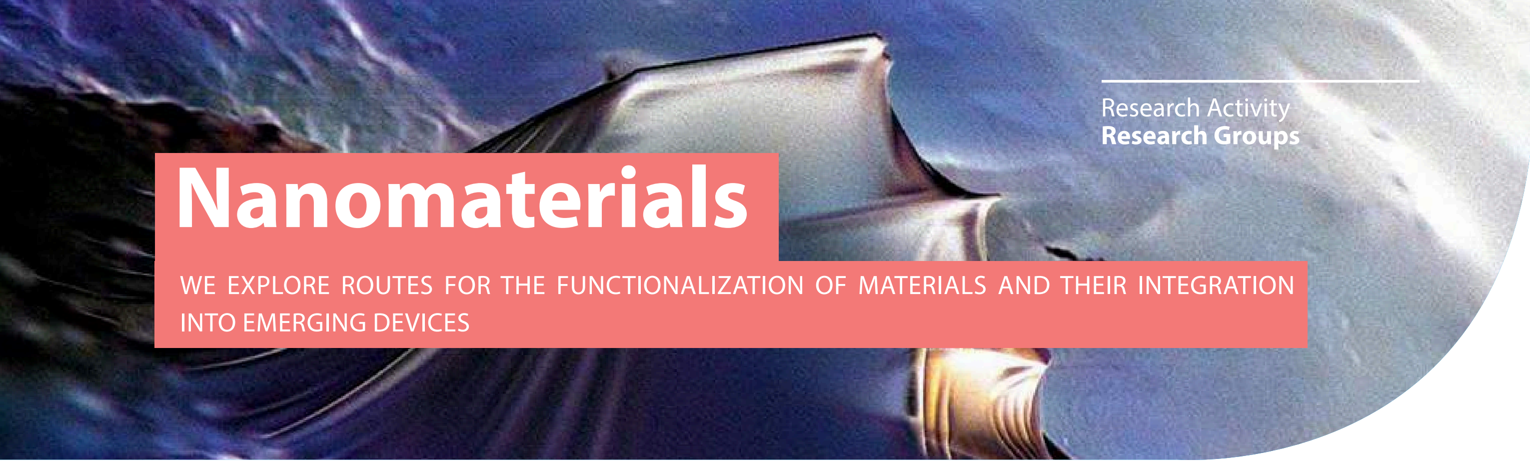
for at least one month

Shiyu Deng,
Pre-doc at Cambridge University - UK

Marjan Famili,
Post-doc at Cambridge University - UK

Konstantinos Konstantinou,
Post-doc at Tampere University - Finland

Martin Irizar,
Pre-doc at DIPC - Spain



Nanomaterials

WE EXPLORE ROUTES FOR THE FUNCTIONALIZATION OF MATERIALS AND THEIR INTEGRATION INTO EMERGING DEVICES

SELF-HEALING MATERIALS

We explore strategies for enabling self-healing of inorganic thin films, which should increase the longevity of future electronic devices.

- ***We have developed*** *a method for producing self-healing organic inorganic materials.*
- ***We have demonstrated*** *that vapor-phase infiltration can enable an entropy-driven self-healing of metal oxides in polymer-inorganic hybrid materials [Advanced Materials, 2022].*

BIOFUNCTIONAL COATINGS

We develop new coating processes for the fabrication of antimicrobial and biocompatible coatings.

- ***We have demonstrated*** *a new vapor-phase deposition process for biocompatible siloxane- and silazane-based hybrid thin films [ACS Applied Nanomaterials, 2022].*

ENZYMATIC CATALYSIS

We investigate strategies for the immobilization and optimization of enzymes for improving their efficiency and reusability.

- ***We have fabricated*** *a multifunctional chemoenzymatic reactor, which mimics NAD(P)H oxidase enzymes in cooperative one-pot cascade reactions [Angewandte Chemie International Edition, 2022].*

HIGHLIGHTS

EU Projects

We are part of HYCOAT, a Marie Sklodowska-Curie ITN. This project develops hybrid thin film coatings for a variety of emerging applications.

We also participate in the m-ERA.net project ALD4MAX, which explores the bottom-up fabrication of MAX phases and MXenes. We are also a member of the consortium of the m-ERA.net project THERMOS, which explores the fabrication of tellurium-free thermoelectric materials.

Patent and industrial collaboration

In the period 2021-2022, we have submitted a patent on a new method for producing self-healing organic inorganic materials, and we have worked on several industrial projects. We have a project in collaboration with Marvel Fusion, a German company developing laser-driven fusion as a solution for the global energy transition to zero carbon emission. We collaborate with the company Andromeda for the development of functional textiles, with Cikatek for the improvement of rubber´s properties, and with Maier for the development of aesthetic coatings.

Group members

Mato Knez

Ikerbasque Research Professor
Group Leader

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Kristina Ashurbekova
Susan Azpeitia
Natalia Chamorro
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Technician

Raydel Pérez

Guest Researchers

for at least one month

Ana Beloqui, Ikerbasque Fellow at Polymat - Spain

Alessandra Imbrogno, Post-doc at Tyndall National Institute - Ireland

Undergraduates

Raquel Corredor, University of the Basque Country
Ane Fagoaga, University of the Basque Country
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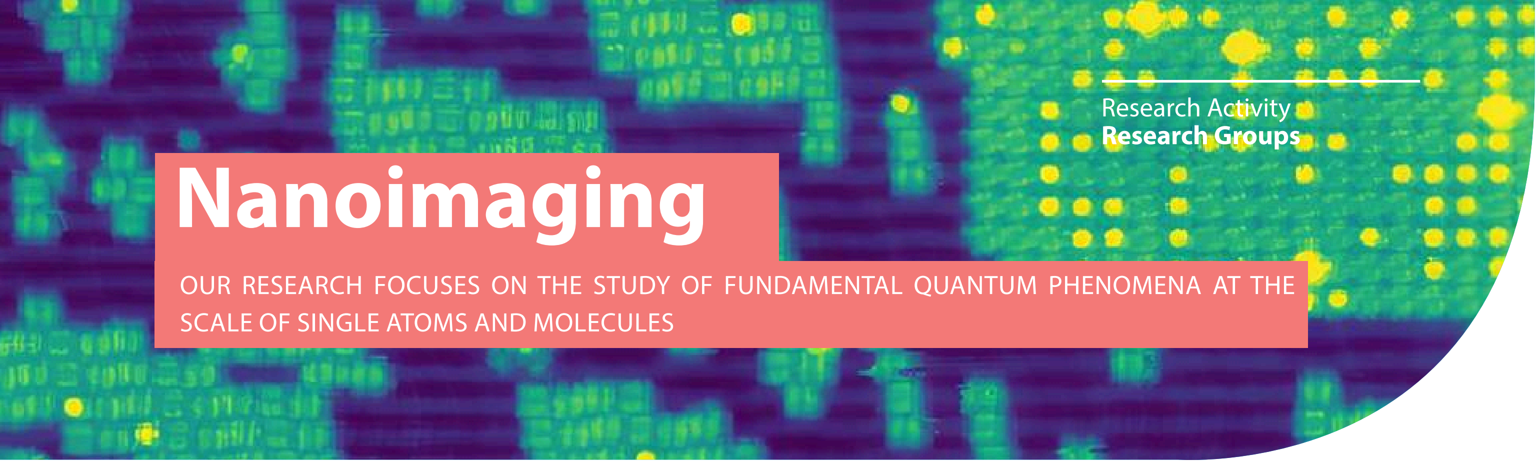

Nanoimaging

OUR RESEARCH FOCUSES ON THE STUDY OF FUNDAMENTAL QUANTUM PHENOMENA AT THE SCALE OF SINGLE ATOMS AND MOLECULES

MOLECULAR MAGNETISM

We develop new methods to induce magnetism in carbon materials and explore their potential for quantum spintronics.

- ***We have demonstrated*** *the emergence of π-paramagnetism in graphene nanostructures [Angewandte Chemie International Edition, 2021].*
- ***We have uncovered*** *a topological transition in chiral graphene nanoribbons [Nature Communications, 2021].*
- ***We have measured*** *electronic transport through magnetic nanoribbons [ACS nano, 2022].*

SUPERCONDUCTIVITY

We develop new models to understand superconductivity at the nanoscale, as well as its interaction with magnetic atoms and molecules.

- ***We have demonstrated*** *the non-trivial effect of intramolecular spin-spin coupling in the bound states induced on a superconductor [Physical Review Letters, 2021].*
- ***We have proven*** *the use of proximitized gold surfaces to achieve long-lived spin excitations in magnetic molecules [Nano Letters, 2022].*

NOVEL LAYERED MATERIALS

We explore materials that exhibit magnetism in two dimensions and methods to grow them on various surfaces.

- ***We have found*** *that magnetism persists in two-dimensions in a single layer of nickel dibromide deposited on a gold surface [ACS nano 2021] .*

HIGHLIGHTS

EU Projects

We coordinate the collaborative FET Open project SPRING, which aims at designing novel magnetic materials based on graphene and exploring their potential use in quantum technologies.

Quantum technologies - Next-QSENSE

We have been working on a research project, Next-QSENSE, funded by the regional government of Gipuzkoa to advance towards sensing strategies for the development of molecular magnetism at the atomic scale using microwaves. These results are expected to facilitate unprecedented resolution in space and energy.

Group members

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Ikerbasque Research Professor
Group Leader

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for at least one month

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Martina Corso,
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Nanoengineering

WE COMBINE LIGHT WITH ARTIFICIAL INTELLIGENCE, IN ORDER TO DISCOVER INCONSPICUOUS BUT SIGNIFICANT FEATURES IN BIOLOGICAL SYSTEMS

VIBRATIONAL SPECTROSCOPY

We apply Raman and FTIR spectroscopy for chemical and biological detection and exploit the data by artificial intelligence.

Spectroscopy techniques are used for *identifying disease patterns as cancer, Alzheimer's, infectious diseases, and hypoxia, and for analyzing food quality. We have demonstrated that we can distinguish specific diseases with more than 90% accuracy [Advanced Science, 2022].*

NANOPLASMONICS

For plasmonic sensing and surface-enhanced Raman spectroscopy we are developing nanostructured Au surfaces and superlattices of self-assembled Au nanoparticles.

Supported by machine-learning algorithms*, we are optimizing designs for plasmonic nanostructured surfaces and exploit the plasmonic spectra by artificial intelligence for enhanced sensing. By template-assisted chemically controlled self-assembly, we build up plasmonic superlattices on stretchable substrates whose lattice periods can be tuned mechanically in two dimensions. This has allowed us to work with different setups –and laser wavelengths– and the same substrate under optimized resonance conditions [Small Methods, 2021].*

HIGHLIGHTS

MedTech Startup

In the context of monitoring perinatal asphyxia, nanoGUNE is promoting the exploitation of the technology through the creation of a new MedTech company. Many initiatives have taken place during the period showing the interest of international investors to accelerate the business development and further develop the technology. The device is protected as part of nanoGUNE´s intellectual property portfolio.

Industrial collaboration

We have been acquiring private funding to make progress in our research line on machine-learning-assisted multispectroscopy. In that frame of reference, a technology for detection and classification of viral respiratory infections based on human plasma samples from pneumonia patients has been established. In a second project, protocols for the detection of microplastics in specific food products have been developed with the potential to extend the findings to a broad range of aliments.

Group members

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Leyre Serna,
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Nagore Torres,
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Highlighted Publications

1

REAL-SPACE OBSERVATION OF VIBRATIONAL STRONG COUPLING BETWEEN PROPAGATING PHONON POLARITONS AND ORGANIC MOLECULES

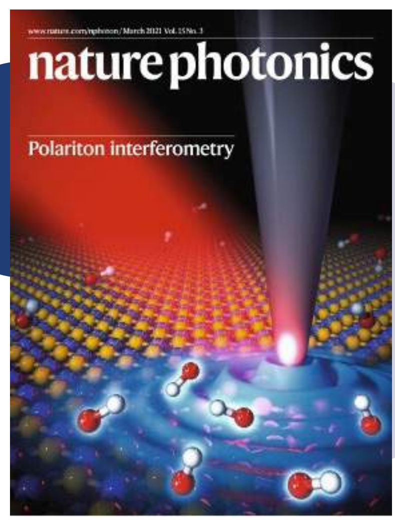
Nature Photonics **15**, 197 (2021)

A. Bylinkin, **M. Schnell, M. Autore, F. Calavalle**, **P. Li**, J. Taboada-Gutierrez, S. Liu, J. Edgar, **F. Casanova, L. Hueso**, P. Alonso-Gonzalez, A. Nikitin, and **R. Hillenbrand**

We employed a spectroscopic nanoimaging technique to study how infrared nanolight - in form of phonon polaritons - and molecular vibrations interact with each other. The images reveal that vibrational strong coupling can be achieved, which is a phenomenon that recently attracts wide attention for its potential use to control fundamental physical and chemical material properties. The result could lead the development of a novel platform for on-chip chemical identification of tiny amounts of molecules and for studying fundamental aspects of strong coupling phenomena on the nanometer scale.

Light has many important applications in science and technology, including optical communication, medical diagnosis, and laser surgery. Recently, it was discovered that the interaction between infrared light and molecular vibrations can be strong enough to modify the material's properties, such as conductivity and chemical reactivity. This effect, called vibrational strong coupling, can be achieved by placing the material in a microcavity where the light is concentrated. However, this interaction weakens when the number of molecules is reduced, eventually preventing strong vibrational coupling to be achieved. This problem can be overcome by concentrating light in nanocavities or by compressing its wavelength.

A strong compression of infrared light can be achieved by coupling it with lattice vibrations (phonons) in thin layers of high-quality polar crystals, resulting in the formation of infrared waves known as phonon polaritons. To study the interaction between propagating phonon polaritons and molecule vibrations, we placed a thin layer of hexagonal boron nitride on top of organic molecules and used a scanning near-field microscope to generate phonon polaritons in the boron nitride layer. The microscope also allowed us to observe the phonon polaritons interacting with the nearby organic molecules - forming hybrid polaritons - in real space. These hybrid polaritons are strongly attenuated at the frequency of the molecular vibrations, which could be useful for future on-chip sensing applications. Further, strong coupling between the phonon polaritons and the molecular vibrations could be demonstrated, which could potentially be used for the development of ultrasensitive spectroscopy devices or to study quantum aspects of vibrational strong coupling.



Artistic impression of nanoimaging of molecular vibrations coupled to phonon polaritons (blue wave) in a thin layer of hexagonal boron nitride. Nanoimaging is performed by recording the light scattered from a sharp metal tip that is scanned across the sample surface.

2

ULTRATHIN HYBRID SiAlCOH DIELECTRIC FILMS THROUGH RING-OPENING MOLECULAR LAYER DEPOSITION OF CYCLIC TETRASILOXAN

Chemistry of Materials **33**, 1022-1030 (2021)

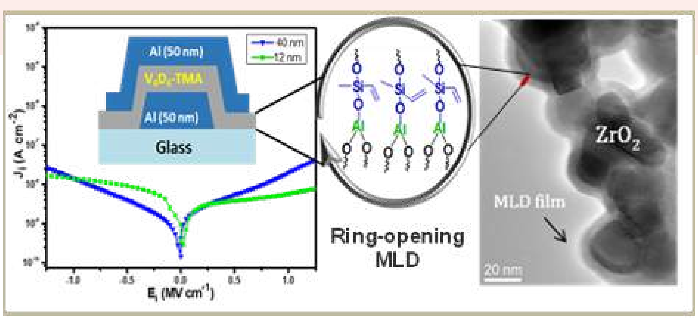
K. Ashurbekova, K. Ashurbekova, I. Saric, **M. Gobbi, E. Modin, A. Chuvilin**, M. Petravic, I. Abdulagatov, and **M. Knez**

Molecular layer deposition (MLD) is a powerful vapor phase approach for growing thin polymer films with molecular level thickness control. We developed a new ring opening MLD process to deposit a siloxane-alumina hybrid organic-inorganic thin film using tetramethyl-tetravinylcyclotetrasiloxane (V_4D_4) and trimethylaluminum (TMA) as precursors. The grown siloxane-alumina film, even as thin as 12 nm, showed an extremely low leakage current density (lower than 5.1×10^{-8} A cm^{-2} at ± 2.5 MV cm^{-1}) and a dielectric constant (k) of 4.7.

Siloxane-based polymers possess a set of physical and chemical properties, which are of great importance for many future application designs. The exceptional properties result from the highly flexible siloxane (Si-O-Si) backbone that imparts a high degree of molecular mobility and one of the lowest glass transition temperatures found within polymers. Atomic layer deposition (ALD)/MLD of SiO_2/siloxane-based materials is limited mainly by the poor reactivity of silicon precursors at low temperatures, corrosive by-products, or the need of a catalyst.

The ring-opening polymerization (ROP) of cyclic siloxanes is an example of a rare entropically driven polymerization, as the vibrational and rotational freedom in the linear siloxane units is much greater than in the corresponding rings. Here we introduce cyclic siloxanes as a new class of silicon-based molecular precursors for a ROP MLD. The process appears uncommon as the molecules are lacking reactive groups, but are reactive because of the reactive sites upon ring-opening of the cyclosiloxane, which enables lowering the MLD processing temperature.

In this work, we used MLD to deposit siloxane-alumina hybrid organic-inorganic thin films. The growth process was characterized in situ with a quartz crystal microbalance (QCM) and the thin films with various spectroscopies and microscopies to identify the growth mechanism. We have shown that this MLD process allows for the fabrication of highly conformal ultrathin films with excellent insulating properties, stability at high-temperature annealing conditions, and the possibility to control and vary the composition of the film with the processing temperature.



Left: J_i–E_i characteristics of 40 and 12 nm thick MLD films. Inset: Structure of the Al/V_4D_4-TMA/AlMIM device used for the characterization.
Right: TEM image of ZrO_2 NPs coated with a 50 Å thick MLD film.

