BCMATERIALS
BASQUE CENTER FOR MATERIALS, APPLICATIONS & NANOSTRUCTURES
ehu.group

ANNUAL REPORT 2025

EUSKO JAURLARITZA
GOBIERNO VASCO

ikerbasque
Basque Foundation for Science

Universidad del País Vasco
Euskal Herriko Unibertsitatea

BASQUE CENTER FOR MATERIALS, APPLICATIONS & NANOSTRUCTURES

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Basque Foundation for Science

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ON THE PATH TO APPEALING CHALLENGES

Senentxu Lanceros-Méndez
Scientific Director

Dear colleagues and friends,

This is a particularly nice year to write the forewords of our annual report. The year 2025 not only has been very positive with respect to our activity, but it also represents the end of the strategic plan 2022-2025. Thus, I also want to share a feeling of accomplishment and happiness for the work developed during those years.

With the effort and compromise of everyone, from the ones already present in 2022 to the latest incorporations in 2025, we have by far surpassed our goals in publications, meetings, researchers, outreach activities, internationalization… We have provided excellent scientific contributions and technology for the benefit of the society. We have fulfilled our mission to provide "new materials for a better life" and we have consolidated a research certer with a nice human environment and strong international impact and dimension.

Unavoidable in life, ups and downs have accompanied our path. We have been able to tackle difficulties and find out ways to always look forward with solidarity and optimism and put the necessary work and will to overcome the most demanding situations.

Just go through the pages ahead and enjoy our growth and our accomplishments as, I hope, you have enjoyed each and every day we have been working together in an enriching and dynamic environment, which aim is also that everyone of us accomplish his/her professional goals.

> **"The impediment to action advances action. What stands in the way becomes the way."**
>
> **'Meditations'**
> **Marcus Aurelius (121-180 A.C.)**

With this sense of fulfilment, it is time to look ahead. A new strategic plan has been designed for the 2026-2029 period. A strategic plan in an extremely dynamic and uncertain contest in which science, technology, materials and their emerging applications are at the center of technological competitivity, geopolitical decisions and social attention.

Critical materials, sustainable materials, quantum materials are concepts not just known by the scientific community, but also by the broad public. Energy transition or digitalization of the economy and society are recurrently in the media. Materials value chains or microchip fabrication are in the middle of political discussions… and geopolitical conflicts…

Thus, the new strategic plan must place our strong know-how on advanced materials at the service of the societal needs in the most ambitious, efficient and productive way. We must assume a central position in the area of advanced materials and solutions with even stronger focus, ambition and responsibility, being aware on the potential of our contributions and the need of our commitment.

We have numbers that record our productivity every year. Publications, funding, outreach, training, patents must be there to set clear and objective goals and achievement. We must certainly accomplish those goals as a means to objectively demonstrate the results of our activity. But those quantitative goals mut not deviate the focus on our primary and main mission and goal: to generate knowledge and translate that knowledge in the best possible way for the benefit of society.

The relevant and noble mission we have to achieve with ever growing focus, objectivity, commitment, and collaboration, is to contribute to address the grand challenges we are facing nowadays. To achieve this goal, the new strategic plan comes with a new structure for the center, based on research groups, built and consolidated over the last years, new laboratories dedicated to more technological activities, and growing ambition and commitment with excellence.

The achievements you are about to read in the 2025 year report, and the achievements in the 2022-2025 strategic plan period, demonstrate that we are ready to the challenge that this represents.

The demonstrated excellence in all our areas of activity and the stronger focus on the main materials science challenges and societal needs will make the 2026-2029 period and exciting one with even more rewarding activity and with increased commitment with excellence and compromise with technology transfer. We will further implement conditions for creative, collaborative and excellent atmosphere for relevant work, grow in local, national and international collaborations, we will reinforce the formation of young scientist and be present in the society and will focus on what really matters to achieve "new materials for a better life".

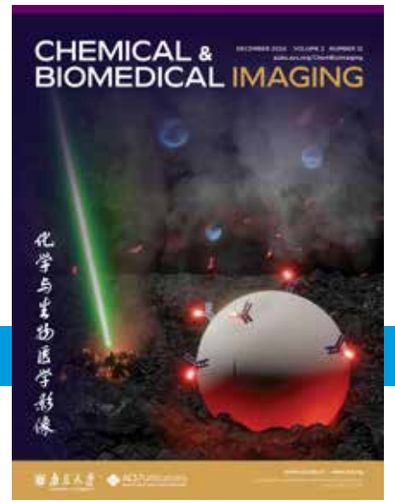
Enjoy this 2025 scientific report, reflecting the excellent contributions of BCMaterials members, colleagues and friends. Contributions reflecting each person, each action and each interaction making possible the existence of BCMaterials as an excellence research center. Enjoy this 2025 scientific report also as a guide and motivation to continue the ambitious path towards the development of "new materials" that will truly enable "a better life".

> **Change is not always equivalent to improvement, but to improve, one must change.**
>
> **Winston Churchill, 1874-1965**

2025 HIGHLIGHTS

2026-2029 ACTION PLAN

After evaluating the many milestones achieved under the 2021–2025 Strategic Plan, with the support of our advisory committees, we defined the 2026–2029 Action Plan. This document sets out the roadmap to consolidate BCMaterials' growth as an international leader in materials science.

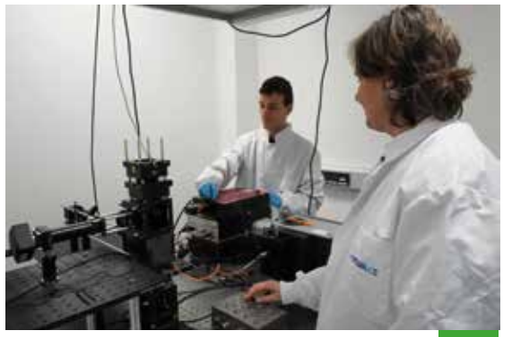


91% OF Q1 PUBLICATIONS

For the second consecutive year, we exceeded 240 publications, reached an H-index of 99, and recorded more than 13,000 citations of our scientific articles.

22 NEW PROJECTS

In 2025, we coordinated and participated in 22 new research projects at the European, national, regional, and private levels. In total, BCMaterials was involved in 83 projects by the end of the year, with total funding of €5,800,000.



CLEAN ROOM WORKS

Throughout the year, construction work was carried out in our new cleanroom. This facility represents a major milestone for our centre, expanding our capabilities in microfabrication and microelectronics.

NEW OUTREACH ACTIONS

In 2025, we expanded our outreach programme by adding new initiatives, including participation in the 'Be Zientzia' science fair and the 'STEAM Sare' catalogue. These activities further strengthened our efforts to communicate the value and impact of materials science to primary and secondary school students.

NOBEL PRIZE FOR OMAR YAGHI

A member of our International Advisory Commitee until January 2025, Prof. Omar Yaghi was awarded in November the Nobel Prize in Chemistry for its contribution to the development of metal-organic frameworks (MOFs), along with along with Susumu Kitagawa and Richard Robson. Congratulations!!

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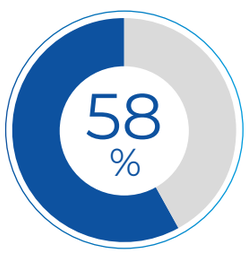
THE CENTER

BCMaterials, Basque Center for Materials, Applications and Nanostructures, is an autonomous research center launched in June 2012 by Ikerbasque, the Basque Foundation for Science and the University of the Basque Country (UPV/EHU) as a research center for Materials, Applications and Nanostructures. The center is included in the BERC's (Basque Excellence Research Centers) network and its mission is to generate knowledge on next generation materials, turning this knowledge into (multi)functional solutions and devices for the benefit of society.