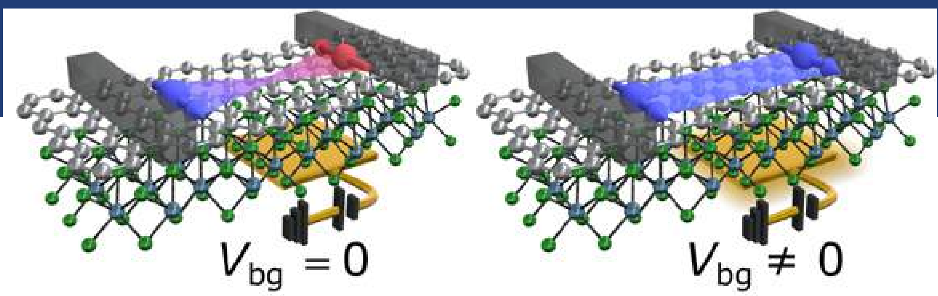
3

ELECTRICAL CONTROL OF VALLEY-ZEEMAN SPIN-ORBIT-COUPLING-INDUCED SPIN PRECESSION AT ROOM TEMPERATURE

Physical Review Letters **127**, 047202 (2021)

J. Ingla-Aynes, F. Herling, J. Fabian, **L. E. Hueso,** and **F. Casanova**

Van der Waals heterostructures are new synthetic materials, where an atomically-thin layer of a particular material is placed very close to another one with completely different properties thus forming a hybrid structure which inherits properties from both layers. We placed a bilayer graphene (BLG) in close contact with WSe_2, a van der Waals semiconductor with high spin-orbit coupling (SOC). The WSe_2 layer modified the BLG's spin transport properties, leading to the first observation of magnetic-field-free spin reversal in graphene. Our results open new routes for the realization of spin-based logic devices, which can be integrated into chips because they do not require a magnet to operate.



The search for electrical control of the spin polarization has been a core goal of spintronic research over the last 20 years, starting from the semiconductors made out of III-V materials and Si and continuing with graphene, which is an ideal material for long-distance spin transport. Its low atomic mass and high electronic quality guarantee a long spin lifetime and an efficient propagation over long distances. However, the active manipulation of spins requires the application of external magnetic fields, which require bulky hardware that cannot be integrated in a small electronic circuit. Luckily, there is an alternative: the introduction of a high SOC which couples the electron spins to their motion. The most successful approach to introduce SOC in graphene is by proximity to other van der Waals materials with heavier atoms, like WSe_2. The resulting stacks possess a large SOC, which gives rise to a special spin texture whose out-of-plane component has opposite sign in each of the two valleys present in the graphene band structure. As a consequence, in-plane spins are very sensitive to the SOC.

We have optimized the proximity between graphene and WSe_2, and we have discovered that in-plane spins can be reversed when crossing the graphene/WSe_2 region, whereas the out-of-plane ones remain fairly intact. Additionally, by using in-plane and out-of-plane electric fields to control the spin dynamics, we have obtained control of the in-plane spins, tuning their sign without a magnetic field for the first time in a van der Waals heterostructure. Our observation, which occurs up to room temperature, is a significant step forward for the realization of new spintronic devices.

4

TOPOLOGICAL PHASE TRANSITION IN CHIRAL GRAPHENE NANORIBBONS: FROM EDGE BANDS TO END STATES

Nature Communications **12**, 5538 (2021)

J. Li, S. Sanz, N. Merino-Diez, M. Vilas-Varela, A. Garcia-Lekue, M. Corso, D. G. de Oteyza, T. Frederiksen, D. Pena, and **J. I. Pascual**

In the last decades, a mathematical description of symmetries in nature called topology has been applied to describe and predict new electronic and magnetic properties of materials. A very simple aspect of topology connects a symmetry in the atomic structure of a crystal with a class of materials. Many materials that we know or use in current technology (silicon, diamond, gallium arsenide, etc.) belong to a topological class called trivial, meaning standard, and behave as normal semiconductors or insulators.

Novel materials with “anomalous” topology (technically called non-trivial) can be fabricated with advanced techniques of material science, which achieve control of their structure with atomic precision. For such materials, mathematical models predict “exotic” properties that can be utilized in future technologies; for example, such materials could be insulating in the bulk and, at the same time, metallic at the surface.

In this work, we show that graphene nanoribbons (GNRs) acquire an anomalous topological state of matter when narrowed down to just a few nanometers width. GNRs are atomically thin, planar carbon nanostructures that can be obtained from a sheet of graphene (carbon atoms arranged in a planar hexagonal lattice) by cutting in different directions. Conceptually, they can be thought of as stripes of graphene aligned along different directions, i.e, as nanoscale wires that may be used to transport an electronic current.

We fabricated GNRs of different widths and orientations with atomic precision using organic synthesis from precursors on a metallic substrate, and we have studied the connection of their atomic structure with their electronic properties using low-temperature Scanning Tunnelling Microscopy (STM) and tight binding simulations. Our results have demonstrated a global property of chiral GNRs: that they turn from metallic into an insulating state when their width is reduced below a few nanometers, and that this new state corresponds to a non-trivial topological class. Because of their anomalous topology, electronic states were found localized at the ends of the ribbons (as shown in the figure). These states represent a novel source of non-conventional magnetism with promising applications in quantum technologies.

STM image resolving the hexagonal structure (schematically indicated by black lines) of one of the studied GNRs. The bright, localized feature at the right side reveals the emergent “exotic” state at the end of the ribbon.

MODIFYING CRITICAL EXPONENTS OF MAGNETIC PHASE TRANSITIONS VIA NANOSCALE MATERIALS DESIGN

Physical Review Letters **127**, 147201 (2021)

L. Fallarino, E. Lopez-Rojo, **M. Quintana,** J. S. Salcedo-Gallo, B. J. Kirby, and **A. Berger**

Phase transitions are among the most fascinating phenomena in nature, also because very diverse systems and phases exhibit identical behavior close to a critical point. This universality can be credited for much of our understanding of phase transitions, because complex systems can be described by highly idealized models. It also results in fundamentally limiting materials engineering choices, since critical behavior was understood to be independent from materials design. In the present study, however, we demonstrate that by means of nanoscale graded materials, it is possible to design critical behavior *a la carte* and override universality.

In contrast to the generally accepted understanding of phase transitions and decades of experimental and theoretical studies confirming universality, here we have demonstrated a nanoscale materials design pathway that allows one to override universality in thin ferromagnetic films. Furthermore, this approach enables a tuning of critical exponents for ferromagnetic phase transitions in an extremely wide parameter range, while at the same time preserving scaling in an extended phase space near the critical temperature TC. The detailed magnetometry data, of which examples are shown in Fig. 1, reveal that single crystal CoRu alloy films, in which the pre-defined depth-dependent exchange coupling strength follows a V-shaped profile (Fig. 1(a)), exhibit critical scaling behavior over many orders of magnitude. Their critical exponents, however, can be designed and controlled by modifying their specific nanoscale structures, thus demonstrating full tunability of critical behavior (Fig. 2). The reason for this disappearance of universality is shown to be the competing relevance of collective *versus* interface propagation of ferromagnetic phase transitions, whose balance we have found to be dependent on the gradient *s* of the exchange coupling strength profile, resulting in previously unknown abilities to tune critical exponents via nanoscale materials design.

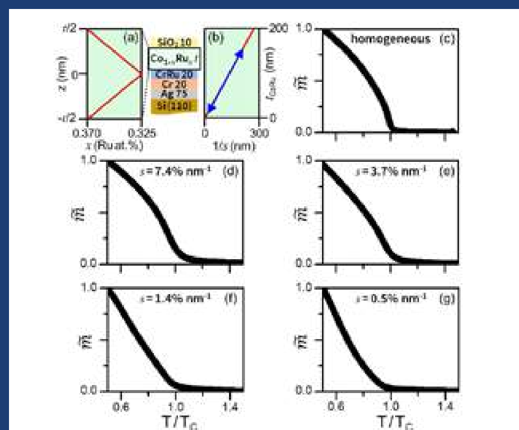


FIGURE 1: (a) Depth-dependent Ru content profile for a ferromagnetic $Co_{1-x}Ru_x$ graded film sample, which is part of a growth sequence to facilitate epitaxy (layer thickness in nm), and which is characterized by a linear gradient *s* of the depth-dependent exchange coupling strength *J*, normalized to its maximum value in the center of the film ($z = 0$). (b) Linear relationship between the film thickness *t* and 1/*s*, which reflects the experimental strategy followed in this work (the blue double arrow indicates the (1/*s*, *t*) range explored experimentally). (c) – (g) Temperature dependence of the normalized easy-axis magnetization $\widetilde{m}$ (normalized to its value at $T/Tc = 0.5$) for a $Co_{0.675}Ru_{0.325}$ homogeneous film (c), and graded structures for $s = 7.4\%$ (d), 3.7% (e), 1.4% (f), and 0.5% nm^{-1} (g). The data were measured while cooling each sample from $T = 300$ K to $T = 50$ K, in the presence of an applied field of strength $\mu_0 H = 4$ mT.

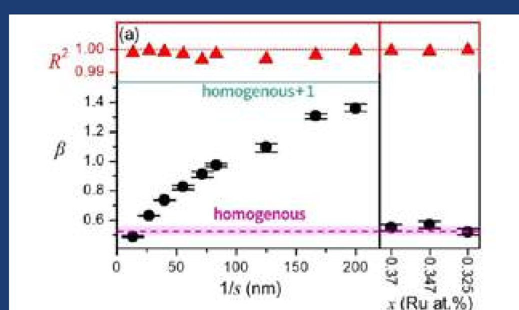


FIGURE 2: 1/*s* dependence of the order parameter critical exponent *b* (black circles) and the corresponding R^2 coefficients (red triangles) that indicate near perfect scaling behavior; the dotted red line displays $R^2 = 1$; the pink dashed line indicates the average measured β value for homogeneous systems, shown on the right side, while the straight green line indicates this value + 1, the presumed asymptote for $s \to 0$.

6

REAL-SPACE NANOIMAGING OF THz POLARITONS IN THE TOPOLOGICAL INSULATOR Bi_2Se_3

Nature Communications **13**, 1374 (2022)

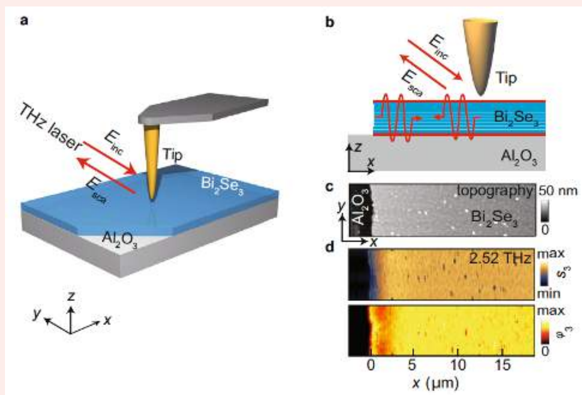
S. Chen, **A. Bylinkin,** Z. Wang, **M. Schnell,** G. Chandan, P. Li, A. Y. Nikitin, S. Law, and **R. Hillenbrand**

Plasmon polaritons in topological insulators attract wide attention for their potential use in THz photonics. We used spectroscopic THz near-field imaging to observe and analyze polaritons in thin layers of a prototypical topological insulator called Bi_2Se_3. We found that the polariton momenta are strongly increased compared to that of photons of the same energy, but their propagation lengths are rather short. We could explain the polaritons by the coupling of THz radiation to various carriers at the surfaces and in the bulk of Bi_2Se_3, as well as to its optical phonons. The study provides new insights into the nature of THz polaritons in topological insulators and establishes methods for imaging them.

Topological insulators (TIs) are a class of materials that have a unique electronic structure, with a conductive surface and an insulating bulk. This property arises due to the presence of a topological band gap, which allows for the existence of massless Dirac carriers at the surface of the material. These massless carriers can couple to electromagnetic radiation, resulting in the formation of hybrid modes known as Dirac plasmon polaritons.

We used scattering-type scanning near-field optical microscopy (s-SNOM) to study the properties of THz polaritons in thin Bi_2Se_3 layers in real space and as a function of frequency. We could reproduce the polariton dispersion (i.e., the dependence of momentum on energy) theoretically, but only when taking into account the contributions of various carriers (Dirac and massive carriers at the surface and massive bulk carriers) and optical phonons in Bi_2Se_3. We also measured the polariton propagation lengths from which we determined the decay times of the THz polaritons, which were found to be around 0.48 ps, similar to or even better than the decay times of plasmons in graphene.

Our work provides new insights into the nature of THz polaritons in TIs and demonstrates the capabilities of spectroscopic THz near-field microscopy for imaging these quasiparticles. It also highlights the potential of TIs to be used in plasmonic and THz photonic applications.



THz s-SNOM imaging polaritons in Bi_2Se_3. a) Schematic of the THz s-SNOM. A THz beam is focused onto the apex of a scanning probe tip. The tip-scattered THz field is collected and recorded interferometrically as a function of the tip position, simultaneously with topography. b) Illustration of polariton mapping. Near fields at the tip apex launch a polariton that is backreflected at the Bi_2Se_3 edge (sine waves) and scattered by the tip (red arrow). c) Topography image of a 25-nm-thick Bi_2Se_3 film and d) simultaneously recorded amplitude and phase images at a frequency of 2.52 THz, revealing the polariton as a dark fringe parallel to the Bi_2Se_3 edge.

GATE-TUNEABLE AND CHIRALITY-DEPENDENT CHARGE-TO-SPIN CONVERSION IN TELLURIUM NANOWIRES

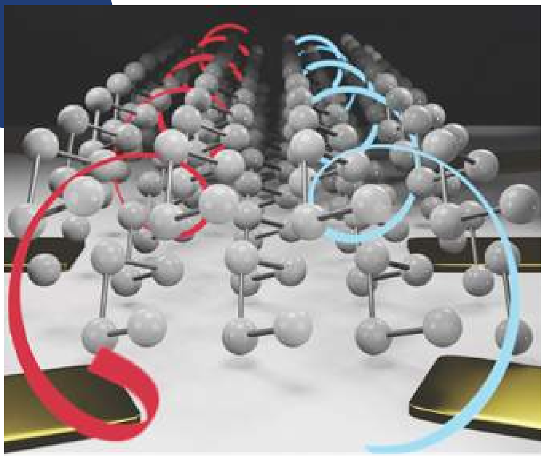
Nature Materials **21**, 526 (2022)

F. Calavalle, M. Suarez-Rodriguez, B. Martin-Garcia, A. Johansson, **D. C. Vaz, H. Yang**, I. V. Maznichenko, S. Ostanin, A. Mateo-Alonso, **A. Chuvilin**, I. Mertig, **M. Gobbi, F. Casanova**, and **L. E. Hueso**

When traveling through chiral tellurium nanowires, spins align in the direction of their momentum. The orientation of the polarized spins is determined by the chirality and current direction, and the spin density can be manipulated using electrical gating and current flow.

Chirality is a property arising from broken mirror and inversion symmetries commonly found in objects like screws. It plays a key role in many different areas, such as biochemistry or particle physics. However, its potential in materials science has not been deeply explored yet. Of particular interest are chiral structures that interact with moving spins, leading to polarization in their orientation. This intriguing process is known as chiral-induced spin selectivity (CISS) and has mostly been observed in organic enantiomers which can produce significant spin polarizations. While CISS has gained attention across many fields for its potential applications, the mechanism behind it is yet to be fully understood. Additionally, the organic molecules under study present poor electronic conductivities limiting their potential for applications. As such, new data from new chiral systems, including inorganic materials, and new detection schemes are in high demand for understanding CISS and developing practical devices.

Here, we report the observation of chirality-dependent spin filtering from an inorganic chiral material, tellurium nanowires. Tellurium has unique chiral helices and broken mirror and inversion symmetries that give rise to radial spin textures. We have demonstrated that the orientation of the electrically generated spin polarization is determined by the nanowire handedness and uniquely follows the current direction, while its magnitude can be manipulated by an electrostatic gate. This was found by recording a large (up to 7%) and chirality-dependent unidirectional magnetoresistance. Our results pave the way for the development of magnet-free chirality-based spintronic devices.



Artistic representation of a tellurium device employed in this study. Since mirror and inversion symmetries are broken, the traveling spins align in their momentum direction.

8

ENTROPY-DRIVEN SELF-HEALING OF METAL OXIDES ASSISTED BY POLYMER-INORGANIC HYBRID MATERIALS

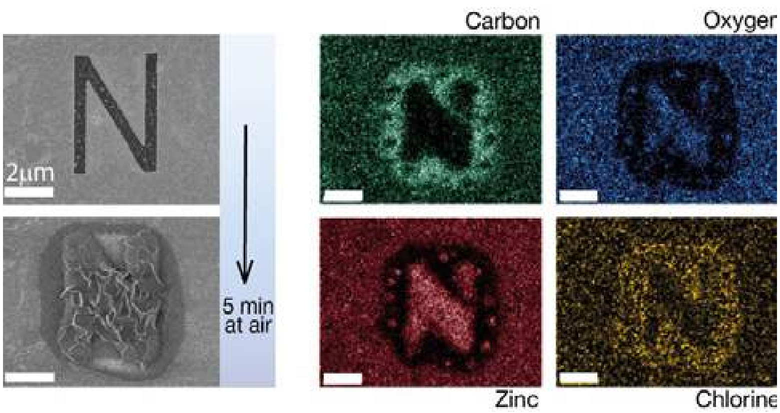
Advanced Materials **34**, 2202989 (2022)

O. Yurkevich, E. Modin, I. Saric, M. Petravic, and **M. Knez**

Enabling self-healing of materials is crucially important for saving resources and energy in emerging and future applications. While strategies for self-healing of polymers are advanced, self-healing mechanisms for semiconducting inorganic materials are scarce due to the lack of suitable healing agents. Here, a concept for the self-healing of metal oxides is developed that bases on the infiltration of inorganic species into polymeric substrates.

In this work, we have developed a methodology for the self-healing of metal-oxide-based thin film coatings. The healing process was achieved without the use of liquid and reactive chemical agents, but through the growth of well-dispersed metal oxide (MeO) nanoparticles (NPs) inside chlorinated polymers and enabling their diffusion and aggregation. Artificially induced defects in the coatings became sealed after exposure of the system to air. This diffusion process is likely driven by an entropic penalty, which arises in the metal oxide/polymer hybrid system and drives the migration of NPs to the damaged sites and microcracks. Furthermore, our studies reveal that the presence of chlorides is of crucial importance for enhancing the mobility of the MeO nanoparticles inside the polymeric host matrix and thereby the ability of the system to self-heal in general.

The oxides of zinc and indium, investigated in this study, are constituent materials of common transparent conductive oxides (TCOs), which are used as electrodes in a plethora of modern electronic devices. By enabling the healing of defects in such TCOs, our methodology can support the longevity of current transparent conductive materials as cracks that occur upon bending could recover up to a certain degree. Moreover, this discovery forms a cornerstone for the development of further inorganic self-healing materials by infiltrating alternative metal oxides into halogenated polymers. We expect this development to benefit numerous technological areas: flexible electronics, wearable sensors, photovoltaics, displays, and energy by enhancing the durability and longevity of the devices.



Healing of selectively FIB-etched patterns on the surface of ZnO-coated ParyleneC, before and after exposure to air, and the corresponding color-coded EDX maps of the mended ParyleneC/ZnO hybrid structure.

9

ADDRESSING ELECTRON SPINS EMBEDDED IN METALLIC GRAPHENE NANORIBBONS

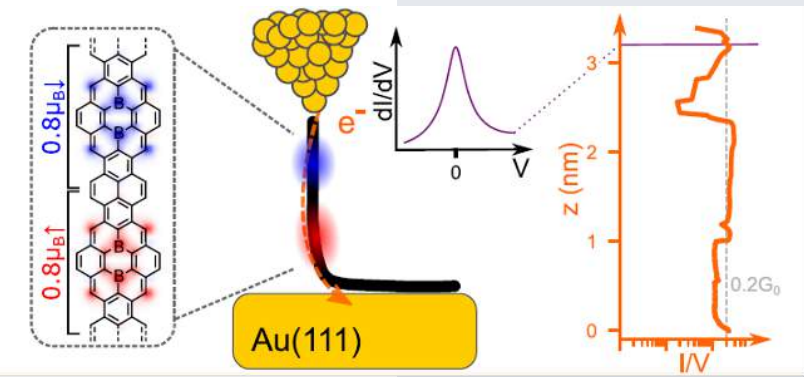
ACS Nano **16**, 14819 (2022)

N. Friedrich, R. E. Menchon, I. Pozo, **J. Hieulle, A. Vegliante, J. Li,** D. Sanchez-Portal, D. Pena, A. Garcia-Lekue, and **J. I. Pascual**

Perfect ballistic conductance is demonstrated through a graphene nanoribbon designed and fabricated with atomic precision to be metallic. This ballistic conductor offers unique experimental access to localized magnetic moments in its interior. We have demonstrated both ballistic conductance and localized magnetic moments *via* two-terminal transport measurements of a customized graphene nanoribbon with a few boron atoms in its structure. The boron atoms localize electron spins in their surrounding, without affecting the ballistic channels.

To fabricate the graphene nanoribbon, we used methods of on-surface synthesis. Thus, we used an organic precursor on metallic gold surfaces to steer a controlled chemical reaction that results in the targeted nanoribbon structure. For this project, we used ribbons including substitutional boron atoms inside.

Through an interplay of symmetries of the different electronic components, ribbon band structure and boron atoms, the electrons occupying the frontier states of the boron moieties did not interact with the nanoribbon electron bands.



From left to right: Representation of calculated results on the spin polarization of the graphene nanoribbon, the two-terminal measurement strategy, a Kondo spectrum, revealing the presence of embedded spins, and the length-independent linear conductance, showing the ballistic character of the nanoribbon.

Ballistic electronic transport refers to the perfect electronic transmission through an electrical conductor. It occurs when the conductor is shorter than the electronic mean free path, so, on average, electrons suffer no scattering inside the conductor. In ballistic conductors, the resistance is independent on the length and amounts to a universal constant value of 12.9 kΩ. In this work, we have demonstrated that a graphene nanoribbon customized to be metallic behaves as a ballistic conductor. We have further demonstrated that the ballistic transport channels bring information about localized magnetic moments inside, allowing us to address localized spins with electronic currents.

In this way, we could address both the ballistic electron transport and the spin localized in the ribbon.

Our results represent a method to address these spin-hosting graphene nanostructures, showing that they are promising metal-free systems for elementary quantum spintronic devices.

10

PHOTONIC TECHNOLOGY FOR IN VIVO MONITORING OF HYPOXIA-ISCHEMIA

Advanced Science **10**, 2204834 (2022)

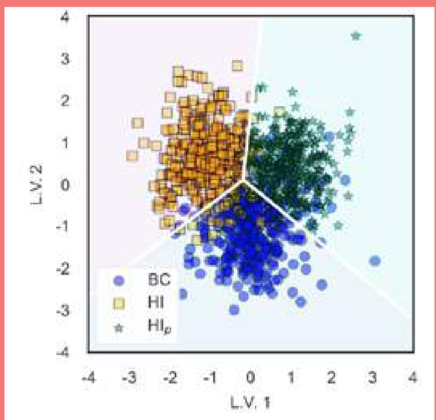
I. Olaetxea, H. Lafuente, **E. Lopez,** A. Izeta, I. Jaunarena, and **A. Seifert**

Physiological surveillance of newborns during delivery triggers medical decision making, can rescue life, and helps avoid unnecessary cesareans. For monitoring perinatal asphyxia, we have demonstrated in a preclinical study the power of photonic technology for the detection and classification of hypoxic-ischemic states. Our technology does not rely on a single biomarker; it instead monitors changes of the entirety of physiological parameters that are attainable by the measurement technique. By applying artificial intelligence to the spectroscopic data, we have achieved 90% levels for discriminating hypoxic states.

Worldwide, newborn deaths count for 2.5 million, of which 24% are caused by intrapartum complications. Perinatal asphyxia is one of the most common medical disorders in high-risk births. By insufficient oxygen supply to fetal tissue, a prolonged episode of perinatal asphyxia can produce neurological damage as hypoxic-ischemic encephalopathy. Fetal monitoring plays a key role in the diagnosis of perinatal asphyxia and correlated adverse outcomes. However, the performance of current standard, such as cardiotocography or fetal scalp blood sampling, has been questioned in obstetric care due to both false positive and negative rates.

We have developed a photonic technology, using a fiber-coupled Raman probe in controlled contact with the skin of the subject. The near-infrared Raman spectra are analyzed by artificial intelligence. In contrast to the state of the art, our technology provides continuous data in real-time and in a non-invasive way. Whereas the state of the art focuses on a single parameter, as pH or lactate, we have developed a systemic approach whose algorithms consider the entirety of physiological changes accessible by Raman spectroscopy, which allows for the detection of metabolomic variations correlated to the disease pattern and delivers a more detailed and precise clinical picture.

In an asphyxia model in newborn pigs, we acquired more than 1 000 Raman spectra at different clinical phases – basal condition, hypoxia-ischemia, and post-hypoxia-ischemia–. In this proof-of-concept study, figures of merit reach 90% levels for classifying the clinical phases and demonstrate the power of the technology as an innovative medical tool for diagnosing a perinatal adverse outcome.



2D visual separability between basal condition, hypoxia-ischemia, and post hypoxia-ischemia, using hybrid multiclass classification. Input for machine learning are preprocessed Raman spectra from in vivo experiments.

4 Business Connection

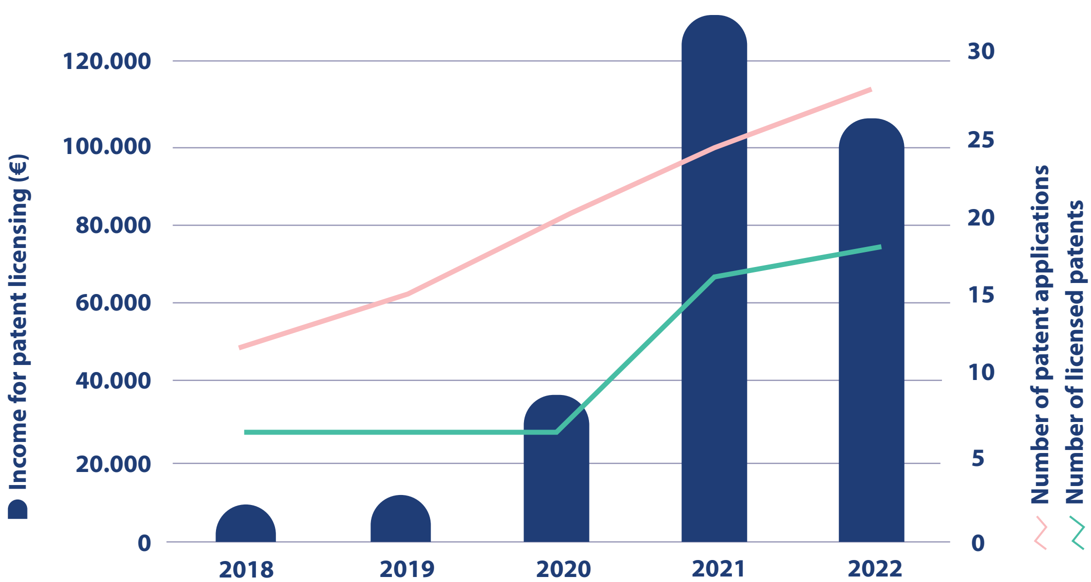
Business Connection

NanoGUNE is fully commited to bridge the gap from research to industry, by facilitating the transfer of our knowledge and technology to the productive sector

The three pillars on which we base our technology-transfer endeavour are: industrial research under contract, patent licensing, and the exploitation of our technologies through the creation of startup companies. In this regard, the period 2021-2022 has been particularly fruitful, as a considerable number of new patents has been licensed for exploitation, a very reasonable amount of private funding has been maintained, and important steps have been taken for the consolidation of our startup companies.

27 Patents in Portfolio

18 Patents licensed



Enzymes for genetic engineering

In the framework of a research contract developed by the Nanobiotechnology group for Tyris Therapeutics, important work has been done on the ancestral reconstruction of genetic sequences for enzyme synthesis. The high-quality outcome of the project has allowed the filing of a patent application.

Contract Research

BASQUE COMPANIES

- GSF
- microLIQUID experts in microfluidics
- BALENCIAGA SHIPYARD
- BALAB Factory
- FAGOR AUTOMATION
- IKERLAT polymers Personalized Polymer Particles
- i+Med
- KUSUDAMA
- CULTZYME

OTHERS COMPANIES

- ThermoFisher SCIENTIFIC
- intel
- neaspec
- attocube WITTENSTEIN group
- regineering
- SRC Semiconductor Research Corporation
- SCALE Nanotech
- KUBOS SEMICONDUCTORS
- BASF We create chemistry
- Marvel Fusion
- membrasenz
- tyris tx
- IT3D GROUP
- Integra therapeutics
- DYNAMIC ABUTMENT SOLUTIONS

RESEARCH CENTERS & ORGANIZATIONS

- CIC bioGUNE MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE
- CIC biomaGUNE MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE
- FUNDELA
- tecnalia
- DIPC Donostia International Physics Center
- Tyndall National Institute

External Services

Our external-services department represents a tool to contribute with our know-how and state-of-the-art infrastructure to the innovation processes of industrial and technological companies, specially in three areas.

Electron Microscopy

By providing a detailed understanding of the microstructure and nanostructure of materials, electron microscopy can enable knowledge-based production processes with enhanced quality-control measures. This allows for the development of materials and products that meet exacting specifications, ensuring consistent performance and reliability over time.

Moreover, electron microscopy has diverse scientific applications, enabling researchers to study the fundamental properties of materials and explore new frontiers in fields such as materials science, nanotechnology, and biotechnology.

Nanofabrication

Our film fabrication services offer the possibility to grow films of a wide variety of materials, such as metals, semiconductors, and dielectrics on various types of substrates with precise thicknesses.

On the other hand, our nanostructurization services allow us to shape different structures at the nanoscale. We fabricate nanomembranes for chemical sensors and biosensors, patterns for microfluidics, and electronic devices. Also, by using our proprietary electrospinning technology –Novaspider–, we are successfully fabricating, for example, 3D nanostructures made of nanocellulose and polymer fibers, which show a high potential for the creation of scaffolds with bioinstructive properties.

Chemical characterization

We provide nanoscale chemical characterization services based on s-SNOM, RAMAN, EDX, and EELS techniques, as well as a number of monochromatic and broadband infrared lasers. We have recently revealed hidden properties of polymer membranes fabricated for gas permeation, thus allowing for the development of new-generation films with unprecedented properties.

Alliances

The path that leads us to bridging the gap between research and industry cannot possibly be done alone. Of particular importance is to establish alliances between academia, policy makers, and industry, so that our knowledge and technology can be translated into industrial competitiveness, new services, and new products.

Technology vouchers for a proof of concept

In the framework of a collaboration agreement with Fomento San Sebastian, technological vouchers are offered to companies for a proof of concept, so that the company can test whether our knowledge and technology has the potential to contribute with an added value to their new processes and products.

CULTZYME

"This program has allowed us to collaborate with a high-value research team and to carry out the first proofs of concept for the development of a new nanotechnology to improve the food biofabrication process"

Juan Manuel Garzón Vela
Founder and CEO at Cultzyme

Exploitation strategies

We have managed to participate four times already in a very competitive call set up by BIC Gipuzkoa in 2018 for the valorization of intellectual assets. This tool is allowing us to identify the right exploitation strategy for our intellectual and industrial property. In the framework of this program, we explore the feasibility of the existing alternatives to commercially exploit our research activity, such as patent licensing and the launch of new startup companies. The four projects that we have developed jointly have shown the potential of nanotechnology in the biomedical sector, in particular.

Partnering with Industrial and Technological Clusters and Platforms

AFM cluster for advanced & digital manufacturing

BASQUE HEALTHCLUSTER

nanomedicine European Technology Platform

INAM innovation network for advanced materials

PACKAGING CLUSTER

materplat

NEW PATENTS 2021 2022

MATERIALS

Novel lytic polysaccharide monooxygenase and uses thereof

R. Pérez-Jiménez, B. Alonso, and L. Barandiaran

Priority date: 13/09/2021

Licensed to Evolgene

Additive manufacturing system

J. Latasa

Priority date: 14/09/2021

Novaspider

Method for producing self-healing organic inorganic materials

O. Iurkevich and M. Knez

Priority date: 21/10/2021

Method for the production of a conductive graphene-based ink and product thereof

B. Fernández-D'Arlas and R. Pérez-Jiménez

Priority date: 19/05/2022

HEALTH

Synthetic CAS proteins

R. Pérez-Jiménez and B. Alonso

Priority date: 25/05/2021

Licensed to Integra Therapeutics

Ancestral enzymes for genetic engineering

R. Pérez-Jiménez, A. Quesada, B. Alonso, and J. Oyarzabal

Priority date: 29/06/2022

Licensed to Tyris Therapeutics

Visit Patent Portfolio

3D printing of biomaterials for heart implants

Our proprietary electrospinning technology –Novaspider– offers unique and particularly interesting features in the promising fields of 3D printing and biomaterials. Our experience and control of this technology have led us to participate in an exciting project, named Cardioprint, which is aimed at designing, producing, and testing new biofabrication processes for heart implants.

novaspider.com

Integra Therapeutics acquires an exclusive licence for our patented CRISPR system

We have concluded a licensing agreement with Integra Therapeutics, a leading biotech company, in next-generation gene writing, which entails the transfer of the exclusive operating rights of a technology that we have patented at nanoGUNE. This particular license agreement will allow Integra Therapeutics to use our ancestral CRISPR-Cas technology, which has the potential to be more versatile than the currently existing variants.

Startup Companies

Graphenea launches a Graphene Foundry and the spin-off KIVORO

NanoGUNE's first startup company is nowadays a world-leading graphene producer. In the period 2021-2022, the company has launched a Graphene Foundry, where graphene-based materials and chips are designed and manufactured and then supplied to industry. Graphenea has also made significant progress in the use of CVD graphene for biosensors, and in 2022 a spin-off company has been launched, KIVORO, a specialty chemicals company that is focused on creating solutions for industrial challenges.

II Global Graphene Call launched in 2022

In the framework of a collaboration with BerriUP, Graphenea, and Fomento San Sebastian, we have launched the second Global Graphene Call, an initiative designed to develop business ideas related to graphene. The selected candidate was Aavalor Greentech, a company from the United Kingdom which is using graphene to develop a sustainable water-filtration technology.

Aavalor GreenTech

Partners

BERRIUP

CIC nanoGUNE
MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE

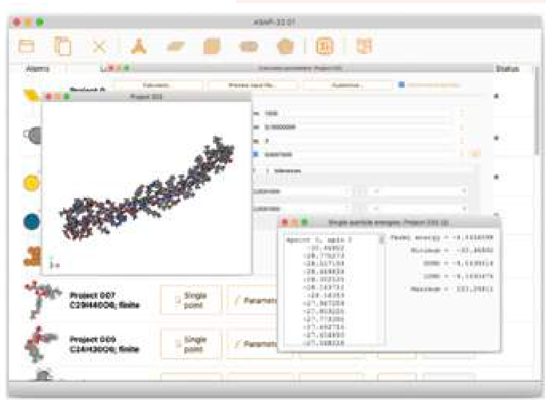
donostiasustapena fomentosansebastián
DESARROLLO ECONÓMICO DE SAN SEBASTIÁN
DONOSTIAKO GARAPEN EKONOMIKOA
SAN SEBASTIAN ECONOMIC DEVELOPMENT

Graphenea

Simune strengthens its position in microelectronics and quantum computing

Simune Atomistics provides cutting-edge scientific software tools and consulting services to industry and academia. In the period 2021-2022, the team has further developed their Atomistic Simulation Advanced Platform, ASAP, a software platform for materials modeling that is based on an atomistic *ab initio* scheme and has included an automated workflow for electronic-transport calculations in its last version ASAP 2022.3.

Simune experts have been assessing and training R&D teams all over the globe, including companies such as JSOL Corp. (Japan), Kostech (Korea), or REPSOL TechLab. Simune is also involved in a number of Basque, national and EU-funded research projects.



SIMUNE
ATOMISTIC SIMULATIONS

Biotech Foods takes a giant step forward

The world's largest meat processing company (by sales) has entered into the capital of Biotech Foods with an investment of 36 million euros. This capital increase will allow Biotech Foods to build in San Sebastian the largest cultured-meat plant to be located in southern Europe.

Biotech Foods was launched at nanoGUNE in 2017, when Mercedes Vila –at the time scientific director of nanoGUNE's startup company Ctech-nano– brought the idea to grow meat at the laboratory from animal cells. In 2021, the company moved to the Technology Park in Miramon, and in 2022 the construction of a pilot plan was launched at Eskuzaitzeta in San Sebastian, which will have the capacity to produce, at a first stage, a few thousand tons of protein per year.

Bio.Tech.
Foods.

Our startups, working on bioeconomy

Bioeconomy means using renewable biological resources to produce food, materials, and energy. NanoGUNE's startup companies **Simune**, **Ctech-nano**, and **Evolgene** are directly involved in R&D projects aiming at providing solutions towards a circular and low-carbon economy. Our initiatives have been selected by the Basque Government to facilitate this transition in our industrial fabric.