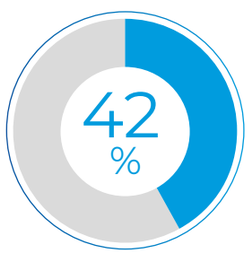
BCMATERIALS **IN NUMBERS**

RESEARCH **COMMUNITY**

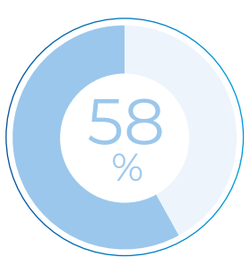
244
RESEARCHERS
Visitors included



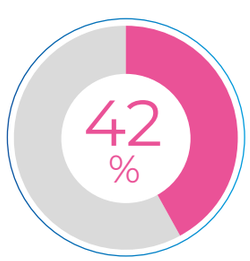
National= 142



International=102



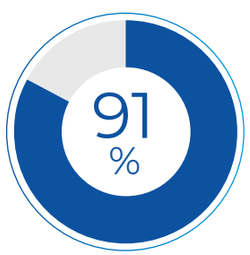
Men= 141



Women=103

RESEARCH **OUTPUT**

241
SCOPUS
Indexed Items



Q1 Publications

99
H INDEX

13618
CITATIONS

3
BOOKS

10
BOOK CHAPTERS

PROJECTS & **FUNDING**

83
ONGOING PROJECTS

= 5.800.000 €
FUNDING

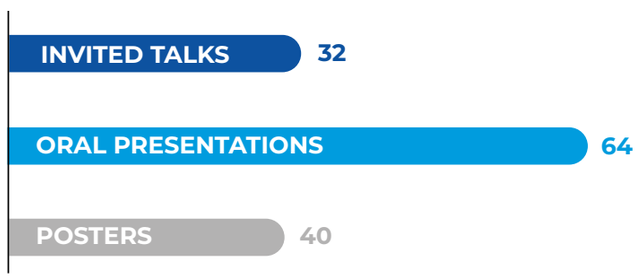
TRAINING

23
PHD
Thesis Defended

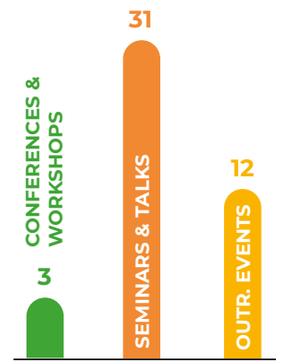
15
Master
Thesis Defended

10
Final Degree
Projects Defended

OUTREACH



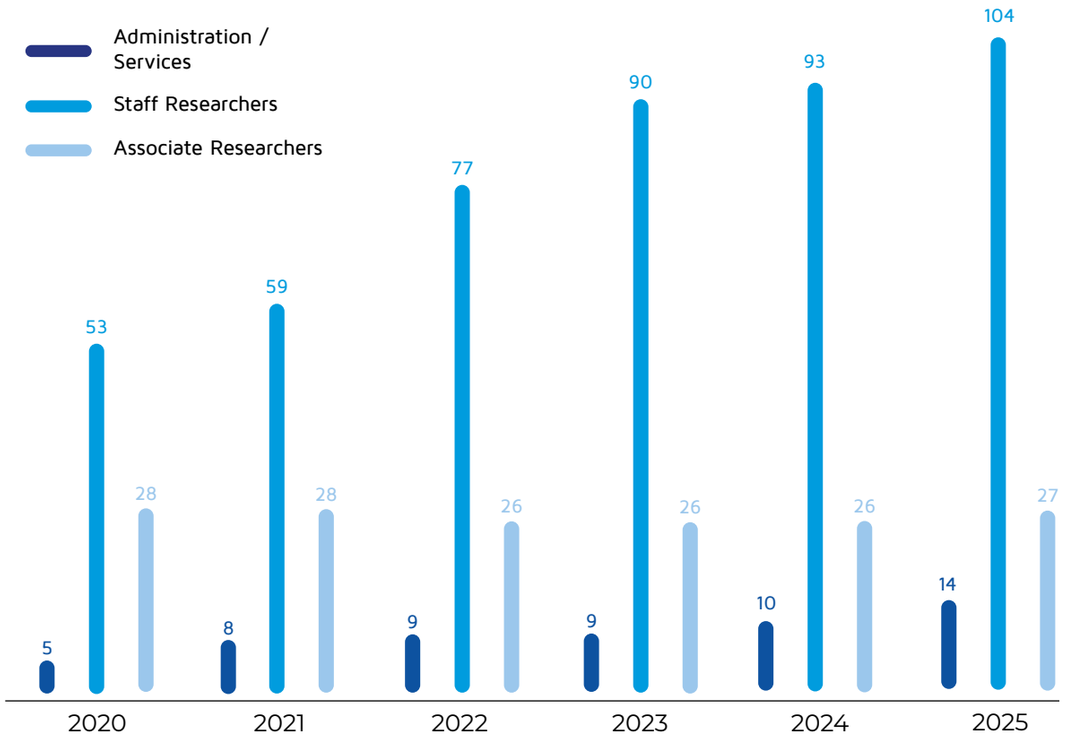
OUTSIDE BCMATERIALS



ORGANIZED BY OR WITH PARTICIPATION OF BCMATERIALS

BCMATERIALS **COMMUNITY**

4.14%	Ikerbasque Research Professors
2.07%	Ikerbasque Research Associate Professors
3.45%	Ikerbasque Research Fellows
14.48%	Post-doctoral Researchers
1.38%	MSCA Fellows
3.45%	Ramón y Cajal Fellows
3.45%	Research Fellows
38.62%	Pre-doctoral Researchers
18.62%	UPV/EHU Research Associates
9.66%	Administration / Services



INTERNATIONAL REPRESENTATION

Argentina	1
	1
Brasil	1
Colombia	8
	7
Germany	1
Iran	1
	1
Lithuania	1
Pakistan	
	1
Russia	2
UK	1
	5
USA	1

Azerbaiyan	1
	1
Canada	
	1
Czech Rep.	1
Hungary	
	3
Italy	4
	1
México	
	10
Poland	
	1
Spain	95
	63
UK	1
	1
Venezuela	1

Belgium	
	1
Chile	1
Croatia	
	1
India	3
	1
Kazakhstan	
	1
Morocco	1
Portugal	4
	1
Switzerland	1
Ukraine	1

131
STAFF & ASSOCIATE RESEARCHERS

113
VISITING RESEARCHERS

RESEARCH **NETWORK**

>400
COLLABORATORS

>300
INTERNATIONAL

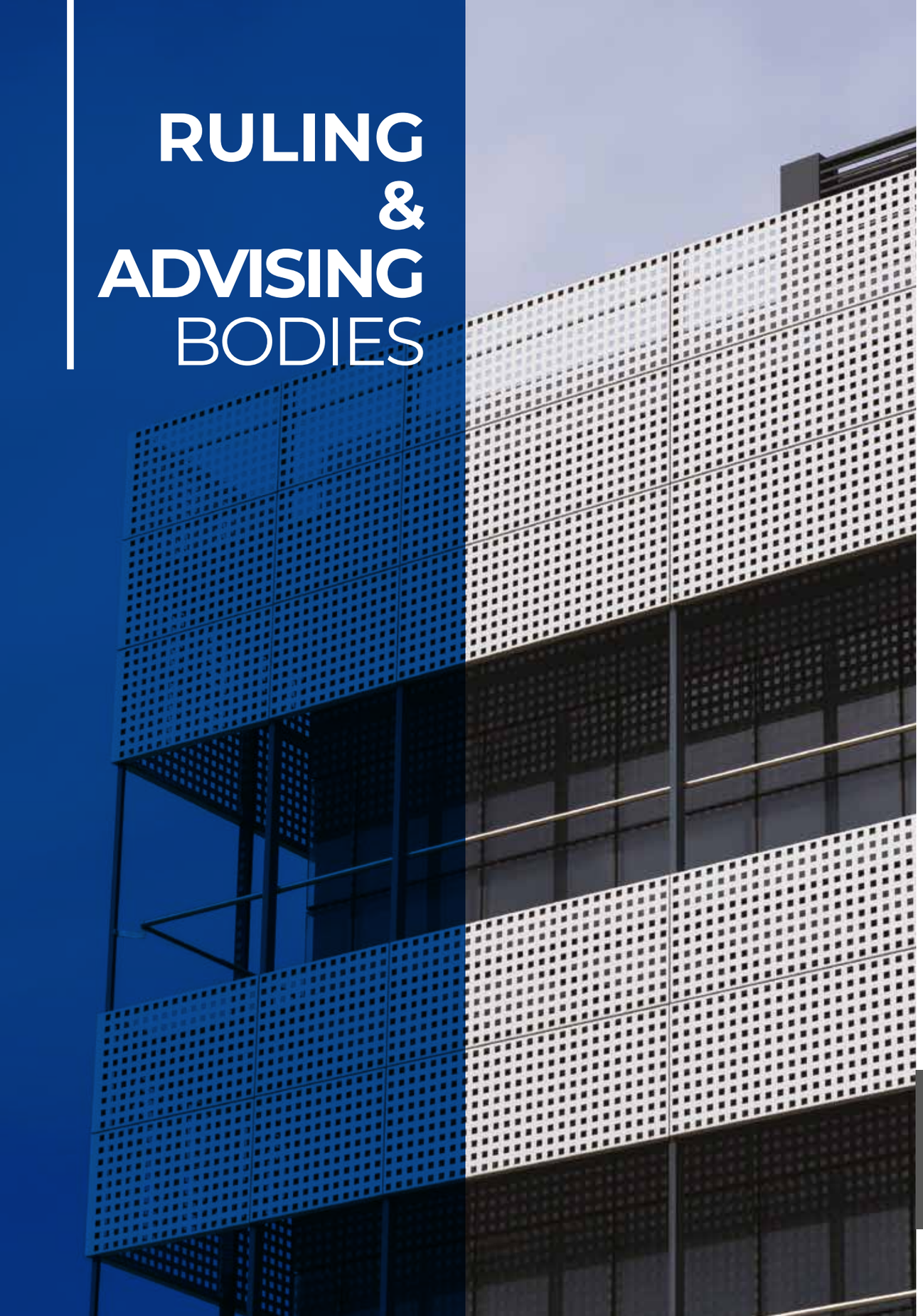
68
COLLABORATIONS IN SPAIN

73
REGIONAL COLLABORATIONS

43 RCVT | **8** CLUSTER | **22** PRIVATE

ARGELIA • ARGENTINE • AUSTRALIA • AUSTRIA • BELGIUM • BRAZIL • CANADA • CHILE • CHINA • COLOMBIA • CZECH REPUBLIC • DENMARK • EGYPT • FINLAND • FRANCE • GERMANY • GREECE • HOLLAND • INDIA • IRAK • IRAN • IRELAND • ISRAEL • ITALY • JAPAN • MALAYSIA • MOROCCO • NORWAY • PAKISTAN • PERU • POLAND • PORTUGAL • ROMANIA • RUSSIA • SERBIA • SLOVAKIA • SLOVENIA • SOUTH AFRICA • SWEDEN • SWITZERLAND • THAILAND • TURKEY • UAE • UNITED KINGDOM • UKRAINE • USA • VIETNAM

RULING & ADVISING BODIES



BOARD OF TRUSTEES

ADOLFO MORAIS

President, Vice-President of the Ikerbasque Foundation

JON UMEREZ

Vice President. Vice-Rector for Research at the UPV/EHU

LEIRE GARMENDIA

Secretary. Secretary General of the UPV/EHU

GOTZONE BARANDIKA

Member. Vice-Rector for Transfer and Internationalization of the UPV/EHU

AMAIA ESQUISABEL

Member. Secretary of the Ikerbasque Foundation

FERNANDO COSSÍO

Member. Scientific Director of Ikerbasque

Under the Basque and Spanish laws, foundations are governed by a Board of Trustees (Patronato). The Board of Trustees of BCMaterials Foundation is composed by representatives of Ikerbasque (the Basque Foundation for Science) and the University of the Basque Country (UPV/EHU).