Ctech-nano is developing the project SEMILLALD to explore the potential of the technique known as Atomic Layer Deposition to extend the storage time of seeds and enhance their germination rate by depositing tailored thin films depending on the characteristics of the soil.

On the other hand, Simune and Evolgene are working together to optimize microelectronic systems through modeling and simulation, focused on the search of alternative materials to replace copper and aluminum –and reduce silver– in circuits for RFID (Radio Frequency Identification) applications.

5 Connecting with Society

Outreach and communication

We aim at spreading an egalitarian scientific culture, in order to inspire a critical society, capable of building a future in a sustainable manner. With this objective in mind, we participate in the organization of several science outreach activities, events, and projects.

25 Outreach events & projects

30 nanoGUNE researchers involved

13 000 Participants

nanoGUNE: the Charm of the Small

In 2021, we published the book *nanoGUNE: the Charm of the Small,* where the journalist and writer Elixabete Garmendia gathers the testimonies of eleven people, major stakeholders and participants in the development of nanoGUNE since its conception in 2005.

All year

School visit program

February

April

Women in Science

The women in science initiative "Emakumeak Zientzian" has gained force and recognition. On the 2022 edition, coordinated by nanoGUNE and Polymat, 17 organizations of the Basque Research, Technology, and Innovation network assembled a program composed of 35 activities. The same year 2022, the initiative was awarded with the first STEAM Euskadi Prize of Innobasque and the Basque Government, and was recognized by the local development agency Fomento de San Sebastian as an innovative initiative.

May

June

September

October

November

Bilbo Zientzia Plaza

In september 2022, we participated in the Bilbao Zientzia Plaza science dissemination event, in collaboration with the Scientific Culture Chair of the University of the Basque Country. In the framework of this collaboration, we took to Bilbao the exhibition *A walk through the nanoworld*, which we had built a few years ago within the so-called *10alamenos9* project, and we scheduled two guided tours.

Ekaiak badu garrantzia

In 2022, we sponsored the publication of the Basque translation of the book *STUFF MATTERS: The Strange Stories of the Marvelous Materials that Shape Our Man-made World* by Mark Miodownik. The translation was made by Jose Ramon Etxebarria.

In the media

Communicating our activity to the community surrounding us (academia, industry, and all citizens) is key to closing the circle between science, market, and society. Our close collaboration with local and international media gives us the possibility to reach a wide audience. In this sense, we are especially grateful to editors and journalists who are working to turn scientific results into meaningful stories.

630

Impact media

www.nanogune.eu

@CICnanoGUNE

Zientziaren mundua guztion eskura

CIC NANOGUNEREN HISTORIARI BURUZKO 'NANOGUNE, TXIKIAREN XARMA' LIBURUA IDATZI DU ELIXABETE GARMENDIAK ETA HAMAIKA ELKARRIZKETEZ OSATUTAKO EUSKARAZKO DIBULGAZIO LANA BURUTU DU HORRELA

AL DÍA

«Euskadi está recogiendo lo que ha sembrado en ciencia»

Félix Casanova
Investigador Ikerbasque de Nanogune

Ha sido galardonado con el premio Intel al Investigador Destacado 2020 por sus contribuciones en la tecnología MESO

Convocatoria foral para atraer y retener talento investigador

TECNOLOGÍA VASCA

Centros de Investigación Cooperativa | Balance

CIC NANOGUNE TIENDE PUENTES ENTRE CIENCIA E INDUSTRIA

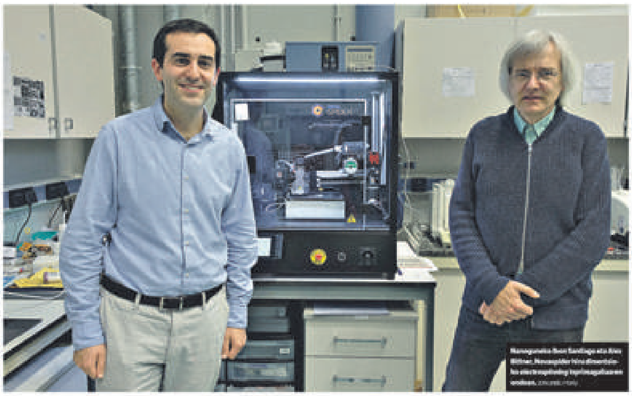
En 2020 cerró contratos de investigación con empresas con un millón de euros de financiación privada, el 13,2 por ciento de los ingresos del centro

DESARROLLAN PROYECTOS CON RPK, ASTILLEROS BALENCIAGA Y OTRAS EMPRESAS

23 son las patentes

30 Bizigiro Zientzia

BERRIA



Laborategian bihotz-ehun zatiak sortzeko CardioPrint ikerketa proiektua abiatu dute. Hiru dimentsioko inprimagailuak erabiliko dituzte prozesuan. Bihotzekoren bat izan dutenen bihotzak birsortzea da helburua. Zazpi bazkideetatik lau Euskal Herrikoak dira.

Bihotza 'inprimatzeko' saioa

20 | GARA

EKONOMIA

Nanogune, mundu oso bat sartzen da milimetro baten milioirenean

CIC nanoGUNE nanozientzia ikerketa kooperatiboko zentroan, Donostian, arruntena soilik ikusten da; berezi eta garrantzitsuena ezkutuan dago. Hori ezagutzera goaz hain zuzen, erabateko aktualitatea duten asmakizunak jaiotzen diren tokira –materialak autokonpontzeko teknologia eta covida detektatzeko makina, adibidez–.

ERREPORTAJEA

38 Bizigiro Zientzia

BERRIA

«Nanomedikuntza indartu beharko genuke, agian»

Txema Pitarke • CIC Nanoguneko zuzendari nagusia

Pitarkek ohiko neurria du nanometroa, milimetroaren milioirena, eta txikitasunaren eragin erraldoia bideratzen eta kudeatzen du. Nanomedikuntzan sakontzea du erronketako bat.

Conferences and Workshops organized

APS March Meeting 2021. Focus Topic - Magnetic Nanostructures: Materials and Phenomena

Date: 15-19 March 2021

Place: Virtual

Organizer and Co-Chair:
Andreas Berger

Functional Materials by Thin Film Coatings Symposium | Nano 2022 International Conference

Date: 06-10 June 2022

Place: Seville, Spain

Symposium co-organizer:
Mato Knez

International Conference on Advanced Plasmonics, Magnetics, and Magneto-optical Technologies (ICAPMOT)

Date: 24-28 May 2021 and 24-28 May 2022

Place: Virtual

Member of the advisory board:
Paolo Vavassori

Nanoscience and Molecular Materials (GENAM) | XXXVIII Meeting of the Royal Spanish Physical Society

Date: 11-15 July 2022

Place: Murcia, Spain

Symposium co-organizer:
Luis Hueso

Materials for Nanoelectronics and Nanophotonics Symposium | EMRS SPRING 2022 Conference

Date: 30 May - 03 June 2022

Place: Virtual

Symposium co-organizer:
Andreas Seifert

67th Annual Conference on Magnetism & Magnetic Materials (MMM 2022)

Date: 31 October - 4 November 2022

Place: Minneapolis, USA

Member of the program committee:
Fèlix Casanova

nanoGUNE community

As our community is getting bigger, we would like to stay together. With this objective in mind, we organize a number of social activities.

29 Jan. 2021 & **31 Jan. 2022**

Anniversary workshop, organized by PhD students

18 July 2022

Poster session and International lunch

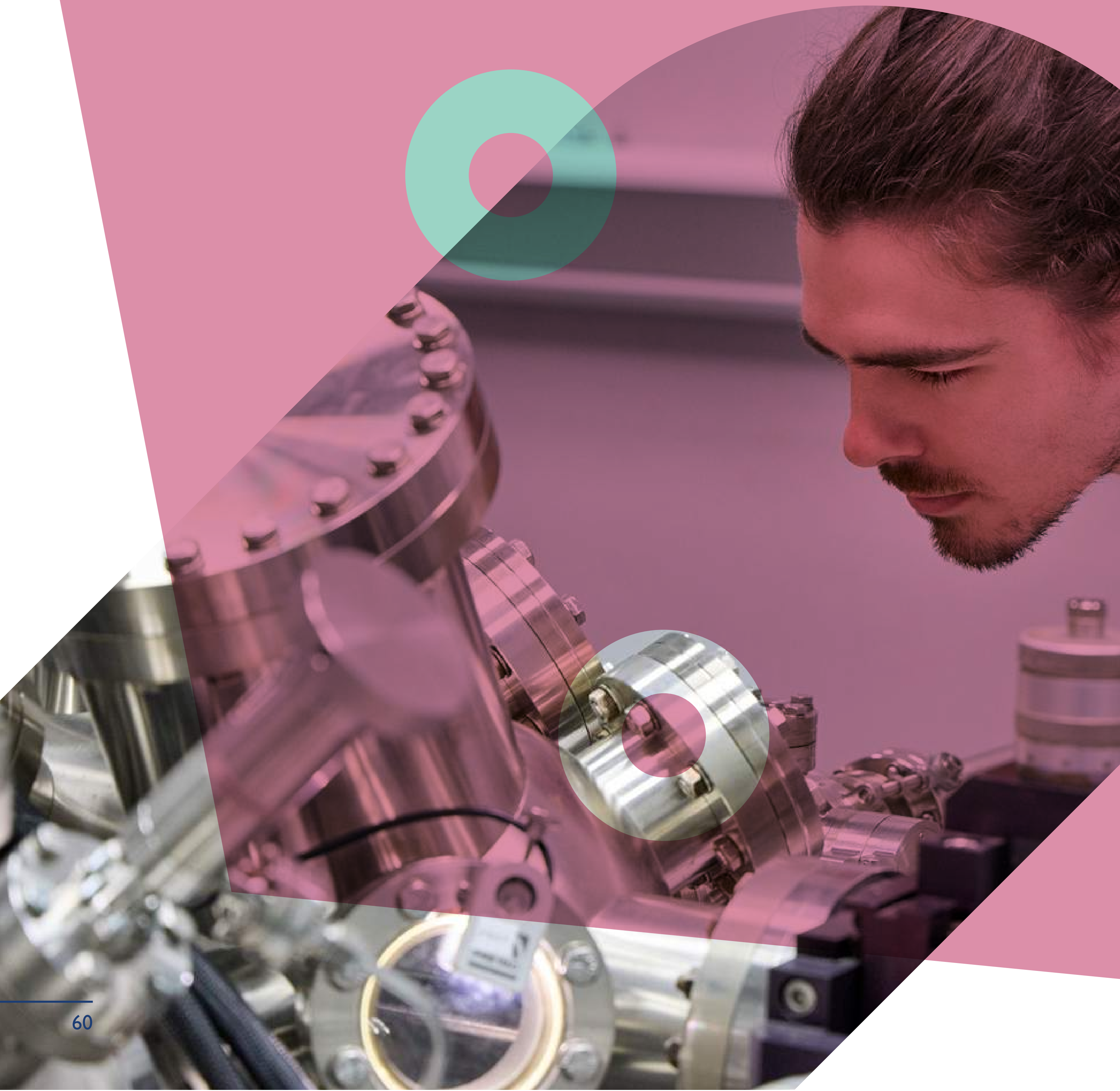
20 Dec. 2022

New Year celebration

ALUMNI

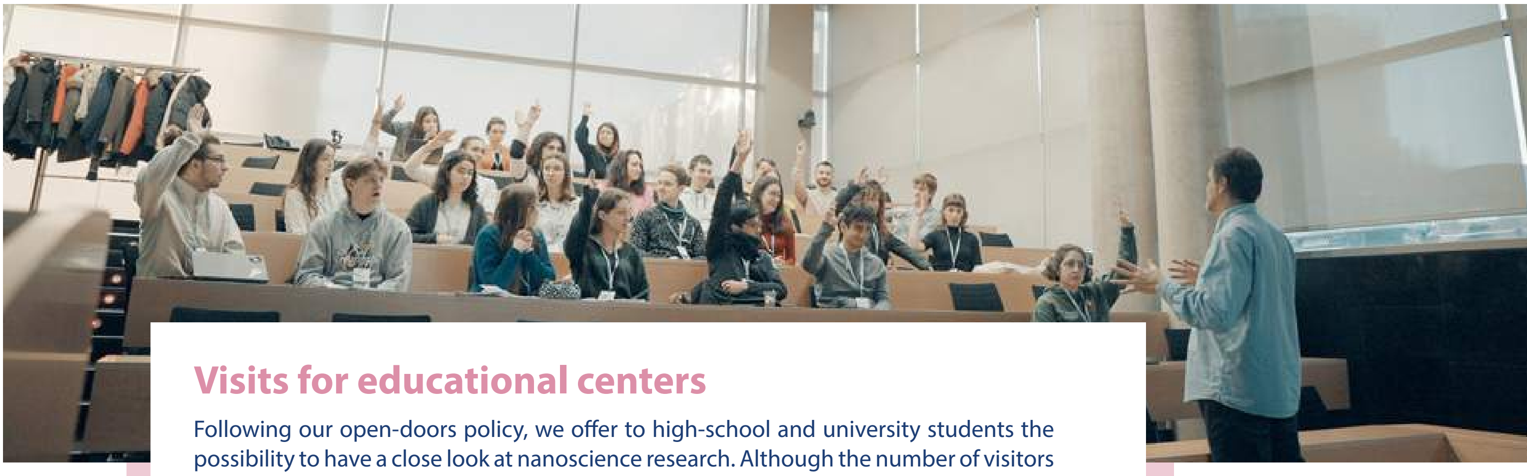
22 Nov 2022

We launched the **nanoGUNE Alumni Network**, an online worlwide dynamic community connecting current and former nanoGUNE employees.



6 A career in Science and Technology

First steps



Visits for educational centers

Following our open-doors policy, we offer to high-school and university students the possibility to have a close look at nanoscience research. Although the number of visitors was reduced due to the pandemic, still 60 students visited nanoGUNE in the period 2021-2022.

Summer Internships

Every year, we offer undergraduate students the opportunity to participate at our Summer Internship Program. Scholarships are offered to 3rd and 4th year undergraduates for a two-months project. In the period 2021-2022, 25 undergraduates joined the program.

Winter School

After a break in 2021, a group of 20 students joined the 2022 edition of our Winter School. The event is primarily aimed at undergraduate and master students. The school includes a combination of academic lectures, soft-skills training sessions, and hands-on lab practices.

Bachelor and master thesis

In the framework of collaboration agreements with various universities and official master programs, we offer the possibility to develop bachelor and/or master theses in our center. In particular, we closely collaborate with the Master in Nanoscience and the Master in New Materials of the University of the Basque Country (UPV/EHU).

A call for master grants is launched every year. In the period 2021-2022, 10 bachelor and 11 master theses have been conducted at nanoGUNE.

PhD Theses

PhD-thesis projects are offered to physics, chemistry, biology, engineering, and materials-science graduates. We closely collaborate, in particular, with the PhD program "Physics of Nanostructures and Advanced Materials (PNAM)" offered by the UPV/EHU. At the end of 2022, we had 45 ongoing PhD theses at nanoGUNE and we were cosupervising the thesis of another 8 PhD students that were enrolled at other research centers or universities in the Basque Country.

AWARDED IN 2021-2022

Lars Mester
18 January 2021 - UPV/EHU

Substrate-enhanced and subsurface infrared near-field spectroscopy of organic layers

Supervisor: Rainer Hillenbrand

Mathias J. A. Charconnet
7 June 2021 - UPV/EHU

Self-assembly and optical properties of gold nanoparticle superlattices for surface-enhanced Raman spectroscopy

Supervisors: Andreas Seifert and Luis Liz-Marzan (biomaGUNE)

Francesco Calavalle
4 March 2022 - UPV/EHU

Probing and tuning the electronic properties of low-dimensional van der Waals materials

Supervisor: Luis Hueso

Franz P. Herling
4 March 2022 - UPV/EHU

Spin-orbit proximity in van der Waals heterostructures

Supervisors: Fèlix Casanova and Luis Hueso

Inge Groen
9 March 2022 - UPV/EHU

Optimization of spin-orbit magnetic-state readout in metallic nanodevices

Supervisors: Fèlix Casanova and Luis Hueso

Nerea Ontoso
14 March 2022 - UPV/EHU

Spin-to-charge conversion in low-symmetry $MoTe_2$ / graphene van der Waals heterostructures

Supervisors: Fèlix Casanova and Reyes Calvo (University of Alicante)

Maiara A. Iriarte
1 April 2022 - UPV/EHU

Surface models of influenza virus envelope: biophysical studies under various hydration scenarios

Supervisors: Alex Bittner and Silvina Cerveny (CFM)

Ion Olaetxea
7 June 2022 - UPV/EHU

Photonic technology for diagnosis of perinatal asphyxia

Supervisors: Andreas Seifert and Joseba Zubia (UPV/EHU)

Niklas Friedrich
14 October 2022 - UPV/EHU

Electronic transport through suspended graphene nanoribbons using a scanning tunneling microscope

Supervisor: Jose Ignacio Pascual

Karina Ashurbekova
15 December 2022 - UPV/EHU

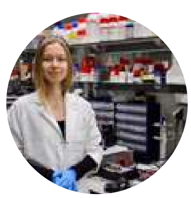
Surface engineering of biomimetic antibacterial and biocompatible hybrid materials through molecular layer deposition

Supervisors: Fèlix Casanova and Luis Hueso

Andoni Rodriguez
16 December 2022 - UPV/EHU

Dressing enzymes with tailored nanogels as a versatile approach for the development of heterogeneous biocatalysts

Supervisors: Mato Knez and Ana Beloqui (Polymat)



Oksana Yurkevich
19 December 2022 - UPV/EHU

Electronic and self-healing properties of polymer-inorganic hybrids enabled by vapor phase infiltration

Supervisor: Mato Knez

Building a career path

We are committed to providing high-level training and contributing to a successful professional development of our team, both in the academia and industry.

Business-culture training program

This training program aims at strengthening the business culture of our young researchers, thus making it easier for them to become part of the industrial world in case they might be interested to choose this career path. The program includes training on Oral communication, Entrepreneurship, and Taking the step from academia to industry.

Science-related soft skills

In 2022, we offered all the staff the possibility to access the Nature Masterclasses online platform including trainings to improve science-related soft skills.

General soft skills

In 2022, we also offered skills-development sessions in order to improve our daily work, such as Teamwork and collaboration and Stress prevention and management at the workplace.

Basque and Spanish courses

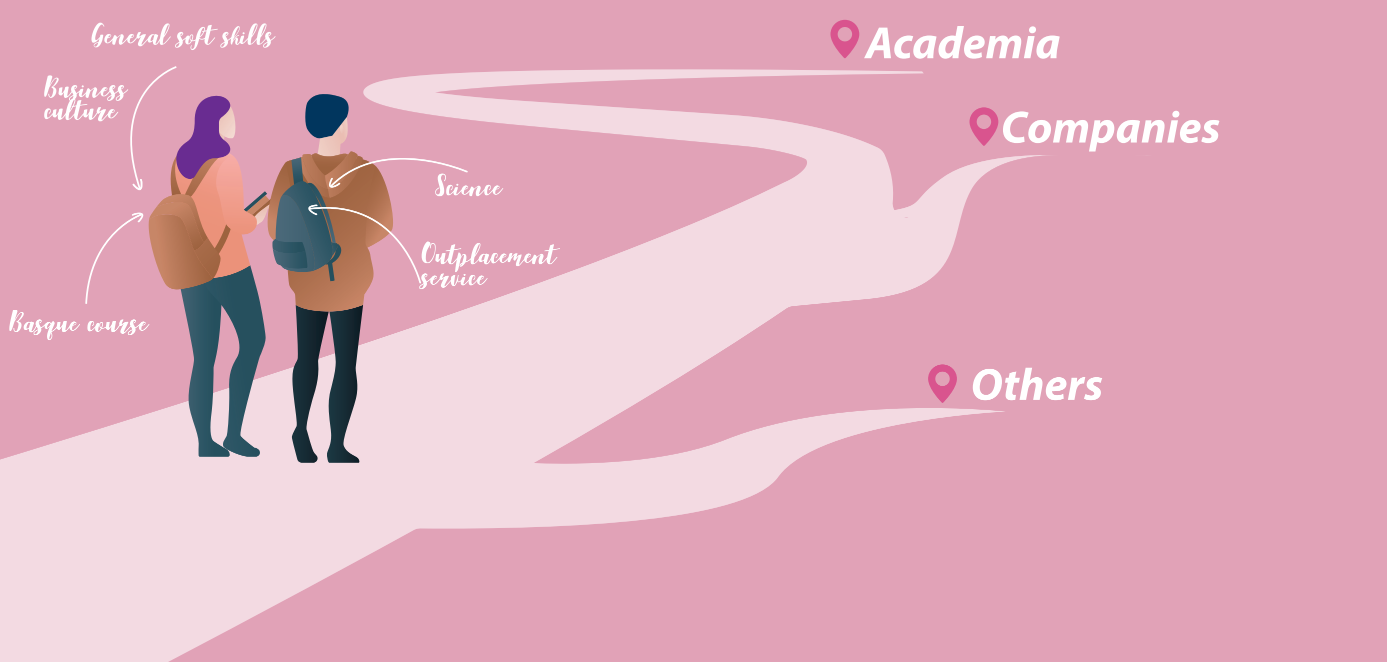
Language courses in-place are offered to all the staff.

Women-in-Science mentoring program

In 2022, we launched a Women-in-Science mentoring program, with the aim of supporting young female researchers in their reflection about their career goals and the possible ways of achieving them, both in academia and industry.

Outplacement service

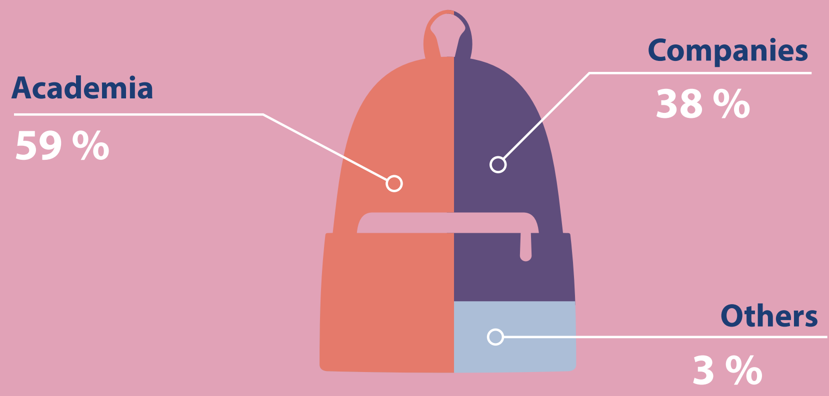
An outplacement service is offered to all staff members that would like to pursue their professional career in local industry.



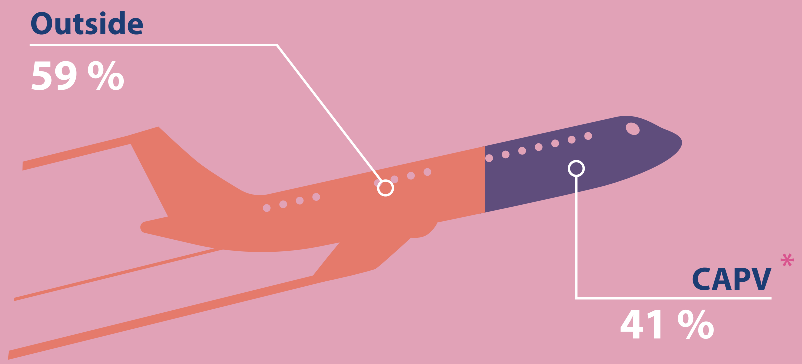
NanoGUNE is a research center where most employees (mainly PhD students and post-docs) are expected to follow their professional career somewhere else after a period of 3-5 years. Therefore, we monitor their professional development beyond nanoGUNE.

The territorial mobility is significant, as expected, and the net flux is positive, which means that the number of researchers coming to the Basque Country is higher than the number of researchers leaving to another place elsewhere in the world. On the other hand, it is interesting to point out that the transfer of highly-qualified personnel to companies, in general, and local companies, in particular, is increasing.

Career path



Movility



These percentages refer to the sum of pre-docs, post-docs, and fellows.

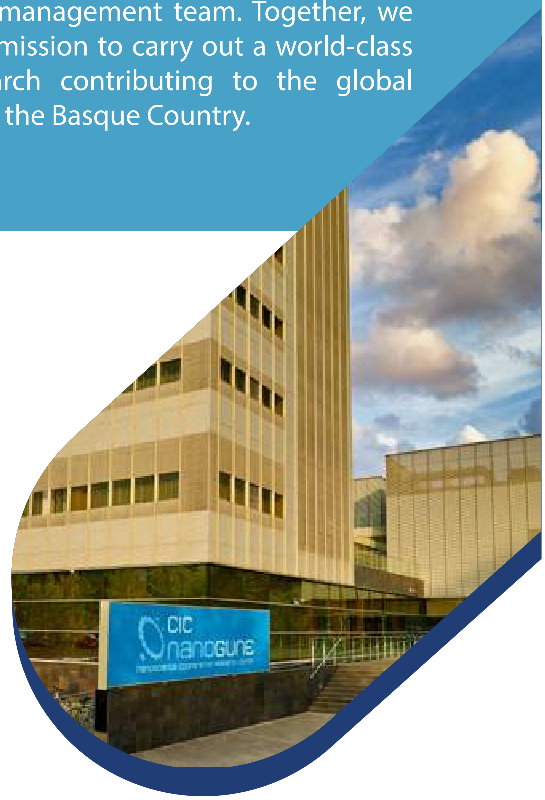
* *CAPV: Autonomous Community of the Basque Country.*

7 Organization and Funding

Organization

Over the years, nanoGUNE has grown considerably, in terms of personnel and research projects, as well as in terms of laboratories and scientific equipment.

In the period 2021-2022, our activity has been developed around 10 research groups supported by the technical and management team. Together, we push nanoGUNE's mission to carry out a world-class nanoscience research contributing to the global competitiveness of the Basque Country.



Governance

NanoGUNE is a non-profit association launched by the Basque Government in 2006 and officially inaugurated in 2009.

A Governing Board, currently composed by all partners, is the final responsible for the overall management of the center. An International Advisory Committee, composed of renowned scientists and professionals, periodically evaluates our general performance and advises us on the orientation that should be given to the center.

Miren Alberdi,
new Finance Director

In October 2021, Miguel Odriozola left his position as nanoGUNE's Finance Director, after 14 years working with us. Since then, Miren Alberdi has held this position, as responsible for the financial and human-resources management of the center.

EUSKO JAURLARITZA
GOBIERNO VASCO

Donostia International Physics Center

Universidad del País Vasco / Euskal Herriko Unibertsitatea

Gipuzkoako Foru Aldundia / Diputación Foral de Gipuzkoa

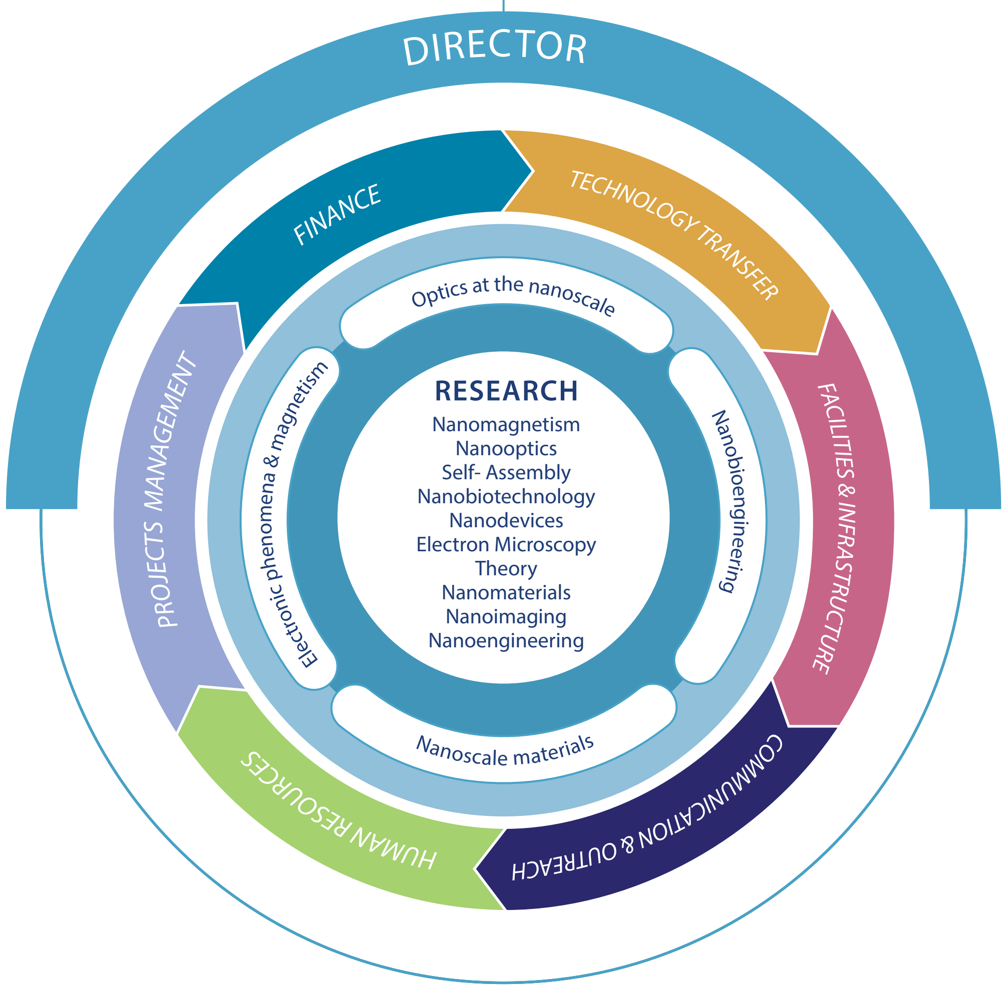
ETORKIZUNA ORAIN Es futuro

CAF

Petronor

iKOR SPAIN MEXICO CHINA

Board of Partners



International Advisory Committee

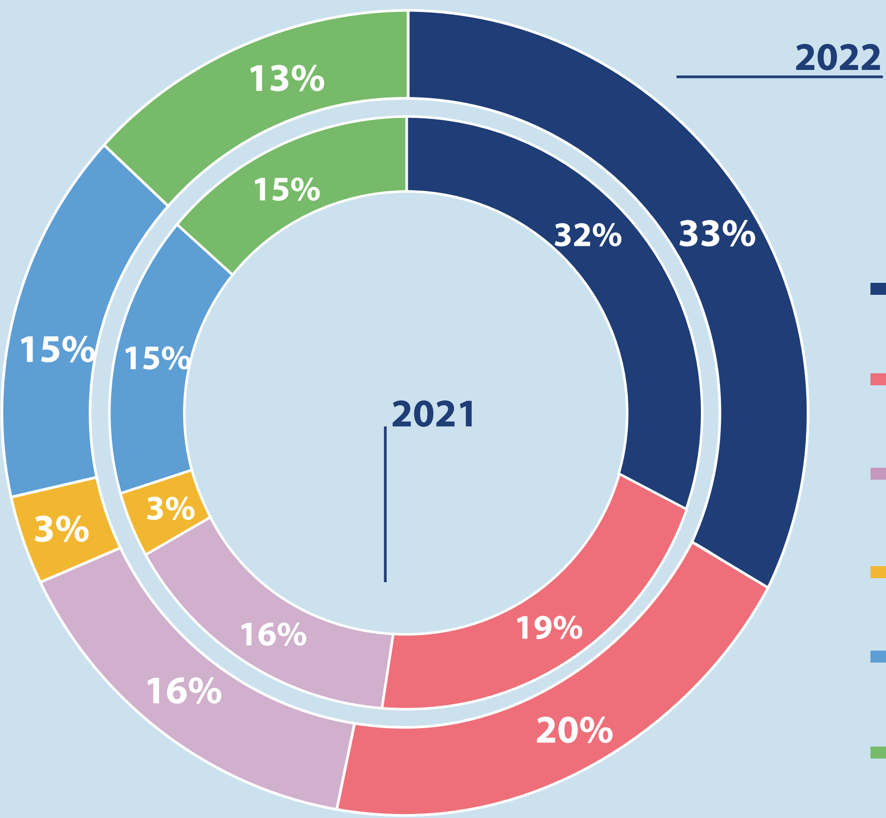
Prof. Sir John Pendry, Chair, Imperial College, London (UK)
Prof. Anne Dell, Imperial College, London (UK)
Dr. José Maiz, Intel Fellow, Oregon (USA)
Prof. Emilio Méndez, Brookhaven National Laboratory, New York (USA)
Prof. Sir John Pethica, CRANN, Dublin (Ireland)
Prof. Marileen Dogterom (until 31/01/2022), Delft University of Technology, Delft (Netherlands)
Prof. Jean Marie Lehn, Chemistry Nobel Prize 1987, Strasbourg University, Strasbourg (France)

Funding

In the period 2021-2022, we have been able to attract a considerably large amount of funding from the Regional Government of Gipuzkoa, the Basque Government, the Spanish Government, the European Commission, and private sources. We have also benefited from the support we have received from the Basque Science Foundation (Ikerbasque) through its program to attract top-class researchers from all over the world. The overall funding (both public and private) that we have received has allowed us to comply with our mission to carry out world-class nanoscience research for the competitive growth of the Basque Country.

Income
(in thousand EUR)

2021	2022
8 162	7 921



- *Non-competitive public funding from the Basque Goverment*
- *Competitive public funding from the Basque Government*
- *Competitive public funding from the Spanish Government*
- *Competitive public funding from the Regional Government of Gipuzkoa*
- *Competitive public funding from the European Commission*
- *Private funding*

Alliances

Partnerships are extremely important to us, as they contribute to better channel our efforts towards a greater impact of our activity onto society.

BRTA
BASQUE RESEARCH & TECHNOLOGY ALLIANCE

NanoGUNE is a founding member of the Basque Research and Technology Alliance (BRTA), composed of 13 technology centers and 4 cooperative research centers. BRTA aims at responding to the socio-economic challenges of the Basque Country, through research and technology, with international scope and visibility.

SOMM EXCELLENCE ALLIANCE

NanoGUNE is a member of SOMMa, the alliance of Severo Ochoa Centers and Maria de Maeztu Units built to promote Spanish excellence in research and to enhance its social impact at the highest international level.

Organizational themes

Innovation Management System

NanoGUNE's management is organized around an Innovation Management System (IMS), which is certified under the standard UNE 166002:2014. This standard aims to guide organizations in the development, implementation, and maintenance of a framework for systematic innovation management practices, integrating them with a R&D and innovation management system. The person responsible for the Innovation Management System is the Finance Director.

People

NanoGUNE was granted by the European Commission the "HR Excellence in Research" award, which gives public recognition to research institutions that have made progress in aligning their human-resources policies with the principles of the so-called European Charter&Code for Researchers. Specific forums that have been established to facilitate the participation of our employees in the organization of the center are the following: a PhD Committee and a Gender Equality Committee (GEC).

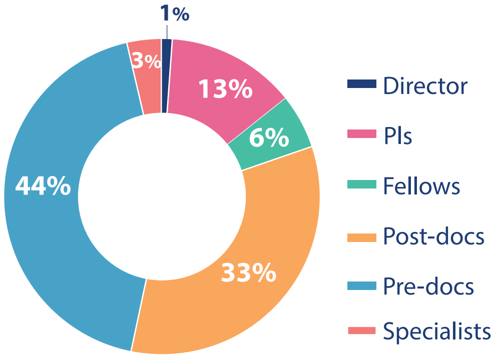
Gender Equality Plan

A Gender Equality Plan was approved in 2019. The plan was structured around five main key areas and ten strategic objectives, and it included an action plan with a total of 39 actions to be developed in the period 2019-2022. More than 90% of the actions have been succesfully deployed, such as a sexual and gender-based anti-harassment protocol, a women-in-science mentoring program, and a number of awareness campaigns and training sessions. The implementation of the plan was led by the Outreach Manager and the Director, in close collaboration with the GEC.

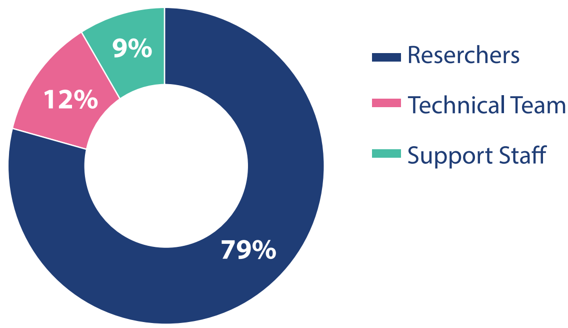
Our community in numbers

In December 2022, the nanoGUNE team was composed of 115 employees, with a Full-Time Equivalent (FTE) of 107. The FTE pie-charts below illustrate the composition of our personnel.