INTERNATIONAL
ADVISORY COMMITTEE

PROF. MARÍA VALLET-REGÍ

Leader of the Smart Biomaterials Research Group. Group leader of the Biomedical Research Networking Centre in Bioengineering, Biomaterials and Nanomedicine (CIBER-BBN), and of the Research Institute of the Hospital 12 de Octubre, Madrid. Dept. of Chemistry in Pharmaceutical Sciences, Faculty of Pharmacy,Universidad Complutense Madrid (UCM)

PROF. CAROLINE A. ROSS

Associate Head of the Department of Materials Science and Engineering
Toyota Professor of Materials Science and Engineering
Massachusetts Institute of Technology (MIT), USA.

PROF. GORDON WALLACE

Director ARC Centre of Excellence for Electromaterials Science (ACES)
Director ANFF (Materials Node)
Director Translational Research Initiative for Cellular Engineering and Printing (TRICEP).

DR. SABETH VERPOORTE

Professor of microfluidics and miniaturized "lab-on-a-chip" systems. Faculty of Science and Engineering, University of Groningen, Netherlands

DR. PHIL WITHERS

Regius Professor of Materials at the University of Manchester, UK.
Chief Scientist of the Henry Royce Institute.

The International Advisory Committee is made up of internationally recognized experts in the different strategic areas of the center. It is a body in charge of monitoring and supporting the progress of the center, helping to improve its competitiveness to position BCMaterials as a reference center worldwide.

LOCAL
ADVISORY COMMITTEE

PROF. TEÓFILO ROJO

Professor of Inorganic Chemistry at the UPV-EHU. Scientific director of CIC EnergiGUNE from 2010 to 2020
President of the Group pf Solid State Chemistry of the Royal Spanish Society from 2000 to 2010. National prize in Inorganic Chemistry of the Royal Spanish Society of Chemistry in 2013.

PROF. Mª ISABEL ARRIORTUA

Professor of Crystallography and Mineralogy at UPV/EHU, since 1992. Director of the UPV/EHU Advanced Research Facilities (SGIker) since its creation (2002-2021).Euskadi research award in Science and Technology in 2010.

PROF. LUIS MANUEL LEÓN

Professor of Physical Chemistry
Founder of the Macromolecular group at the Department of Physical-Chemistry, University of the Basque Country. Member of the PhD commission and/or post-graduation of the UPV/EHU.

DR. ELENA GUEDE VÁZQUEZ

Cement & Roadstone Holding Corporative Quality Manager in the last two years and Plant Manager in Cementos Lemona, S.A for 6 years in previous ones. First woman appointed Cement Plant Manager in Spain and in the CRH Group.

DR. ANTONIO PORRO

Former Chief Technology Officer and Business Development Director at TECNALIA Research & Innovation, BT Division.
Former member of the Conseil Scientifique et Technologique of NOBATEK-INEF4 (France).

The Local Advisory Committee is made up of internationally recognized experts in the different strategic areas of the center. It is a body in charge of monitoring and supporting the center's progress, helping to improve its integration, competitiveness and contribution to the Basque system of science, technology and innovation, also helping its position as an international reference center

HUMAN RESOURCES

HSR4R ACTION PLAN

During 2025, the different working groups established under the Human Resources Strategy for Researchers (HSR4R) action plan at BCMaterials were developing a series of key documents addressing strategic areas such as Training and Mobility, Ethics, and Human Resources.
These documents will ensure alignment with the principles of the European Charter for Researchers and the European Code of Conduct for the Recruitment of Researchers. In particular, The Charter and Code promote transparent and merit-based recruitment processes, the safeguarding of fair and supportive working conditions, and a strong commitment to the professional development of researchers at all stages of their careers. They also emphasize the importance of recognizing and fostering international, intersectoral, and interdisciplinary research mobility as a key element in enhancing research excellence.

PSYCHOSOCIAL WELLBEING

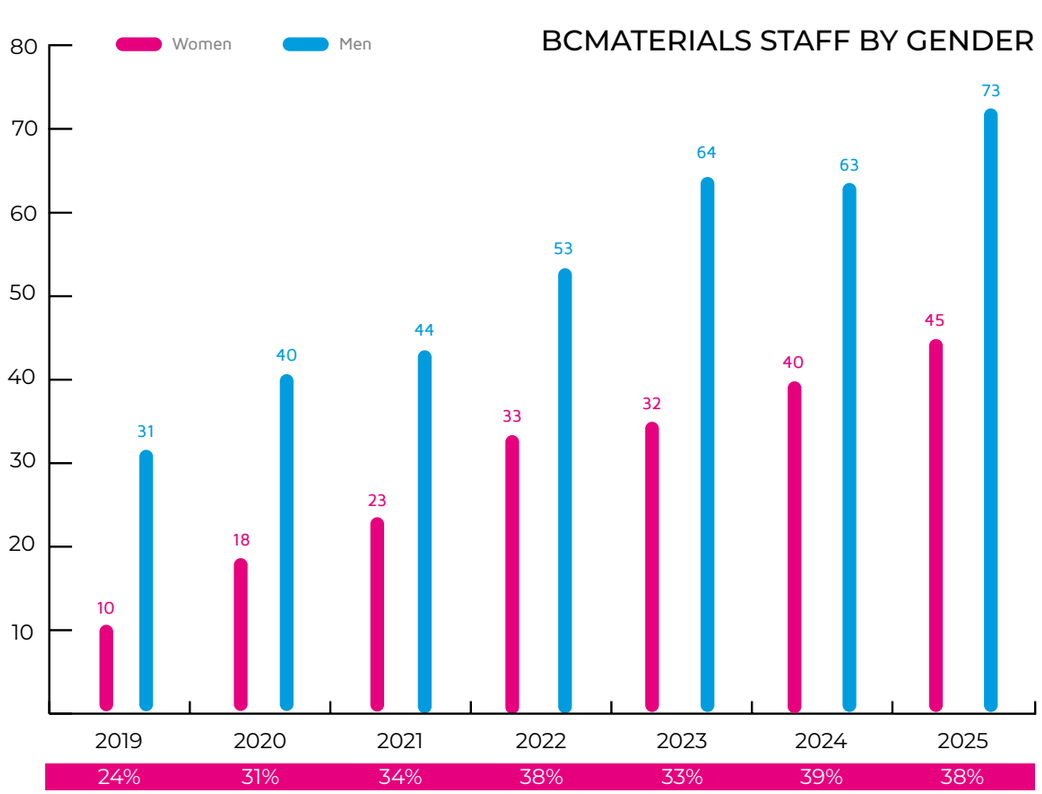
BCMaterials places people at the core of its strategy. The organization prioritizes their well-being, recognizing psychological support as a key factor in creating a positive, healthy work environment that fosters both professional development and personal growth.
In 2025, BCMaterials initiated the development of its Psychosocial Wellbeing Plan, beginning with a comprehensive diagnostic assessment of the workforce's current psychosocial conditions. This analysis provides the foundation for defining the plan's objectives and guiding the implementation of targeted actions.

HR EXCELLENCE IN RESEARCH

GENDER EQUALITY

GENDER EQUALITY PLAN

Throughout the year, BCMaterials' Equality Committee carried out a comprehensive evaluation of the 2021–2025 Equality Plan. The aim was to assess the extent to which its objectives had been achieved and to define a clear roadmap for the new 2026–2030 Equality Plan. Beyond setting new targets to further advance gender equality, the upcoming plan places a strong emphasis on strengthening gender awareness and training among staff. It also includes the development of internal communication initiatives to ensure the plan is effectively disseminated and widely understood across the organization.



NEW **PERSONNEL**

IKERBASQUE RESEARCH PROFESSOR

PABLO DOCAMPO

IKERBASQUE RESEARCH ASSOCIATE PROF.