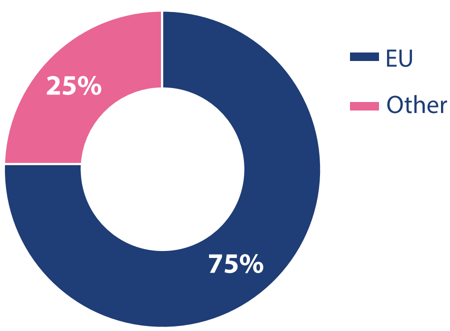
Researchers



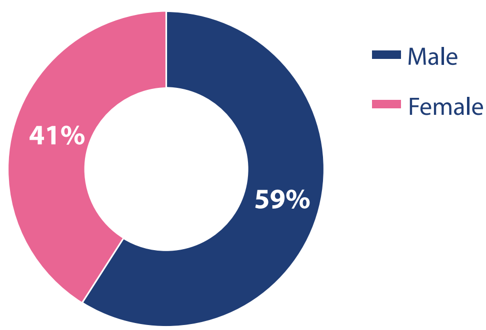
Staff categories



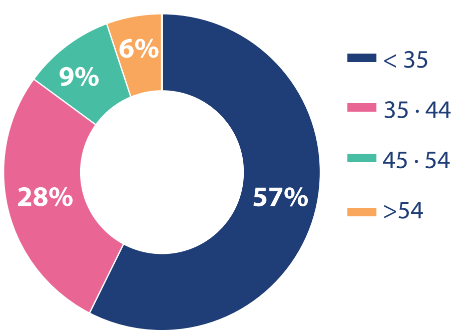
Origin



Gender



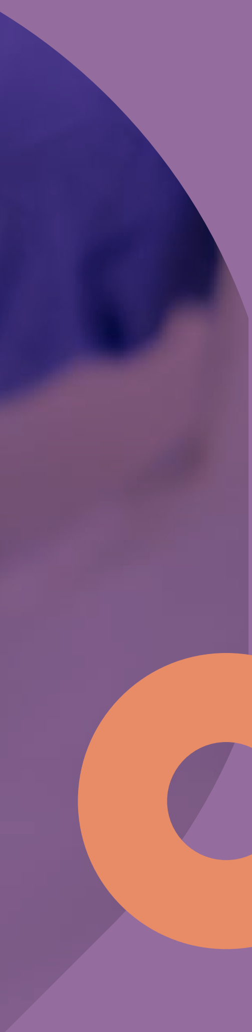
Age Structure



NanoPeople


CIC
nanoGUNE
MEMBER OF BASQUE RESEARCH & TECHNOLOGY ALLIANCE

8 Apendix



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43. A. Parappurath, S. Mitra, G. Singh, N. Gill, T. Ahmed, T. Sai, K. Watanabe, T. Taniguchi, and A. Ghosh
Physical Review Applied **17**, 064062 (2022)
Interlayer charge transfer and photodetection efficiency of graphene-transition-metal-dichalcogenide heterostructures

44. D. Spirito, Y. Asensio, L. Hueso, and B. Martin-Garcia
Journal of Physics: Materials **5**, 034004 (2022)
Raman spectroscopy in layered hybrid organic-inorganic metal halide perovskites

45. Z. Koczor-Benda, P. Roelli, C. Galland, and E. Rosta
Journal of Physical Chemistry A **126**, 28 (2022)
Molecular vibration explorer: an online database and toolbox for surface-enhanced frequency conversion and infrared and Raman spectroscopy

46. A. Rodriguez-Abetxuko, A. Reifs, D. Sanchez-deAlcazar, and A. Beloqui
Angewandte Chemie International Edition **61**, e202206926 (2022)
A versatile chemoenzymatic nanoreactor that mimics NAD(P)H oxidase for the in situ regeneration of cofactors

47. D. Munoz-Santiburcio
Journal of Chemical Physics **157**, 024504 (2022)
Accurate diffusion coefficients of the excess proton and hydroxide in water via extensive ab initio simulations with different schemes

48. B. Medina-Clavijo, J. Rafael-Velayarce, E. Modin, M. Saez-de-Buruaga, D. Soler, C. Motz, P. Arrazola, and A. Chuvilin
Scientific Reports **12**, 12591 (2022)
Mechanical properties of friction induced nanocrystalline pearlitic steel

49. G. Alvarez-Perez, J. Duan, J. Taboada-Gutierrez, Q. Ou, E. Nikulina, S. Liu, J. Edgar, Q. Bao, V. Giannini, R. Hillenbrand, J. Martin-Sanchez, A. Nikitin, and P. Alonso-Gonzalez
Science Advances **8**, eabp8486 (2022)
Negative reflection of nanoscale-confined polaritons in a low-loss natural medium

50. K. Vaxevani, J. Li, S. Trivini, J. Ortuzar, D. Longo, D. Wang, and J. I. Pascual
Nano Letters **22**, 6075 (2022)
Extending the spin excitation lifetime of a magnetic molecule on a proximitized superconductor

51. Q. Zhang, Q. Ou, G. Si, G. Hu, S. Dong, Y. Chen, J. Ni, C. Zhao, M. Fuhrer, Y. Yang, A. Alu, R. Hillenbrand, and C. Qiu
Science Advances **8**, eabn9774 (2022)
Unidirectionally excited phonon polaritons in high-symmetry orthorhombic crystals

52. Y. Polynskaya, I. Lebedeva, A. Knizhnik, and A. Popov
Computational and Theoretical Chemistry **1214**, 113755 (2022)
Optimal model of semi-infinite graphene for ab initio calculations of reactions at graphene edges by the example of zigzag edge reconstruction

53. A. Minkin, I. Lebedeva, A. Popov, and A. Knizhnik
Nanobiotechnology Reports **17**, 472 (2022)
Simulation of tribological properties of a graphene bilayer with twisted layers

54. T. Saleh, A. Al-Bogami, K. Narasimharao, Z. Khan, I. Amenabar, and M. Mokhtar
Catalysts **12**, 868 (2022)
Explorative sonophotocatalytic study of C-H arylation reaction of pyrazoles utilizing a novel sonophotoreactor for green and sustainable organic synthesis

55. P. Gypens, N. Leo, M. Menniti, P. Vavassori, and J. Leliaert
Physical Review Applied **18**, 024014 (2022)
Thermoplasmonic nanomagnetic logic gates

56. P. Aguado-Puente and P. Chudzinski
Physical Review B **106**, L081103 (2022)
Thermal topological phase transition in SnTe from ab initio calculations

57. W. Yan, A. Akimov, M. Barra-Burillo, M. Bayer, J. Bradford, V. Gusev, L. Hueso, A. Kent, S. Kukhtaruk, A. Nadzeyka, A. Patane, A. Rushforth, A. Scherbakov, D. Yaremkevich, and T. Linnik
Nano Letters **22**, 6509 (2022)
Coherent phononics of van der Waals layers on nanogratings

58. N. Koval, D. Sanchez-Portal, A. Borisov, and R. Diez-Muino
Physical Chemistry Chemical Physics **24**, 20239 (2022)
Time-dependent density functional theory calculations of electronic friction in non-homogeneous media

59. L. Barandiaran, B. Alonso-Lerma, A. Reifs, I. Larraza, R. Olmos-Juste, A. Fernandez-Calvo, Y. Jabalera, A. Eceiza, and R. Perez-Jimenez
Communications Materials **3**, 55 (2022)
Enzymatic upgrading of nanochitin using an ancient lytic polysaccharide monooxygenase

60. J. Goedecke, L. Schneider, Y. Ma, K. That, D. Wang, J. Wiebe, and R. Wiesendanger
ACS Nano **16**, 14066 (2022)
Correlation of magnetism and disordered Shiba bands in Fe monolayer islands on Nb(110)

61. N. Friedrich, R. Menchon, I. Pozo, J. Hieulle, A. Vegliante, J. Li, D. Sanchez-Portal, D. Pena, A. Garcia-Lekue, and J. I. Pascual
ACS Nano **16**, 9 (2022)
Addressing electron spins embedded in metallic graphene nanoribbons

62. M. Wagner, A. Seifert, and L. Liz-Marzan
Nanoscale Horizons **7**, 1259 (2022)
Towards multi-molecular surface-enhanced infrared absorption using metal plasmonics

63. S. Martin-Rio, C. Frontera, J. Gomez-Perez, M. Aguilar-Pujol, S. Catalano, J. Gazquez, F. Casanova, L. Balcells, A. Pomar, and B. Martinez
Advanced Materials Interfaces **9**, 2201171 (2022)
Interfacial magnetic features of La_2CoMnO_6/Pt bilayers studied by using spin Hall magnetoresistance

64. W. Choi, I. Arango, V. Pham, D. Vaz, H. Yang, I. Groen, C. Lin, E. Kabir, K. Oguz, P. Debashis, J. Plombon, H. Li, D. Nikonov, A. Chuvilin, L. Hueso, I. Young, and F. Casanova
Nano Letters **22**, 19 (2022)
All-electrical spin-to-charge conversion in sputtered Bi_xSe_{1-x}

65. U. Vernik, A. Lomonosov, V. Vlasov, L. Kotov, D. Kuzmin, I. Bychkov, P. Vavassori, and V. Temnov
Physical Review B **106**, 144420 (2022)
Resonant phonon-magnon interactions in freestanding metal-ferromagnet multilayer structures

66. J. Ingla-Aynes, I. Groen, F. Herling, N. Ontoso, C. Safeer, F. de Juan, L. Hueso, M. Gobbi, and F. Casanova
2D Materials **9**, 045001 (2022)
Omnidirectional spin-to-charge conversion in graphene/$NbSe_2$ van der Waals heterostructures

67. I. de Luzuriaga, A. Sanchez-Gonzalez, W. Synoradzki, X. Lopez, and A. Gil
Physical Chemistry Chemical Physics **24**, 25918 (2022)
Unravelling the binding affinity and selectivity of molybdenum(ii) phenanthroline complexes with DNA G-quadruplexes by using linear-scaling DFT studies. The important role of ancillary ligands

68. J. Melillo, E. Nikulina, M. Iriarte-Alonso, S. Cerveny, and A. Bittner
Scientific Reports **12**, 16512 (2022)
Electron microscopy and calorimetry of proteins in supercooled water

69. Y. Asensio, S. Marras, D. Spirito, M. Gobbi, M. Ipatov, F. Casanova, A. Mateo-Alonso, L. Hueso, and B. Martin-Garcia
Advanced Functional Materials **32**, 51 (2022)
Magnetic properties of layered hybrid organic-inorganic metal-halide perovskites: transition metal, organic cation and perovskite phase effects

70. G. Pippia, D. Van Hamme, B. Martin-Garcia, M. Prato, and I. Moreels
Nanoscale **14**, 15859 (2022)
A colloidal route to semiconducting tungsten disulfide nanosheets with monolayer thickness

71. S. Syubaev, I. Gordeev, E. Modin, V. Terentyev, D. Storozhenko, S. Starikov, and A. Kuchmizhak
Nanoscale **14**, 16618 (2022)
Security labeling and optical information encryption enabled by laser-printed silicon Mie resonators

72. J. Pereira, D. Tezze, I. Niehues, Y. Asensio, H. Yang, L. Mester, S. Chen, F. Casanova, A. Bittner, M. Ormaza, F. Schiller, B. Martin-Garcia, R. Hillenbrand, L. Hueso, and M. Gobbi
Advanced Functional Materials **32**, 52 (2022)
Percolating superconductivity in air-stable organic-ion intercalated MoS_2

73. S. Lee, D. de Sousa, Y. Kwon, F. de Juan, Z. Chi, F. Casanova, and T. Low
Physical Review B **106**, 165420 (2022)
Charge-to-spin conversion in twisted graphene/WSe_2 heterostructures

74. C. Valderrama, M. Quintana, A. Martinez-de-Guerenu, T. Yamauchi, Y. Hamada, Y. Kurokawa, H. Yuasa, and A. Berger
Journal of Physics D: Applied Physics **55**, 435007 (2022)
Sensitivity and reproducibility of transverse magneto-optical Kerr effect (T-MOKE) ellipsometry

75. Y. Polynskaya, I. Lebedeva, A. Knizhnik, and A. Popov
Journal of Physical Chemistry Letters **13** , 44 (2022)
Reconstruction of zigzag graphene edges: energetics, kinetics, and residual defects

76. S. Gurbatov, V. Puzikov, E. Modin, A. Shevlyagin, A. Gerasimenko, E. Mitsai, S. Kulinich, and A. Kuchmizhak
Materials **15**, 8091 (2022)
Ag-decorated Si microspheres produced by laser ablation in liquid: all-in-one temperature-feedback SERS-based platform for nanosensing

77. J. Halliday, M. Famili, N. Forcellini, and E. Artacho
Physical Review Research **4**, 043077 (2022)

Ab initio electronic stationary states for nuclear projectiles in solids

78. M. Quintana, A. Melendez, C. Valderrama, L. Fallarino, and A. Berger
Physical Review Applied **18**, 054024 (2022)
Temperature-independent coercivity in compositionally graded ferromagnetic multilayers

79. H. Yang, E. Schmoranzerova, P. Jang, J. Nath, T. Guillet, I. Joumard, S. Auffret, M. Jamet, P. Nemec, G. Gaudin, and I. Miron
Nature Communications **13**, 6790 (2022)
Helicity dependent photoresistance measurement vs beam-shift thermal gradient

80. I. Dolado, C. Maciel-Escudero, E. Nikulina, E. Modin, F. Calavalle, S. Chen, A. Bylinkin, F. Alfaro-Mozaz, J. Li, J. Edgar, F. Casanova, S. Velez, L. Hueso, R. Esteban, J. Aizpurua, and R. Hillenbrand
Nature Communications **13**, 6850 (2022)
Remote near-field spectroscopy of vibrational strong coupling between organic molecules and phononic nanoresonators

81. I. Olaetxea, H. Lafuente, E. Lopez, A. Izeta, I. Jaunarena, and A. Seifert
Advanced Science **10**, 2204834 (2022)
Photonic technology for in vivo monitoring of hypoxia-ischemia

82. A. Kimel, A. Zvezdin, S. Sharma, S. Shallcross, N. de Sousa, A. Garcia-Martin, G. Salvan, J. Hamrle, O. Stejskal, J. McCord, S. Tacchi, G. Carlotti, P. Gambardella, G. Salis, M. Munzenberg, M. Schultze, V. Temnov, I. Bychkov, L. Kotov, N. Maccaferri, D. Ignatyeva, V. Belotelov, C. Donnelly, A. Rodriguez, I. Matsuda, T. Ruchon, M. Fanciulli, M. Sacchi, C. Du, H. Wang, N. Armitage, M. Schubert, V. Darakchieva, B. Liu, Z. Huang, B. Ding, A. Berger, and P. Vavassori
Journal of Physics D: Applied Physics **55**, 463003 (2022)
The 2022 magneto-optics roadmap

83. S. Merkens, G. De Salvo, and A. Chuvilin
Nano Express **3**, 045006 (2022)
The effect of flow on radiolysis in liquid phase-TEM flow cells

84. A. Antanovich, L. Yang, S. Erwin, B. Martin-Garcia, R. Hubner, C. Steinbach, D. Schwarz, N. Gaponik, and V. Lesnyak
Chemistry of Materials **34**, 10361 (2022)
$CdSe_xS_{1-x}$ alloyed nanoplatelets with continuously tunable blue-green emission

85. S. Ferreira-Teixeira, A. Vanstone, A. Pires, W. Branford, J. Arafijo, L. Cohen, and A. Pereira
Acs Applied Electronic Materials **4**, 5789 (2022)
Electronic conduction channels engineered in topological insulator sputtered thin films

86. J. Kruse, M. Sanroman-Iglesias, A. Marauri, I. Rivilla, and M. Grzelczak
Chemsystemschem **5**, e202200031 (2022)
Coupling reversible clustering of DNA-coated gold nanoparticles with chemothermal cycloaddition reaction

87. Y. Bogawat, S. Krishnan, F. Simmel, and I. Santiago
Biophysical Journal **121**, 4810 (2022)
Tunable 2D diffusion of DNA nanostructures on lipid membranes

Invited Conference Talks

2021

Nanophotonics with phonon polaritons in 2D materials
11/03/2021, **Rainer Hillenbrand**
Electrons, Photons and Plasmons 2021, Virtual

Spin-orbit proximity effects in graphene-based heterostructures
15/03/2021, **Felix Casanova**
2021 APS March Meeting, Virtual

Materials for nanoscale spatial control of ferromagnetic phase transitions
18/03/2021, **Lorenzo Fallarino**
APS March Meeting 2021, Virtual

Nanophotonics with phonon polaritons in 2D materials
22/04/2021, **Rainer Hillenbrand**
CarbOnlineHagen 2021, Virtual

Hibridni materijali: buducnost tehnologije?
14/05/2021, **Mato Knez**
Science Festival Rijeka, Virtual

Substrate-enhanced and subsurface infrared near-field spectroscopy of organic layers
19/05/2021**, Rainer Hillenbrand**
The National Synchrotron Light Source II (NSLS-II) and Center for Functional Nanomaterials (CFN) Users' Meeting, Virtual

Magnetism and topology in atomically precise graphene nanoflakes
27/05/2021, **Jose Ignacio Pascual**
ESMOLNA 14th European School on Molecular Nanoscience, Benidorm (Spain)

Natural and bioinspired hybrid materials
08/06/2021**, Mato Knez**
HYCOAT workshop, Virtual

Spin-to-charge conversion in oxide-based heterostructures
07/07/2021, **Felix Casanova**
Oxides for spin-orbitronics and spin-caloritronics Workshop, Virtual

2D nanoconfined and irradiated water
13/07/2021, **Emilio Artacho**
Water: Grand Challenges for Molecular Science and Engineering, Virtual

Spin devices with 2D materials
30/07/2021, **Luis Hueso**
IEEE Nano Conference, Virtual

Electrical control of valley-Zeeman spin-orbit-coupling-induced spin precession
16/08/2021, **Josep Ingla-Aynés**
NanoPortugal Online Conference 2021, Virtual

Novel spin-orbit effects in graphene-based van der Waals heterstructure
24/08/2021, **Josep Ingla-Aynés**
Graphene and 2D Materials 2021, Paris (France)

Materials with exchange coupling profiles for nm-scale magnetization state control
06/09/2021, **Andreas Berger**
Solid State Devices and Materials 2021, Virtual

Strong coupling between phonon polaritons and molecular vibrations
13/09/2021, **Rainer Hillenbrand**
METANANO 2021, Virtual