ERIC HILL

UPV/EHU **ASSOCIATE**

JANIRE SÁEZ

RAMÓN Y CAJAL POST-DOCTORAL FELLOWS

PABLO SIMÓN

SANTIAGO RODRÍGUEZ

POST-DOCTORAL RESEARCHERS

DAIANA CABROSI

PAOLA CROCOMO

NEKANE NIETO

FRANCISCO PERALTA

RICHARD SCHÖNLEIN

MANTAS LIUTKUS

PRE-DOCTORAL RESEARCHERS

ALEJANDRA CANCILLERI

ANA GÓMEZ

ANA JIMÉNEZ

ANEIRIN GARSTON

CAMILO RODRIGUEZ

DIANA SOTELO

ENEKO SEBASTIÁN

GABRIEL FONSECA

GABRIELE DILENA

GOIZANE SOT

JON VELASCO

JUAN ESTEBAN BEDOYA

JUNE HERREROS

LUCÍA JUAN

MAIDER PINILLOS

MASUMA SULEYMANOVA

PEDRO CANTARERO

PEIO MARTÍNEZ

OMAIRA ARIAS

OMAR ANOUD

ADMINISTRATION & SERVICES

ENRIQUE RODRÍGUEZ

LAURA GARCÍA

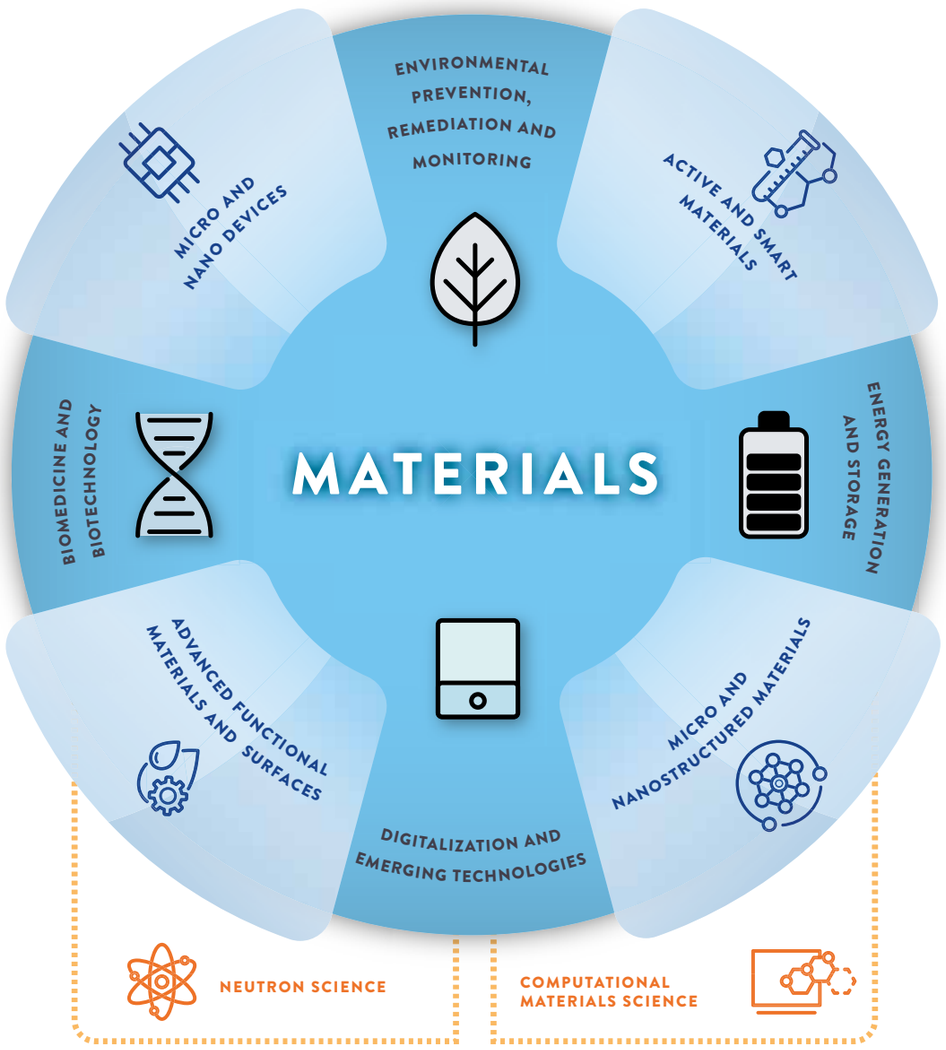
MIKEL ASURMENDI

02

RESEARCH ACTIONS

BCMaterials organizes its activities into Research lines and Research areas. Research lines are designed to generate knowledge in the new generation of smart, active and multifunctional materials, to achieve excellence in the next generation of materials, to discover materials and effects and to transfer this knowledge to society. Research areas are designed to take advantage of the generated knowledge in advanced materials and to apply them to tackle the most relevant challenges of modern society, ranging from environmental prevention,monitoring and remediation, energy generation and storage, biomedicine and biotechnology as well as to provide the advanced materials required by the digitalization strategies.

RESEARCH LINES & AREAS



Areas

Research areas are designed to take advantage to the generated knowledge in advanced materials and to apply them to tackle the most relevant challenges of modern society, ranging from environmental prevention, monitoring and remediation, energy generation and storage, biomedicine and biotechnology as well as to provide the advanced materials required by the digitalization strategies.

Lines

Research lines are designed to generate knowledge in the new generation of smart, active and multifunctional materials, to achieve excellence in the next generation of materials, to discover materials and effects and to transfer this knowledge to society. Within the research áreas, one or more of theses research lines work together in order to give answer to specific technological and society challenges.

Transverse lines

Neutron Science and Computational Materials Science are two research lines with strong impact in all the rest of the research lines and areas. These transversal lines support the desing of advanced and multifunctional materials as well as the understanding of their main physical-chemical and functional properties. Further, their are essential to determine their potential applications and application conditions.

RESEARCH
LINE 1

ACTIVE & SMART MATERIALS

Active and smart materials are at the core of the on-going rapid technological development. Shape memory, magnetocaloric and elastocaloric materials, piezoelectric, magnetoelectric and self-healing materials as well as multifunctional hydrogels are being developed. A deep understating on the structural and molecular modifications behind the active responses allows tailoring materials responses.

Magnetic Field-Based Strategy for Damage Detection and Stratigraphy Assessment for Structural Health Monitoring Applications

Amorim, L., Martins, P., Tubio, C. R., Seoane-Rivero, R., & Lanceros-Mendez, S. (2025). Advanced Engineering Materials, 27(21), e202501217.

Strong efforts are being carrying out to implement efficient and accurate structural health monitoring (SHM) strategies for large surfaces. The criticality of high demanding structures, such as vessels, pipelines, or aircrafts, requires costly integrity inspections to ensure their performance and security. In this work, it is presented a strategy for damage detection and stratigraphy assessment based on the use of hard magnetic particles. The validation of the concept is based on the production of composite laminates containing NdFeB particles on the coating layer.

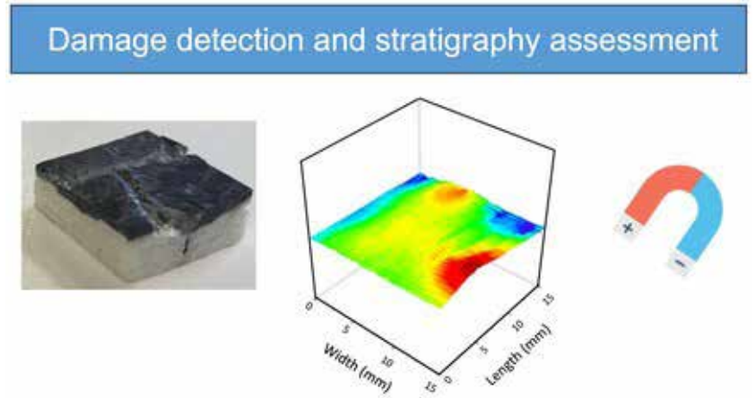


Fig 1
Graphical abstract.

Structural health monitoring (SHM) is critical in different fields, including civil engineering infrastructures, as well as automotive and aerospace. Strong efforts are being carrying out to implement efficient and accurate SHM strategies for damage detection in structures. This study presents a novel SHM approach using magnetic particles for precise damage detection and coating stratigraphy assessment. The methodology is demonstrated on an industrially produced sheet molding compound laminate composite, incorporating an epoxy coating layer doped with 20 wt% NdFeB particles. The coating achieves a coercive field (Hc) of 7000 Oe and a saturation magnetization (Ms) of 136.8 emu/g. Uniform dispersion of magnetic particles is confirmed, while surface characterization indicates minimal impact on roughness and wettability. Mechanical testing shows a negligible effect on flexural modulus but a reduction in bending strength due to constrained molecular mobility. Magnetic flux mapping enables fast and accurate damage detection and coating depth assessment. Perpendicular magnetization enhances damage detection and sensitivity, while longer acquisition times (3 s) and higher magnetization fields (1.1 T) improve resolution and facilitate thickness evaluation. These findings highlight the potential of these coatings for SHM, offering precise damage detection and insights into coating uniformity, ultimately supporting advanced monitoring solutions for critical structures.