Towards the synthesis of SPASER in the near infrared
15/09/2021, **Roman Parkhomenko**
NANOMEET2021, Porto (Portugal)

Plasmonic superlattices

20/09/2021, **Andreas Seifert**

E-MRS European Materials Research Society 2021 Fall Meeting, Virtual

Spin-to-charge current conversion for logic devices

28/09/2021, **Felix Casanova**

DPG Spring Meeting 2021, Virtual

Atomic layer processing of particles to enhance the energy density of Li–S batteries

29/09/2021, **Mato Knez**

Russian ALD conference, Virtual

Atomic layer processing: a toolbox for fabricating functional hybrid materials

05/10/2021, **Mato Knez**

27th Croatian Meeting of Chemists and Chemical Engineers, Veli Losinj (Croatia)

Yu-Shiba-Rusinov states in a multiband superconductor with spin-orbit coupling

12/10/2021, **Jose Ignacio Pascual**

Low-dimensional superconducting hybrids for novel quantum functionalities, Paris (France)

Emergence of pi-magnetism in graphene nanostructures

12/10/2021, **Jose Ignacio Pascual**

10th Vacuum and Surface Sciences Conference of Asia and Australia jointly with the Chinese Vacuum Conference 2021, Virtual

Atomic layer processing: a toolbox for fabricating novel functional hybrid materials

29/10/2021, **Mato Knez**

34th International Microprocesses and Nanotechnology Conference 2021, Virtual

Strong coupling between h-BN phonons, photons and molecular vibrations

10/11/2021, **Rainer Hillenbrand**

Nanophotonics of 2D materials 2021, Benasque (Spain)

Spin-orbit proximity in van der Waals heterostructures

23/11/2021, **Felix Casanova**

Imagine nano 2021, Bilbao (Spain)

Amplification of magneto-optical activity with dark plasmons

25/11/2021, **Paolo Vavassori**

Imagine nano 2021, Bilbao, (Spain)

Visualization and quantitative measurements of strain fields in semiconductor heterostructures during HREM studies

07/12/2021, **Andrey Chuvilin**

The 3rd School "Actual Problems of Semiconductor Nanosystems", Novosibirsk (Russia)

Nanophotonics with phonon polaritons in 2D materials

08/12/2021, **Rainer Hillenbrand**

MRS Fall Meeting 2021, Virtual

Advancing career perspectives in physical sciences

09/12/2021, **Mato Knez**

3rd MULTISECTORAL CONFERENCE Gender Equality Plans as Changemaker: Successful Practices for Sustainability, Virtual

Spinterface devices

16/12/2021, **Luis Hueso**

International Chemical Congress of Pacific Basin Societies, Virtual

2022

Chirality-dependent Edelstein effect in elemental Tellurium nanowires

12/01/2022, **Francesco Calavalle**

2022 Joint MMM-Intermag Conference (INTERMAG), Virtual

Strong light-matter coupling exploiting optical phonons

07/03/2022, **Rainer Hillenbrand**

Nanolight 2022, Benasque, Spain

Electronic response to high-velocity nuclei through matter from first principles

15/03/2022, **Emilio Artacho**

APS March Meeting 2022, Virtual

Detection of pi-magnetism in engineered graphene nanostructures

23/03/2022, **Jose Ignacio Pascual**

Escuela Nacional de Materiales Moleculares, XVIII-ENMM, Santiago de Compostela (Spain)

Spin effects at molecular interfaces

20/03/2022, **Luis Hueso**

XVIII Escuela Nacional de Materiales Moleculares, Santiago de Compostela (Spain)

Near-field probing of vibrational strong coupling

28/03/2022, **Rainer Hillenbrand**

NanoMeta 2022, Seefeld (Austria)

Interfacial effects in 2D materials

05/04/2022, **Luis Hueso**

ECMOLS European Conference on Molecular Spintronics - ECMolS 2022, Dortmund (Germany)

π-magnetism in engineered graphene nanostructures

20/05/2022, **Jose Ignacio Pascual**

NanoSpain 2022, Madrid (Spain)

Interfacial exchange field in heavy metal/magnetic insulators

26/05/2022, **Felix Casanova**

Spin Caloritronics XI 2022, Urbana-Champaign (USA)

Plasmonic superlattices

02/06/2022, **Andreas Seifert**

20th Anniversary of CINSaT – Center for Interdisciplinary Nanostructure Science and Technology, Kassel (Germany)

Electronic heating due to swift ions

09/06/2022, **Emilio Artacho**

Current Challenges in Materials for Thermal Energy Storage, CECAM-ES, Zaragoza (Spain)

π-magnetism in engineered graphene nanostructures

09/06/2022, **Jose Ignacio Pascual**

MolSurfCH workshop, Basel (Switzerland)

Room-temperature quantum correlations and coherent frequency conversion using molecular optomechanics

22/06/2022, **Philippe Roelli**

Mechanical Systems in the Quantum Regime - Gordon Research Conference, Ventura (USA)

π-magnetism in engineered graphene nanostructures

22/06/2022, **Jose Ignacio Pascual**

2DSPM 2022 - II Novel 2D materials explored via scanning probe microscopy & spectroscopy, Donostia - San Sebastian (Spain)

π-magnetism in engineered graphene nanostructures

23/06/2022, **Jose Ignacio Pascual**

European Workshop on Epitaxial Graphene, EWEG22, St. Moritz (Switzerland)

Wetting of virus surfaces

23/06/2022, **Alexander Bittner**

International Black Forest Symposium - "Viral Findings of Curious Scientific Friends" - based on the grounds of Holger Jeske, Freudenstadt (Germany)

Programmable self-assembled DNA hybrid nanostructures

23/06/2022, **Ibon Santiago Gonzalez**

International Black Forest Symposium - "Viral Findings of Curious Scientific Friends" - based on the grounds of Holger Jeske, Freudenstadt (Germany)

Real-space IR and THz nanoimaging of hybrid polaritons

07/07/2022, **Rainer Hillenbrand**

2DNANO - International Workshop - Structured materials and structured light, Erice (Italy)

Magnetoplasmonic nanocavities for the amplification of magneto-optical activity via hybridization with dark plasmons

21/07/2022, **Paolo Vavassori**

META 2022 - 12th International Conference on Metamaterials, Photonic Crystals and Plasmonics, Torremolinos (Spain)

Gate-tuneable and chirality-dependent charge-to-spin conversion in tellurium nanowires

22/07/2022, **Marco Gobbi**

META 2022 - 12th International Conference on Metamaterials, Photonic Crystals and Plasmonics, Torremolinos (Spain)

Spin-orbit proximity in van der Waals heterostructures for logic devices

26/07/2022**, Felix Casanova**

The Joint European Magnetic Symposia - JEMS 2022, Warsaw (Poland)

Spin-orbit proximity in van der Waals heterostructures

23/08/2022, **Felix Casanova**

SPIE Optics + Photonics 2022, San Diego (USA)

Spintronics with low symmetry materials

22/07/2022, **Luis Hueso**

CMD29 - General Conference of the Condensed Matter Division of the European Physical Society, Manchester (UK)

Interfacial water: structures and dynamics

23/08/2022, **Emilio Artacho**

Psi-k Conference 2022, Lausanne (Switzerland)

Molecular magnetism in triangulene nanostructures

05/09/2022, **Jose Ignacio Pascual**

Meeting of Collaborative project PROMETEO, Alicante (Spain)

Overriding universality of ferromagnetic phase transitions through nano-scale materials design

06/09/2022, **Andreas Berger**

Annual DPG Meeting of the Condensed Matter Section (SKM), Regensburg (Germany)

Ultrafast light sources

06/09/2022, **Paolo Vavassori**

TMAG2022 - Trends in Magnetism, Venice (Italy)

Hybrid metal-halide perovskites under micro-Raman and photoluminescence spectroscopy: from fundamentals to applications

06/09/2022, **Beatriz Martin Garcia**

Symposium on Advanced Technologies and Materials /ATAM 2022, Wroclaw (Poland)

Evolution of CRISPR-associated endonucleases as inferred from resurrected proteins

08/09/2022, **Ylenia María Jabalera Ruz**

44º Congreso SEBBM, Málaga (Spain)

2D-confined water. Phases and dielectric response
13/09/2022, **Emilio Artacho**
International EMLG/JMLG Meeting 2022, Barcelona (Spain)

Strong coupling between molecular vibrations and phonon polaritons in van der Waals materials
19/09/2022, **Rainer Hillenbrand**
CeNS/MCQST Workshop: Bridging the Gap: Nano Meets Quantum, Venice (Italy)

Nanoscale mapping of carrier density in intercalated 2D semiconductors by IR and THz nanoscopy
25/09/2022, **Iris Niehues**
2D Materials and Hybrids: Hybrid Quasiparticles in Quantum Materials, Bad Honnef (Germany)

Strong coupling between molecular vibrations and phonon polaritons in van der Waals materials
26/09/2022, **Rainer Hillenbrand**
2D Materials and Hybrids: Hybrid Quasiparticles in Quantum Materials, Bad Honnef (Germany)

Magnetism in engineered graphene nanostructures
29/09/2022, **José Ignacio Pascual**
On-Surface Synthesis International Workshop (OSS22), Sant Felui de Guixolls (Spain)

Doping engineering of single-walled carbon nanotubes by nitrogen compounds using basicity and alignment
06/10/2022, **Karolina Milowska**
3rd International Conference on Materials Science & Nanotechnology, Virtual

Atomic layer processing of particles to enhance the energy density of Li–S batteries
18/10/2022, **Mato Knez**
NETPORE Workshop 2022, Brno (Czech Republic)

La electrónica del futuro
24/10/2022, **Felix Casanova**
WeekINN 2022. Ciencia e Innovación: Hacia la ciudad del mañana, Donostia - San Sebastian (Spain)

Enabling 2D materials with electron-beam lithography
26/10/2022, **Luis Hueso**
8th Spanish Workshop in Nanolithography (NANOLITO), Valencia (Spain)

Gate-tuneable and chirality-dependent charge-to-spin conversion in Tellurium nanowires
01/11/2022, **Marco Gobbi**
67th Annual Conference on Magnetism and Magnetic Materials (MMM 2022), Minneapolis (USA)

Magnetism in engineered graphene nanostructures
02/11/2022, **José Ignacio Pascual**
WEH-Seminar "Molecular Functionality at Surfaces", Bad Honnef (Germany)

Chirality-dependent Edelstein effect in elemental Te nanowires
07/11/2022, **Luis Hueso Arroyo**
SPIN Argentina 2022, Bariloche (Argentina)

Plasmon-assisted nanomagnetic logics
11/11/2022, **Paolo Vavassori**
SPIN Argentina 2022, Bariloche (Argentina)

Design of novel functional hybrid materials by vapor phase processing
17/11/2022, **Mato Knez**
RAFALD – Réseau des Acteurs Français de l'ALD, Caen (France)

Active matter: artificial cells, nanomotors and molecular robotics
17/11/2022, **Ibon Santiago**
International Meeting of Science and Technology, Tayacaja (Peru)

Seminars

2021

ONLINE SEMINAR - Tuning critical exponents via nano-scale materials design
08/02/2021, **Lorenzo Fallarino**
nanoGUNE

ONLINE SEMINAR - Ancient CRISPR systems: evolution towards genome editing
01/03/2021, **Borja Alonso**
nanoGUNE

ONLINE SEMINAR - Análisis químico a nano-escala basada en espectroscopía IR: desde polímeros a muestras biológicas
01/03/2021, **Iban Amenabar**
nanoGUNE

ONLINE SEMINAR - Caracterización avanzada de materiales mediante microscopía electrónica
09/03/2021, **Bentejui Medina**
nanoGUNE

ONLINE SEMINAR - A water window on membrane biochemistry & physics: from water to neurons
12/04/2021, **Sylvie Roke**
École Polytechnique Fédérale de Lausanne – EPFL (Switzerland)

ONLINE SEMINAR - Rational design of self-assembling amyloid building blocks as scaffolds for novel biomaterials
17/05/2021, **Anna Mitraki**
University of Crete (Greece)

ONLINE SEMINAR - Fabricación aditiva, desde polímeros para fibras y tejidos hasta servicios de caracterización
19/05/2021, **Javier Latasa**
nanoGUNE

ONLINE MID-PHD SEMINAR - Non-equilibrium phase transitions in ferromagnetic thin films
06/09/2021, **Mikel Quintana**
nanoGUNE

ONLINE MID-PHD SEMINAR - Nanomagnetic logic via photothermal excitation of nanomagnetic networks
06/09/2021, **Matteo Menniti**
nanoGUNE

ONLINE SEMINAR - Roundtable Discussion on gender-balanced career opportunities and professional development within a scientific and technological environment
20/09/2021, **Ana Beloqui, Dorota A. Pawlak, Raquel Coronado-Robles, Dr. Pawlak**
Polymat, Institute of Electronic Materials Technology, Vall d'Hebron University Hospital

ONLINE MID-PHD SEMINAR - Study of spin to charge conversion in high resistive Bi_xSe_{1-x}
04/10/2021, **Isabel Arango**
nanoGUNE

ONLINE MID-PHD SEMINAR - Superconductivity in organic intercalated MoS?
04/10/2021, **José Manuel Pereira**
nanoGUNE

2022

ONLINE SEMINAR - Skyrmion Hall effect in spin-orbit torque driven topologically trivial and nontrivial structures
07/02/2022, **Jonathan Leliaert**
Ghent University (Belgium)

ONLINE SEMINAR - Observation of phonon polaritons in multilayer hexagonal boron nitride films grown by chemical vapor deposition
21/02/2022, **Eugenio Calandrini**
nanoGUNE

ONLINE SEMINAR - Programmable DNA self-assembled nanostructures
21/03/2022, **Ibon Santiago**
nanoGUNE

New (cryo-)FIB monster at nanoGUNE - new opportunities and research prospectives
25/04/2022, **Evgenii Modin, Nicola Abrescia**
nanoGUNE, bioGUNE

Genealomics, single cell lineage tracing of blood cell production through next generation sequencing
02/05/2022, **Leila Perie**
Institut Curie (France)

Hierarchically structured materials for sustainability
04/05/2022, **Heiner Friedrich**
Eindhoven University of Technology (Neetherlands)

Sexual and gender-based anti-harassment protocol
09/05/2022, **Beatriz Arrizabalaga, Aitziber Eleta, and Itziar Otegui**
nanoGUNE

Computational studies of spintronics materials for energy-efficient electronic devices
10/05/2022, **Jagoda Sławinska**
Zernike Institute for Advanced Materials – RUG (Neetherlands)

Detection of Alzheimer's disease by machine learning-assisted vibrational spectroscopy in cerebrospinal fluid
23/05/2022, **Laura Arevalo**
nanoGUNE

Integrated photonic devices for sensing and telecom applications
06/06/2022, **Hugo Enrique Hernandez Figueroa**
State University of Campinas (Brazil)

(Si)GeSn Semiconductors for integrated optoelectronics and quantum electronics
08/06/2022, **Simone Assali**
Ecole Polytechnique de Montreal (Canada)

The true amphipathic nature of pristine graphene flakes
13/06/2022, **Karolina Zofia Milowska**
nanoGUNE

Nanoporous/nanocomposite thin films by magnetron sputtering deposition in Helium: New materials and applications
16/06/2022, **Asunción Fernández Camacho**
Instituto de Ciencia de Materiales de Sevilla – CSIC (Spain)

Could silicon enable a quantum computing revolution?
20/06/2022, **M. Fernando Gonzalez-Zalba**
Quantum Motion Technologies (England)

Spin chiralility effect in Telurrium nanowires
04/07/2022, **Luis Hueso**
nanoGUNE

The scanning probe tool box for imaging, measuring and manipulating single molecules
11/07/2022, **Fabian Schulz**
nanoGUNE

Quantum network with single-atoms and cavities: a tool for distributed quantum computing
28/07/2022, **Emanuele Distante**
Max Planck Institute of Quantum Optics, (Germany)

Affinity-targeted nanomedicines for the treatment and diagnosis of cancer and endometriosis
18/08/2022, **Lorena Simon-Gracia**
University of Tartu (Estonia)

ONLINE MID-PHD SEMINAR - Modelling radiolisys in liquid phase electron microscopy (LP-EM): from fundamentals to applicative simulations
12/09/2022, **Giuseppe De Salvo**
nanoGUNE

ONLINE MID-PHD SEMINAR - Tuning the magnetic properties of 2D layered MPS3 compounds through molecular intercalation
12/09/2022, **Daniel Tezze**
nanoGUNE

ONLINE MID-PHD SEMINAR - Detection of magnon currents in EuS
19/09/2022, **Montserrat Xochitl Aguilar**
nanoGUNE

ONLINE MID-PHD SEMINAR - Engineering π-magnetism in carbon-based nanostructures
19/09/2022, **Alessio Vegliante**
nanoGUNE

Vapor phase infiltration (VPI) for multifunctional and antimicrobial textile
26/09/2022, **Natalia Chamorro**
nanoGUNE

Evolution of CRISPR-associated Endonucleases as inferred from resurrected proteins
03/10/2022, **Ylenia Jabalera**
nanoGUNE

Cross-sectional chemical nanoimaging of composite polymer nanoparticles by infrared nanospectroscopy
10/10/2022, **Monika Goikoetxea**
nanoGUNE

Outreach and communication at nanoGUNE
11/10/2022, **Itziar Otegui**
nanoGUNE

Towards magnetoelectric spin-orbit logic devices
17/10/2022, **Diogo C. Vaz**
nanoGUNE

Investigating the ubiquitous presence of nanometric water films on surfaces at the nanoscale
24/10/2022, **Alberto Verdaguer Prats**
nanoGUNE

Simultaneous and quantitative measurements of both in-plane magnetization components in Magneto-Optic Kerr magnetometry
31/10/2022, **Claudio Julio Bonin**
nanoGUNE

Topological phase transitions from ab initio simulations
07/04/2022, **Pablo Aguado**
nanoGUNE

Engineering biomimetic selectively antibacterial and biocompatible metallochitin films
14/11/2022, **Karina Ashurbekova**
nanoGUNE

Observation of non-conventional phenomena on Pb nanocrystals on graphene
30/11/2022, **Stefano Trivini**
nanoGUNE