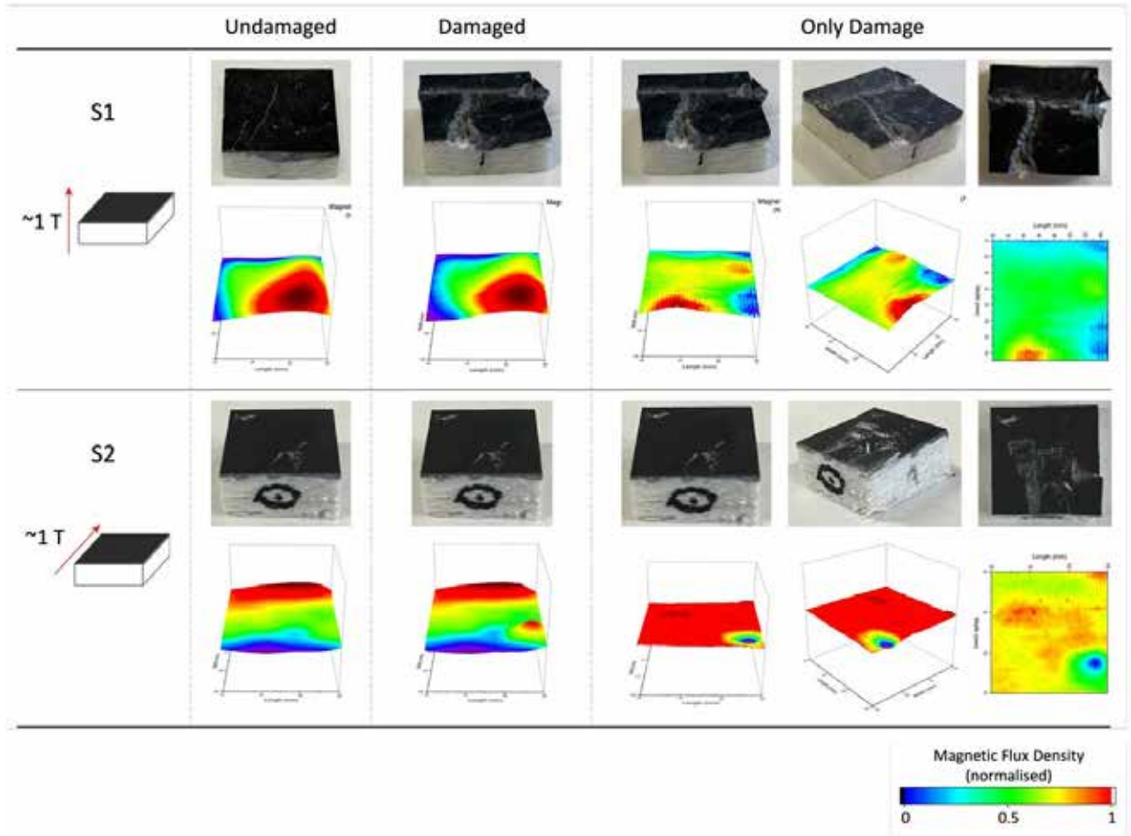


Fig 2
Photos of magnetized samples S1 and S2 and the magnetic flux mapping of them before and after damage. In "Only Damage," collum is presented the magnetic flux map, in different perspectives, after data treatment. The color gradient scale indicates magnetic field density, with red showing strong field density and blue highlighting weak, and leaking areas.

Fully Printed 3D-Thermoformed Electroluminescent Capacitive System for Human–Machine Interface Applications

Campos-Arias, L., Peřinka, N., Vicente, J., Gomes Correia, V. M., Mendes-Felipe, C., Vilas-Vilela, J. L., & Lanceros-Méndez, S. (2025). Advanced Materials Technologies, 10(11), 2402116.

In-mold electronics (IME) represents an improved integration, reduction of assembling parts and lower environmental impact comparing with conventional electronics. The combination of screen-printing and thermoforming enables to develop IME products, such as sensors and conductive circuits. However, adding several functionalities, such as lighting and sensing has not yet been explored. In this work, a completely functional screen-printed thermoformed electroluminescent capacitive interface device is reported for the first time. Thus, this work opens a possibility of novel more complex IME applications.

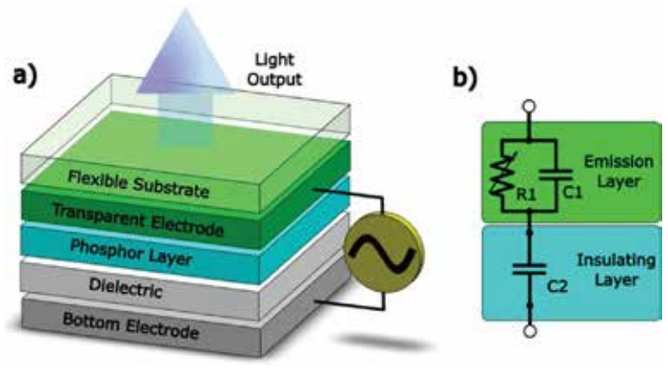


Fig 1
a) Schematic illustration of an ACEL device and b) its equivalent circuit.

The constantly increasing demand for improved integration and conformability of components for electronic devices has led to the development of fabrication methods where electronics and structural parts do not need to be assembled. This is the case of 3D printed electronics, where different layers of functional material are fabricated in its final shape, and in-mold electronics (IME), where functional materials are deposited by 2D printing onto a thermoplastic substrate and subjected to thermoforming to obtain the final 3D shape. The automotive industry has boosted the development of IME products, especially human–machine interfaces (HMI). The HMI systems require also lighting systems integrated with sensors and printed conductive circuits. One of the main methods used currently in displays and lighting technology is alternative current electroluminescence (ACEL). In Figure 1, it is illustrated the structure of an ACEL device and the corresponding equivalent circuit. In this study, we have developed an electroluminescent capacitive interface fabricated by screen-printing and conformed to a 3D shape by thermoforming. The morphology and electrical properties of the device

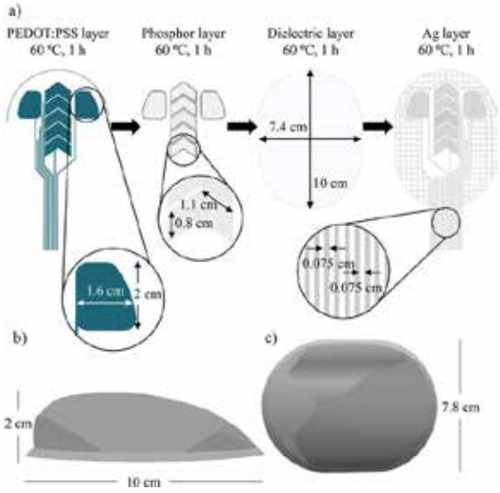


Fig 2
Illustration of the a) screen-printing process and the b) lateral view and c) top view of the mold.

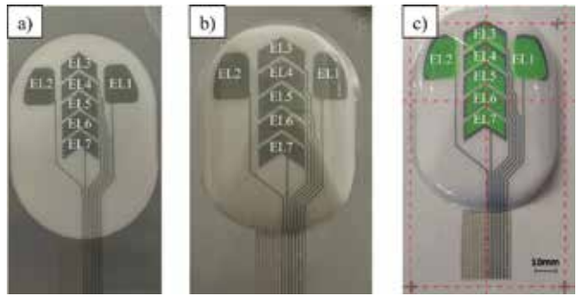


Fig 3
Sample a) before and b) after thermoforming and analysis of the variation of the c) electrodes surface area in the thermoformed device in relation to the electrodes (green) without thermoforming.

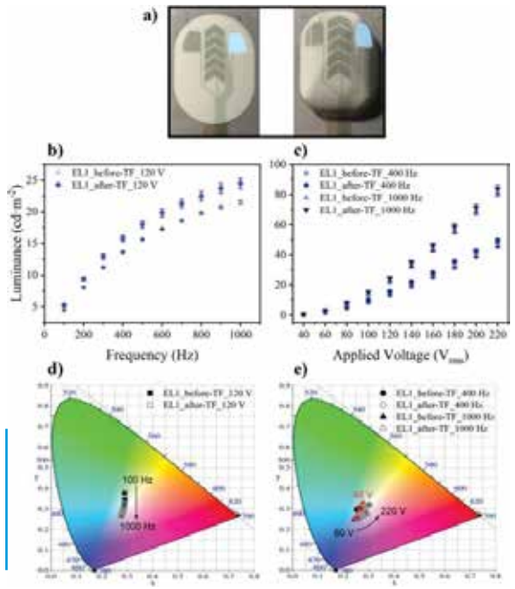
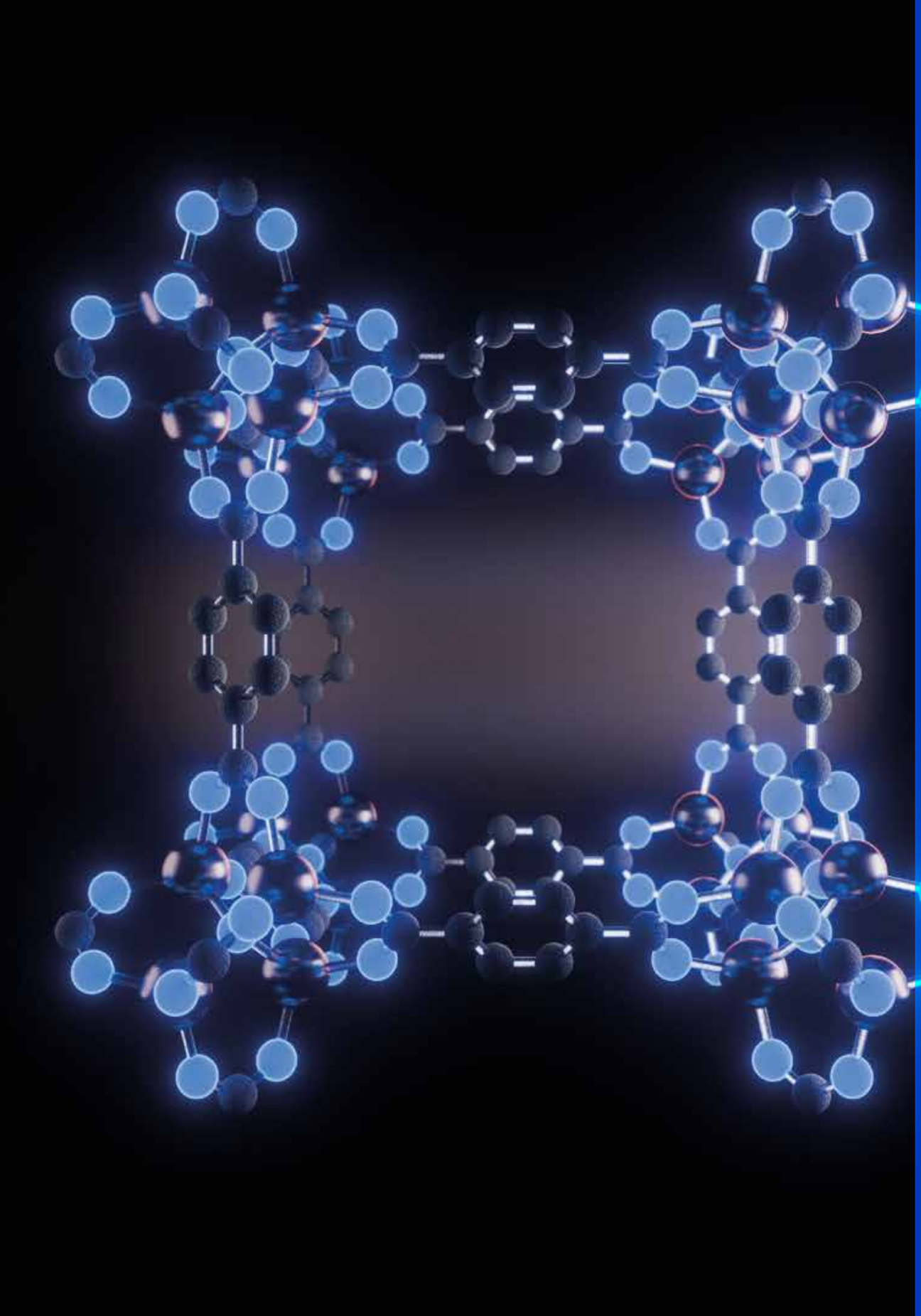


Fig 4
a) Images of devices before and after thermoforming applying 100 V at 400 Hz to EL1. b) Luminance of EL1 at different frequencies, and c) various applied voltages. Color space chromaticity diagram (showing the CIE coordinates) for each d) frequency and e) voltage.

were characterized, and the electroluminescent performance was analysed before and after thermoforming. The ACEL device manufacturing process and the 3D mold for thermoforming are shown in Figure 2. Figure 3 shows an image of the system before and after thermoforming as well as an image of the thermoformed device with an overlap of the electrodes prior to thermoforming. Electroluminescent results of EL1 and images of the device before and after thermoforming are displayed in Figure 4. The luminance of EL1 after thermoforming was higher than before TF as it can be observed in the Figure 4b (an average increase of 14.8%). This was expected, considering that the thermoforming process has a positive effect on inks sintering. The highest luminous efficacy was observed at 220 V and 400 Hz. Finally, the device was connected to the electronic system to verify the ability of the circuit to work as a capacitive sensor and perform a luminous actuation. Thus, the potential of IME technology as a high-deformation solution was demonstrated, highlighting its suitability for HMI applications in various sectors, ranging from car interiors to medical devices.



RESEARCH
LINE 2

MICRO & NANO-STRUCTURED MATERIALS

Nanostructures are being developed in order to take advantage of their specific tailored properties and to support the development of multiresponsive hybrid materials. Magnetic and metallic nanoparticles produced by bacteria and plants, single and hybrid magnetic, plasmonic and photocatalytic nanoparticles are being developed, among others. We devote special attention will be devoted to mesoporous materials, mainly metallic organic frameworks and zeolites, which are being investigated based on their tuneability and specific intrinsic properties for sensing, energy, environmental and biomedical applications. In particular, strong efforts are being developed in the area of hierarchical materials out of MOFS as well as to molecular materials
such as molecular magnets.

MOF-74 Nanofibers as an Advanced Porous Material for Air-Bearing Technology

Andreo, J., Yu, X., Chernova, E., & Wuttke, S. (2025). Small, 21(33), 2411108.

Fig 1
Overview and novelty of the work

Metal–organic frameworks (MOFs) are porous crystalline materials formed by metal nodes and organic linkers, valued for their high surface area, tunable porosity, and structural diversity. Beyond gas storage and catalysis, increasing attention has focused on processing MOFs into robust freestanding films and monoliths for real-world devices. In particular, porous structural materials are highly relevant for aerostatic bearings, where pressurized gas forms a frictionless cushion between surfaces, but current restrictor materials remain costly or fragile. Despite their intrinsic porosity and structural tunability, MOFs have never been explored as functional materials for air-bearing systems. In this context, particle morphology is critical. Although nano- and microcrystals are well established, the controlled synthesis of high-aspect-ratio MOF nanofibers via simple, template-free and scalable routes remains rare. Here we report a room-temperature, template-free synthesis of MOF-74 (Cu) nanofibers in methanol. The process is robust across a broad range of concentrations and stoichiometries and yields fibers 20–100 nm in diameter and several micrometers long. Fiber formation evolves over time, with crystallinity and aspect ratio increasing during aging; optimal yield is reached after three days. The method can be scaled up (×10) and enhanced using a mild base (TEA), which improves yield without altering morphology. Copper nitrate proved the most suitable precursor, and solvent choice was decisive: methanol uniquely enables direct fiber formation, while other solvents generate intermediate phases that convert to MOF-74 upon aging in methanol. Fiber length can be tuned by ultrasonication, with solvent density influencing fragmentation efficiency.

The fibers readily entangle into cohesive, free-standing webs by simple casting. Film thickness and geometry are controlled by sequential layering, and PTFE substrates allow clean release, while strong adhesion to other surfaces may aid device integration. Shaped films replicate sub-millimeter features using PTFE-coated molds. Dried sheets can be repaired or laminated by applying fresh suspension, forming strong welded joints, and they resist redispersion in common solvents. Mechanical properties are enhanced through composites: nylon fibers improve flexibility and crack resistance, while spring-tempered stainless-steel wires increase stiffness and load distribution.

As a proof of concept, and to the best of our knowledge, representing the first implementation of a MOF-based material in an aerostatic bearing, we fabricated a bearing puck from fibrous MOF-74 (Cu) monoliths. An ≈8 mm thick multilayer composite successfully lifted a 51 mm, 0.54 kg steel sphere at ~1.5 bar and withstood forces up to 14 N at 1.75 bar, achieving >30% efficiency. Although below commercial graphite bearings, this performance demonstrates the feasibility of additively manufactured air bearings based on MOF nanofibers.

Overall, this work establishes a scalable route to MOF-74 (Cu) nanofibers and demonstrates their processability into films, composites, and functional porous devices, highlighting their potential in practical engineering applications such as air-bearing technology.

> Aerostatic bearings rely on a thin pressurized air film to achieve near-frictionless motion. We propose MOF-74 (Cu) fibers as porous restrictors for air-bearing devices. Using a green, template-free method, ultra-long, robust fibers with excellent mechanical properties are synthesized and processed into free-standing films and composites. Operational tests confirm their structural reliability under low pressure, highlighting a scalable, cost-effective, and sustainable alternative to conventional bearing materials.

Fig 2
The parameters studied in the synthesis of MOF-74 (Cu) fibers.

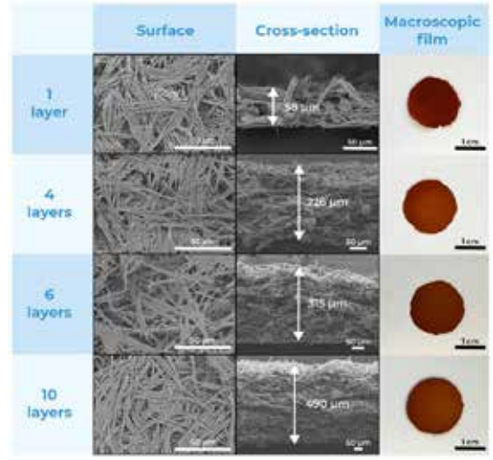


Fig 3
SEM and photo images of MOF-74 (Cu) webs, casted with a different number of layers.

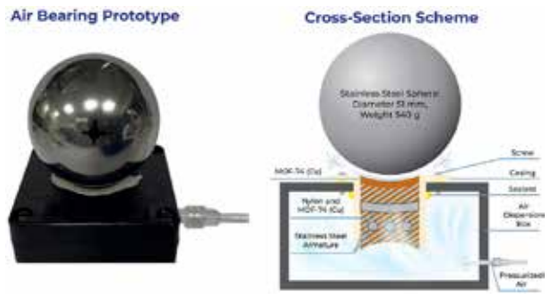


Fig 4
MOF air bearing prototype and cross-section scheme of the bearing.

Mixed matrix membranes of PIM-1 incorporating MOF-808 functionalized with amino acids for enhanced CO2/ CH4separation

Refaat, D., Yahia, M., Martínez-Hernández, H. D., Jimenez-Ruiz, M., Galván, V., Petrenko, V., De Luis, R.F., & Coronas, J. (2025). Journal of Materials Chemistry A, 13(45), 39254-39270.