Research Grants Ongoing 2021 - 2022

European Commission

Project	Period	Call
PETER *Plasmon enhanced terahertz electron paramagnetic resonance* Id. 767227	2018 - 2021	H2020-FETOPEN-2016-2017-RIA
SPRING *Spin research in graphene* Id. 863098	2019 - 2024	H2020-FETOPEN-2018-2020-RIA
BioUPGRADE *Biocatalytic upgrading of natural biopolymers for reassembly as multipurpose materials* Id. 964764	2021 - 2025	H2020-FETOPEN-2018-2020-RIA
INTERFAST *Gated INTERfaces for FAST information processing* Id. 965046	2021 - 2024	H2020-FETOPEN-2018-2020-RIA
SINFONIA *Selectively activated information technology by hybrid organic interfaces* Id. 964396	2021 - 2025	H2020-FETOPEN-2018-2020-RIA
FANTASTICOF *Fabricating and implementing exotic moiré materials from covalent organic frameworks* Id. 101046231	2022 - 2025	HORIZON-EIC-2021-PATHFINDEROPEN
Graphene Core3 *Graphene Flagship core project 3* Id. 881603	2020 - 2023	H2020-SGA-FET-GRAPHENE-2019
ESC2RAD *Enabling smart computations to study space radiation effects* Id. 776410	2018 - 2021	H2020-COMPET-2017

Project	Period	Call
R-I PEERS *Pilot experiences for improving gender equality in research organisations* Id. 788171	2018 - 2022	H2020-SwafS-2017-1
ENSEMBLE3 *Centre of excellence for nanophotonics, advanced materials and novel crystal growth-based technologies* Id. 857543	2019 - 2026	H2020-WIDESPREAD-2018-2020
HYCOAT *A european training network for functional hybrid coatings by molecular layer deposition* Id. 765378	2018 - 2022	H2020-MSCA-ITN-2017
QuESTech *Quantum electronics science and technology training* Id. 766025	2018 - 2021	H2020-MSCA-ITN-2017
SPEAR *Spin-orbit materials, emergent phenomena and related technology training* Id. 955671	2021 - 2025	H2020-MSCA-ITN-2020
DYNAMO *Dynamic control in hybrid plasmonic nanopores: road to next generation multiplexed single molecule detection* Id. 101072818	2022 - 2026	HORIZON-MSCA-2021-DN-01-01
NanoRemedi *Functional nano-scaffolds for regenerative medicine* Id. 101072645	2022 - 2026	HORIZON-MSCA-2021-DN-01-01

Project	Period	Call
2DSTOP *Spin transport and spin-orbit phenomena in 2D materials* Id. 794982	2019 - 2021	H2020-MSCA-IF-2017
ARTEMIS *Graphene molecule interfaces for spintronics* Id. 796817	2019 - 2021	H2020-MSCA-IF-2017
LICONAMCO *Light-controlled nanomagnetic computation schemes* Id. 844304	2019 - 2021	H2020-MSCA-IF-2018
SPIR *Spasers in the infrared range* Id. 838845	2020 - 2022	H2020-MSCA-IF-2018
SPECTER *Spin-charge conversion in highly resistive spin-orbit materials* Id. 892983	2020 - 2022	H2020-MSCA-IF-2019
HYTEM *Organic-inorganic hybrid thermoelectric materials through a new concept of simultaneous vapor phase coating and infiltration (VPI/SCIP)* Id. 101032113	2021 - 2023	H2020-MSCA-IF-2020
MANACOLIPO *Magnetoplasmonic nanocavities for active control of light polarization* Id. 101029928	2022 - 2024	H2020-MSCA-IF-2020
QMOLESR *Addressing molecular spin qubits by ESR-STM* Id. 101064332	2022 - 2024	HORIZON-MSCA-PF 2021

Project	Period	Call
ULTIMATE-I *Ultra thin magneto thermal sensoring* Id. 101007825	2021 - 2025	H2020-MSCA-RISE-2020
ALD4MAX *Atomic layer deposition for tailored bottom-top growth of MAX and MXene films*	2017 - 2021	M-ERA.NET Call 2016
MULTISPIN *Molecular engineering of layered magnetic materials: towards multifunctional spintronic devices*	2021 - 2024	FLAG ERA 3 Call 2021
THERMOS *Tellurium-free thermoelectric modules by interface engineering*	2022 - 2025	M-ERA.NET Call 2021

Spanish Goverment

Project	Period	Call
nanoGUNE Unidad María de Maeztu Id. MDM-2016-0618	2017 - 2021	Excellence Research Centers 2016
nanoGUNE Unidad María de Maeztu Id. CEX2020-001038-M	2022 - 2025	Excellence Research Centers 2020
CryoFIB *Advanced ion beam device with cryogenic functionality* Id. EQC2021-007107-P	2021 - 2023	Acquisition of scientific-technical equipment 2021
ALD4MAX *Atomic layer deposition for tailored bottom-top growth of MAX and MXene films* Id. PCIN-2017-134	2017 - 2021	International joint programs 2017
MULTISPIN *Molecular engineering of layered magnetic materials: towards multifunctional spintronic devices* Id. PCI2021-122038-2A	2021 - 2024	International collaborative projects 2021
Thermos *Tellurium-free thermoelectric modules by interface engineering* Id. PCI2022-132940	2022 - 2025	International collaborative projects 2022
SURFNANOCUT *Knowledge based cutting for surface engineering of aeronautic and automotive materials: understanding the fundamentals of cutting process through micro-nano structure analysis* Id. RTI2018-095463-B-C22	2019 - 2021	Research projects 2018
NOVASPEC *Novel instrumentation and applications of IR and THz nano-spectroscopy* Id. RTI2018-094830-B-I00	2019 - 2021	Research projects 2018

Project	Period	Call
PHOTOTHERMAG *Nanomagnet logic via photothermal excitation of nanomagnetic networks* Id. RTI2018-094881-B-100	2019 - 2022	Research projects 2018
SCARFACE Spin control and related effects at interFACES and heterostructures Id. RTI2018-094861-B-100	2019 - 2022	Research projects 2018
Molding2D *Molecular engineering of superconducting and ferromagnetic 2D materials: towards on-demand physical properties* Id. PID2019-108153GA-I00	2020 - 2022	Research projects 2019
BRIDGE *Bridging the gap between synthetic polymers and biopolymers physical and chemical properties* Id. PID2019-104650GB-C22	2020 - 2023	Research projects 2019
FunMolSyS *Magnetism and topological states of on-surface engineered molecular nanosystems* Id. PID2019-107338RB-C61	2020 - 2023	Research projects 2019
MicroMec *Nanomechanics of microbial infection: towards mechanopharmacology* Id. PID2019-109087RB-I00	2020 - 2023	Research projects 2019
SYNERFUN *Synergistic surface functionalization for advanced diagnostic, catalytic and packaging materials* Id. PID2019-111065RB-I00	2020 - 2023	Research projects 2019
SNOMCELL *Near-field microscopy for label-free ultrastructural pathology* Id. PID2020-115221GA-C44	2021 - 2024	Research projects 2020

Project	Period	Call
NANOSPEC *Advanced near-field optical nanospectroscopy and novel applications in material sciences and nanophotonics* Id. PID2021-123949OB-I00	2022 - 2024	Research projects 2021
HiMat *Hybrid layered materials for nanodevices* Id. PID2021-128004NB-C21	2022 - 2025	Research projects 2021
LSD *Low-dimensional spin devices* Id. PID2021-122511OB-I00	2022 - 2025	Research projects 2021
OPTOMETAMAG *Optical-control of thermally driven magnetic phase transitions in metamaterials* Id. PID2021-123943NB-I00	2022 - 2025	Research projects 2021
CARDIOPRINT *Advanced multifunction 3D biofabrication for the generation of computationally modelled human-scale therapeutic cardiac tissues* Id. PLEC2021-008127	2021 - 2024	Strategic research projects in public-private collaboration 2021
OSMolSis *Molecular science on surfaces: synthetic routes and functionality* Id. RED2018-102833-T	2020 - 2022	Research networks 2018
Wonyyoung Choi Id. FJC2018-038580-I	2020 - 2021	Juan de la Cierva 2018
Josep Ingla Id. FJC2018-038688-I	2020 - 2021	Juan de la Cierva 2018
Dongfei Wang Id. FJC2020-043831-I	2021 - 2023	Juan de la Cierva 2020
Yuan Peisen Id. FJC2020-044666-I	2021 - 2023	Juan de la Cierva 2020

Project	Period	Call
Junhyeon Jo Id. FJC2020-042842-I	2022 - 2024	Juan de la Cierva 2020
Zhendong Chi Id. FJC2021-047257-I	2022 - 2024	Juan de la Cierva 2021
Javier Alfaro *Low-dimensional nanophotonics with hyperbolic polaritons* *Id. BES-2016-076763*	2017 - 2021	FPI predoctoral grant 2016
Juan Manuel Gómez *Electrical excitation and transport of magnons in magnetic-insulator-based lateral nanostructures* *Id. BES-2016-077301*	2017 - 2021	FPI predoctoral grant 2016
Antonio Reifs *Nanomechanical control of viral infections: from bacteria to cells* *Id. BES-2017-081090*	2018 - 2022	FPI predoctoral grant 2017
Nerea Ontoso *Graphene nanostructures for spin-based devices with topological materials* *Id. BES-2017-079631*	2018 - 2022	FPI predoctoral grant 2017
Niklas Friedrich *Towards a graphene based single-molecule OLED* *Id. BES-2017-081162*	2018 - 2022	FPI predoctoral grant 2017
Ramon Weber *Magneto-optical response modification in metallic interfaces and their application in magneto-plasmonics.* *Id. BES-2017-081857*	2018 - 2022	FPI predoctoral grant 2017
Gabriele Botta *Functionalization of 2D materials by ALD* *Id. PRE2018-084190*	2019 - 2023	FPI predoctoral grant 2018

Project	Period	Call
Maria Barra *Extreme nanofabrication of spintronic and plasmonic devices* *Id. PRE2018-084207*	2019 - 2023	FPI predoctoral grant 2018
Stefano Trivini *Atomic scale superconductivity of novel materials* Id. PRE2018-083316	2019 - 2023	FPI predoctoral grant 2018
Andrei Bylinkin *Optical phenomena in novel van der Waals materials* Id. PRE2019-088168	2020 - 2024	FPI predoctoral grant 2019
Jose Pereira *Magnetism at 2D material/molecule interfaces* Id. PRE2019-090346	2020 - 2024	FPI predoctoral grant 2019
Matteo Menniti *Nanomagnetic logic by photothermal excitation of magnetic nanostructure networks* Id. PRE2019-088070	2020 - 2024	FPI predoctoral grant 2019
Mikel Quintana *Magnetic properties of non-planar magnetic films and multilayers* Id. PRE2019-088428	2020 - 2024	FPI predoctoral grant 2019
Montserrat Aguilar *Bringing functional molecular systems onto non-metallic surfaces* Id. PRE2019-089833	2020 - 2024	FPI predoctoral grant 2019
Daniel Tezze *Tuning the physical properties of layered compounds through molecular functionalization* Id. PRE2020-092992	2021 - 2025	FPI predoctoral grant 2020

Project	Period	Call
Leonard Edens *Study of exotic spin phenomena in graphene nanostructures using STM-ESR* Id. PRE2020-094813	2021 - 2025	FPI predoctoral grant 2020
Sara Samperio *Understanding and fighting microbial infections: ancestral sequence reconstruction and mechanobiology against the patogen staphylococcus aureus* Id. PRE2020-094264	2021 - 2025	FPI predoctoral grant 2020
Iker Herrero *Advanced near-field optical nanospectroscopy and novel applications in material sciences and nanophotonics (NANOSPEC)* Id. PRE2021-099011	2022 - 2026	FPI predoctoral grant 2021
Pablo Rodriguez *Magnetoplamonic metamaterials for active control of light polarization* Id. PPRE2021-099586	2022 - 2026	FPI predoctoral grant 2021
Yaiza Asensio *Characterization of 2D materials for spintronic and optoelectronic devices* Id. PRE2021-099999	2022 - 2026	FPI predoctoral grant 2021
Francisco Romero *Developping a spintronic device made of atomically-precise open-shell graphene nanostructures* Id. FPU20/03305	2021 - 2025	FPU predoctoral grant 2020

Basque Goverment

Project	Period	Call
CIC nanoGUNE 2021	2021 - 2021	EMAITEK 2021
CIC nanoGUNE 2022	2022 - 2022	EMAITEK 2022
FastAFM *Atomic force microscope* Id. PZ-2021/00017	2021 - 2022	AZPITEK 2021 Acquisition of scientific and technological infrastructure
PPMS *Equipment for measuring physical properties* Id. PZ-2021/00019	2021 - 2022	AZPITEK 2021 Acquisition of scientific and technological infrastructure
Mask Aligner *Mask aligner for photolithography* Id. PZ-2022/00016	2022 - 2023	AZPITEK 2022 Acquisition of scientific and technological infrastructure
Con-RAMAN *Confocal RAMAN microscope* Id. EC_2020_1_0024	2020 - 2021	EKIZIEN 2020 Acquisition of scientific equipment
ALD6I *ALD system with 6-inch chamber* Id. EC_2022_1_0022	2022 - 2023	EKIZIEN 2022 Acquisition of scientific equipment
nG20 *Strategic research in emerging technologies for the development of advanced surfaces* Id. KK-2020/00001	2020 - 2021	ELKARTEK 2020 Collaborative strategic research: Fundamental
NANOELAS *Research in nanotechnologies for the production of high-value-added elastomers* Id. KK-2020/00036	2020 - 2021	ELKARTEK 2020 Collaborative strategic research: Industrial
nG21 *Strategic research on the properties, applications and effects of polymeric nanomaterials* Id. KK-2021/00001	2021 - 2022	ELKARTEK 2021 Collaborative strategic research: Fundamental

Project	Period	Call
PLAS ALD *Research and development of a new ALD coating and its application technology for the automotive sector* Id. KK-2021/00071	2021 - 2022	ELKARTEK 2021 Collaborative strategic research: Industrial
nG22 *Developments at the nanoscale for manufacturing and healthcare* Id. KK-2022/00001	2022 - 2023	ELKARTEK 2022 Collaborative strategic research: Fundamental
BRTA_Q *BRTA Quantum: towards a harmonized specialization in quantum technologies in BRTA* Id. KK-2022/00041	2022 - 2023	ELKARTEK 2022 Collaborative strategic research: Fundamental
EPARAC *Polymeric food packaging with conductive antimicrobial coatings* Id. 003-B2/2020	2020 - 2024	BIKAINTEK 2020 Industrial pre-docs
PDPA *ALD perovskite thin films* Id. 035-B1/2021	2021 - 2023	BIKAINTEK 2021 Industrial post-docs
RAX *Ancestral reconstruction of beta-xylosidases for use in lignocellulosic enzyme cocktails* Id. 014-B2/2021	2021 - 2025	BIKAINTEK 2021 Industrial pre-docs
TA3 *Self-cleaning antimicrobial fabrics by ALD* Id. 013-B2/2021	2021 - 2025	BIKAINTEK 2021 Industrial pre-docs
FPTTM *Polymeric fibers and fabrics for multifunctional textiles* Id. 018-B1/2022	2022 - 2024	BIKAINTEK 2022 Industrial post-docs

Project	Period	Call
SIESTA CLOUD *Web platform for scientific software* Id. 021-B1/2022	2022 - 2024	BIKAINTEK 2022 Industrial post-docs
Ion Olaetxea *Non-invasive sensing of pH and lactate in newborns during delivery*	2018 - 2021	PFPI predoctoral grant 2017
Andoni Rodríguez *Dressing enzymes with tailored nanogels as a versatile approach for the development of heterogeneous biocatalysts*	2019 - 2022	PFPI predoctoral grant 2018
Stefan Merkens *In-situ studies of nanoparticles growth and self-assembly using liquid cell transmission electron microscopy*	2020 - 2023	PFPI predoctoral grant 2019
Carmen Martín *Ultrasensitive Magneto-Optical Ellipsometry for depth-resolved Magnetometry*	2022 - 2025	PFPI predoctoral grant 2021
Jon Ortuzar *Magnetic interactions in non-conventional superconductor systems*	2022 - 2025	PFPI predoctoral grant 2021

Regional Government of Gipuzkoa

Gipuzkoako Foru Aldundia
Diputación Foral de Gipuzkoa

Project	Period	Call
MODELFOTO2D *Modeling the photoluminescence of two-dimensional (2D) materials through physical and chemical methods*	2020 - 2022	Gipuzkoa Fellows 2019
TOPOS *IV-VI semiconductors for multifunctional electronic devices: coupling between topology, polarization and spin at ferroelectric domain interfaces and walls*	2020 - 2023	Gipuzkoa Fellows 2020
ROBOMOL *Soft molecular robotics with DNA nanotechnology*	2022 - 2023	Gipuzkoa Fellows 2021
PROTALD *Protein film fabrication and stabilization by ALD techniques* Id. 2019-CIEN-000061-01	2019 - 2021	Research projects 2019
nanoESR *Electron spin resonance in graphene nanostructures* Id. 2020-CIEN-000010-01	2020 - 2021	Research projects 2020
ORBILOGIC *Spin-orbit effects in two-dimensional materials for logic devices* Id. 2021-CIEN-000037-01	2021 - 2022	Research projects 2021
faraDNA *Atomically precise fabrication of self-assembled nanodevices using DNA* Id. 2022-CIEN-000015-01	2022 - 2023	Research projects 2022
QSENSE *Molecular scale probe for sensing quantum spins* Id. 2021-CIEN-000069-01	2021 - 2022	Gipuzkoa NEXT 2021

Project	Period	Call
Kuantu-Aldiak *Quantum computing for materials* Id. 2022-QUAN-000032-01	2022 - 2023	Quantum Gipuzkoa 2022
Con-RAMAN *Confocal RAMAN microscope* Id. 2020-CIEN-000008-01	2020 - 2021	Adquisition of scientific and technological equipment 2020
Nano-XRD *X-ray diffractometer for advanced nanomaterial characterization* Id. 2021-CIEN-000048-01	2021 - 2022	Adquisition of scientific and technological equipment 2021
Helipurifactor *Helium purification system for cryogenic measurements* Id. 2022-CIEN-000011-01	2022 - 2023	Adquisition of scientific and technological equipment 2022

La Caixa Foundation

Project	Period	Call
2DPhotoMag *2D material/photochrome heterostructures: photo-switchable magnetism and novel devices* Id. LCF/BQ/PI19/11690017	2019 - 2022	Postdoctoral Junior Leader – Incoming fellowships 2019
Manuel Suárez *Chiral spintronics and optoelectronics* Id. LCF/BQ/DR21/11880030	2021 - 2024	Doctoral INPhINIT fellowships program 2021