> CO_2 removal from biogas is essential for producing CH_4-enriched streams. We have demonstrated that mixed-matrix membranes based on polymers of intrinsic microporosity incorporating MOF-808 functionalized with amino acids significantly enhance CO_2 selectivity and permeability over CH_4. While conventional lab techniques provided general insights, inelastic neutron spectroscopy (INS) combined with density functional theory (DFT) modeling revealed CO_2 interactions with amino groups, forming carbamic acid

Thanks to recent advances, so-called mixed-matrix membranes (MMMs) based on polymer composites are steadily approaching practical application. Nevertheless, permeability and selectivity remain two of the most critical factors limiting technology scale-up under real operating conditions. This is where porous materials—and more specifically, metal–organic frameworks (MOFs) as microporous sorbents—can make a decisive difference by enhancing these properties. MOFs offer exceptional porosity and, more importantly, outstanding chemical versatility, which enables pore functionalization with basic amino acids such as lysine or arginine, promoting selective interactions with CO molecules. These essential building blocks of life enable modulating the gas-adsorption capacity and affinity of the parent mesoporous MOF-808 employed in this work, and hence, adapting their properties to enhance the baseline performance of gas-separation membrane technologies based on polymers of intrinsic microporosity (Figure 1). Following established protocols, MOF-808 scaffold was synthesized and post-synthetically functionalized with the amino acids lysine and arginine, and subsequently incorporated as a nanoporous filler into the polymeric scaffold of PIM-1 membranes. The initial characterization of the materials and membranes enable us to correlate the structure and chemistry of the studied systems with the observed improvements in permeability and, in particular, selectivity in CO /CH gas separation experiments (Figure 2). The permeation results, which rival the best MOF-based mixed-matrix membrane technologies reported to date for CO /CH separation, were published in Journal of Materials Chemistry A in 2025.

While conventional laboratory techniques provided general insights into the physicochemical and functional properties, they were insufficient to reveal the mechanisms of CO /CH separation. To address this, laboratory characterization was combined with inelastic neutron spectroscopy (INS) at ILL's IN1-Lagrange and DFT calculations, enabling detailed identification of intramolecular vibrations influenced by gas adsorption in MOF-808@amino-acid structures.

Among the INS bands affected by gas adsorption (Figure 3), a clear shift is observed for band A, located at 740 cm ^{1}, along with the appearance of a new signal at approximately 1170 cm ^{1} upon gas loading. Both spectral changes are closely linked to the formation of carbamic acid, arising from the reaction of CO with the pendant amino groups of the amino-acid moieties, as confirmed by the Density Functional Theory (DFT) calculations. Overall, the immobilization of amino-acid functionalities within the pore space of MOF-808 endows the material with CO -selective adsorption, which is subsequently reflected in the enhanced selectivity and permeability performance of the resulting mixed-matrix membrane systems. We foresee that the incorporation of amino acids, especially through multivariate functionalization of MOFs with diverse residues, will emerge as a key approach for designing highly selective gas-separation materials, with applications far beyond biogas upgrading.

Fig 1
General strategy to combine (a) polymers of intrinsic microporosity and (b) amino acid functionalized MOF-808 to (c) develop mixed matrix membranes with (d) enhanced properties

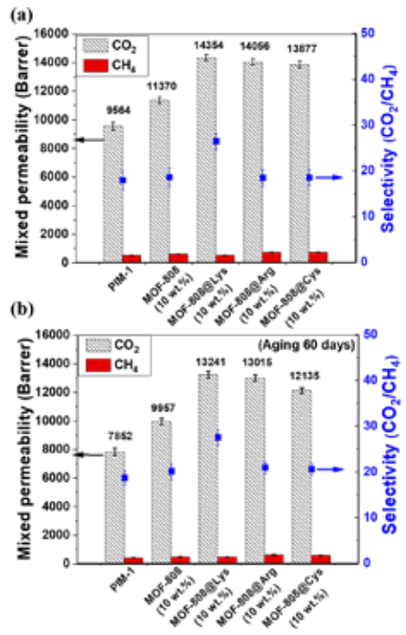


Fig 2
CO2 permeability and mixed CO2/CH4 selectivity for bare PIM-1 membrane and PIM-1/MOF-808 and PIM-1/MOF-808@AA (10 wt.%) MMMs: (a) before aging and (b) after aging (60 days).

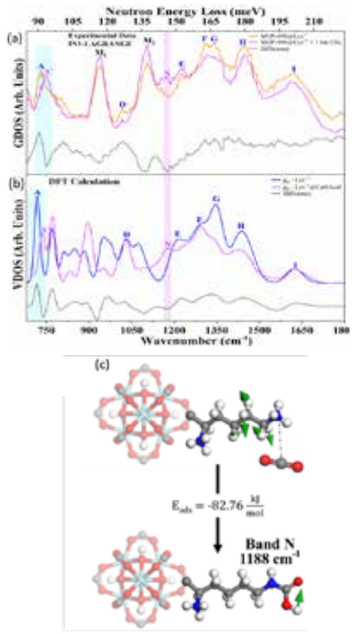


Fig 3
(a) INS spectra of MOF-808@Lys and MOF-808@Lys@CO2. (b) INS spectra calculated from the Lys and Lys-carbamic acid models. (c) Proposed CO adsorption mechanisms highlighting the vibrational modes most affected by the process.

RESEARCH
LINE 3

ADVANCED FUNCTIONAL MATERIALS & SURFACES

This research line is devoted to the development of materials for specific technological needs. BCMaterials covers the synthesis, development and scale-up of a wide range of materials for fuel cells and batteries, photovoltaic materials or permanent magnets. Further, to provide surfaces with additional functionalities beyond the traditional decorative or protective ones is a key issue in science and technology. BCMaterials is working on sensing, self-cleaning, self-healing and antibacterial surfaces, following a wide variety of methods, including chemical and physical deposition and printing techniques.

Coherent Spin Manipulation in Mononuclear Gadolinium-Substituted Polyoxometalate–Organic Hybrids

Corina Rodríguez-Esteban, Estibaliz Ruiz-Bilbao, Janire Bustamante-Fernández, Floriana Tuna, Luis Lezama, Aaron Mailman, Aman Ullah, Alejandro Gaita-Ariño, Beñat Artetxe, Mathieu Gonidec, and Itziar Oyarzabal. The Journal of Physical Chemistry Letters, 16(12), 3072-3077.

While most research on molecule-based electron spin qubits has focused on S = 1/2 ions, the need for qubit interactions in quantum operations has driven interest in higher-spin molecules and multilevel states. Herein, we study the spin dynamics of two mononuclear gadolinium substituted polyoxometalate-organic hybrids. Pulsed EPR measurements reveal spin–lattice relaxation and quantum coherence times of up to 2315 and 2.6 μs at 3 K, respectively, as well as Rabi oscillations up to 20 K. These results place them among the few Gd-based complexes displaying such behaviour, highlighting the challenge of coherently manipulating the spin states of Gd.

Molecular magnetic materials are very promising candidates for quantum computing, as they exhibit multiple low energy states suitable for encoding qubits. The critical parameter that determines their suitability is the phase memory time, T_m, which is associated with the ability of a qubit to remain in the superposition of two states. Decoherence, the loss of superposition or entanglement due to uncontrolled interactions with the environment, causes errors in quantum computers that result in the loss of information.

Gd^{III}-based coordination complexes are ideal candidates for the realization of qudits (quantum systems with more than two accessible states), because, as a free ion, Gd^{III} has an isotropic electronic ground state with L = 0 and S = 7/2, the highest spin found in the periodic table. The chemical engineering of their first coordination sphere allows control of the energy level splitting and consequently, the spin dynamics.

In this work, we study the spin dynamics of two mononuclear gadolinium substituted polyoxometalate-organic hybrids with the general formula $K_5[Gd(\alpha\text{-}XW_{11}O_{39})(H_2L)]\cdot 14H_2O$ (X = Si, Ge; H_2L = N,N′-dimethyl-N,N′-bis(2-hydroxy-3-formyl-5-bromobenzyl)ethylenediamine), 1_{Si}-Gd and 1_{Ge}-Gd. The coordination of the Ln to the four oxygen atoms from the vacant site of the polyoxometalate and the four oxygen atoms of the organic ligand results in a LnO_8 coordination polyhedra with a biaugmented trigonal prismatic (BTPR) geometry, distorted toward square antiprismatic (SAPR) for both complexes (Figure 1). Upon diamagnetic dilution with Y^{III} analogues, 1_{Si}-Gd and 1_{Ge}-Gd exhibit T1 (spin lattice relaxation time) and T_m values of up to 2315 and 2.6 µs at 3 K, respectively (Figure 2). Moreover, the observation of Rabi oscillations in the 3–20 K temperature range confirms the coherent spin state control in both compounds (Figure 3). The obtained results make 1_{Si}-Gd and 1_{Ge}-Gd two of the few Gd-based complexes displaying such behaviour, highlighting the challenge of coherently manipulating the spin states of Gd. Moreover, their hybrid organic inorganic nature endows them with chemical robustness and solution stability, essential prerequisites for surface immobilization and future integration in practical devices.

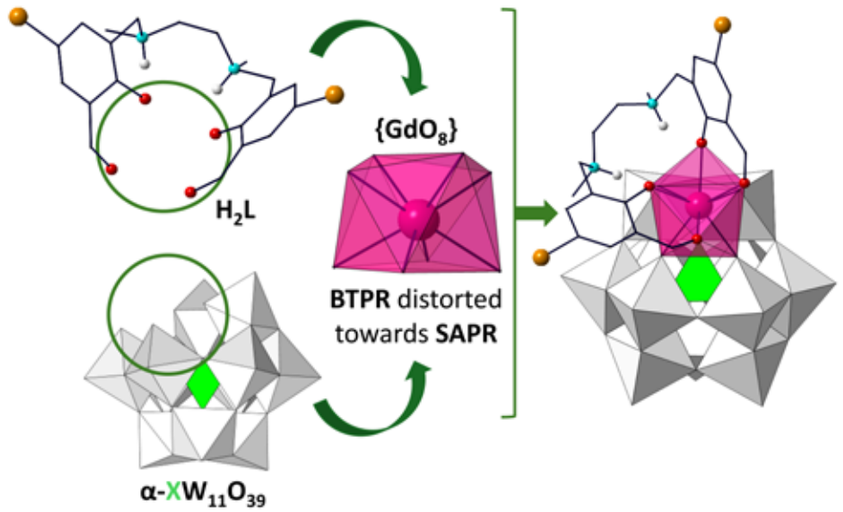


Fig 1
Synthesis and molecular structure of hybrid $[Gd(\alpha\text{-}XW_{11}O_{39})(H2L)]^{5-}$ (X = Si, Ge) anions in 1X-Gd, highlighting the $\{GdO_8\}$ coordination environments. Colour code: WO_6, gray; XO_4, green; Gd, pink; C, black; O, red; N, light blue; Br, orange; H, white.

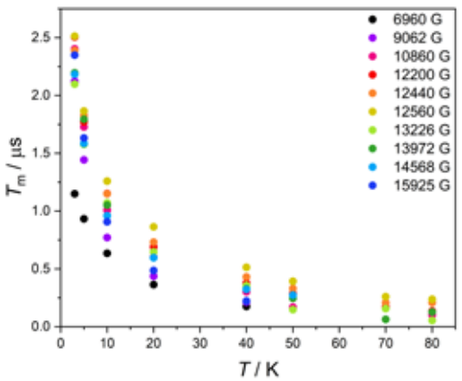


Fig 2
Phase memory times, Tm, at different fields and temperatures for 1_{Si}-Gd.

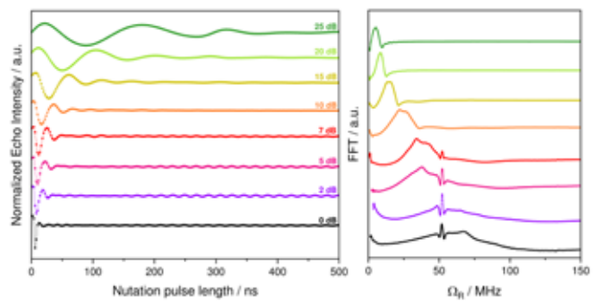


Fig 3
(Left) Rabi oscillations and (right) their corresponding Fourier transforms recorded for 1_{Si}-Gd at 5 K and a magnetic field of B_0 = 12560 G using different microwave powers.

Tailoring Ni–Co–Mn–Sn Ribbons by Ge Doping for Enhanced Magnetocaloric Effect

Ali Ghotbi Varzaneh, Parviz Kameli, Mariana Ríos, Bagher Aslibeiki, Iñaki Orue, Tapati Sarkar, Volodymyr Chernenko, Manfred Kohl, Jingyuan Xu, Daniel Salazar Advanced Electronic Materials, 11(20), e00596.

Ge addition improves lattice compatibility in Ni-Co-Mn-Sn-Gex thin ribbons, reducing martensitic transformation hysteresis to about 12.1 K at x = 2. The x = 2 alloy shows the best magnetocaloric performance, with an adiabatic temperature change of about 2 K at 1.96 T and large entropy changes at both 7 T and 2 T. These results highlight Ni–Co–Mn–Sn–Ge thin ribbons as promising micro-sized magnetocaloric materials for solid-state refrigeration.

Fig 1
a) Unit cell volume versus temperature dependences for SnGe1, SnGe2, and SnGe3 ribbons calculated using Rietveld analysis of the X-ray data; b-d) SEM images of SnGe1, SnGe2, and SnGe3 ribbons at the wheel-side surfaces, respectively, showing progressive grain refinement with increasing Ge content; e) grain size distribution on the free surface of SnGe3.

This work investigates melt-spun $Ni_{42}Co_8Mn_{39}Sn_{1-x}Ge_x$ (x = 1, 2, 3) Heusler-type thin ribbons as low-dimensional magnetocaloric materials for compact solid-state refrigeration. Compared with bulk alloys, these ribbons offer finer grains, better texture, and a high surface-to-volume ratio, making them especially attractive for active magnetic regenerator systems. Unlike many previous studies on ribbons, this work combines indirect magnetocaloric evaluation with direct adiabatic temperature change measurements, providing a more reliable assessment of cooling performance.

The results show that both Ge substitution and the melt-spun microstructure strongly influence the martensitic transformation and magnetocaloric response. Replacing Sn with Ge modifies transformation temperatures and reduces thermal hysteresis, while the high chemical homogeneity and fine microstructure produced

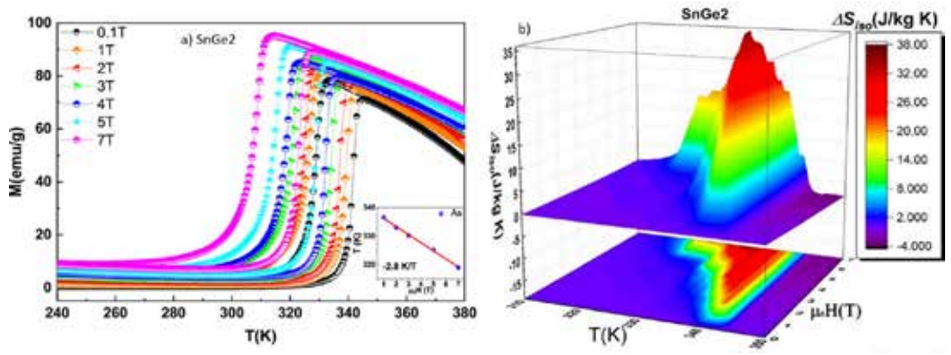


Fig 2
a) Thermomagnetization curves for the SnGe2 ribbon measured under different applied magnetic fields up to 7 T. The inset depicts the As versus magnetic field dependence and corresponding slope of linear approximation in K/T. b) Three-dimensional contour chart of the entropy change (ΔSiso) as a function of temperature and magnetic field for SnGe2 ribbon.

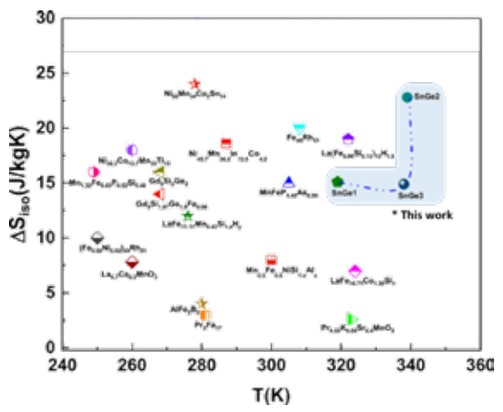


Fig 3
Comparison of the peak isothermal magnetic entropy change (| ΔSiso |) versus peak temperature for the ribbons studied in this work (SnGe1, SnGe2, and SnGe3) with various magnetocaloric materials in different forms (bulk and ribbons) reported in the literature, under a magnetic field change of 2 T.*

by rapid solidification enhance the sharpness of the transformation and increase the fraction of material undergoing field-induced reverse martensitic transformation. This improves cooling efficiency, particularly at lower magnetic fields.

Among all compositions, the SnGe2 ribbon (x = 2) exhibits the best overall performance, showing the highest adiabatic temperature change and isothermal entropy change together with the lowest martensitic transformation hysteresis. This behavior is attributed to improved geometric compatibility between austenite and martensite, which helps balance magnetization change and transformation entropy. Overall, the study demonstrates that combining controlled Ge doping with melt-spinning processing can produce thin ribbons whose magnetocaloric performance rivals bulk Ni-Mn-based alloys while offering added advantages for microscale refrigeration applications.

Strain Engineering of Magnetoresistance and Magnetic Anisotropy in CrSBr

Eudomar Henríquez-Guerra, Alberto M. Ruiz, Marta Galbiati, Álvaro Cortés-Flores, Daniel Brown, Esteban Zamora-Amo, Lisa Almonte, Andrei Shumilin, Juan Salvador-Sánchez, Ana Pérez-Rodríguez, Iñaki Orue, Andrés Cantarero, Andres Castellanos-Gomez, Federico Mompeán, Mar Garcia-Hernandez, Efrén Navarro-Moratalla, Enrique Diez, Mario Amado, José J. Baldoví, and M. Reyes Calvo (2025). Advanced Materials, 2506695.

Mechanical deformation is a powerful tool to control magnetism in 2D materials. We show that biaxial compressive strain enhances magnetoresistance and magnetic anisotropy in few-layer CrSBr, increasing the magnetoresistance ratio and the saturation fields along all crystallographic directions. First-principles calculations attribute these effects to strain-driven changes in interlayer exchange and anisotropy energy. These results establish strain engineering as an effective route to tune magnetotransport in 2D magnetic semiconductors for spintronic applications.

Controlling magnetic anisotropy and magnetoresistance in two-dimensional magnetic materials is essential for their integration into spintronic and information storage technologies. In this work, we demonstrate that strain engineering provides an effective and versatile route to tune the magnetotransport properties of the layered magnetic semiconductor CrSBr.

Few-layer CrSBr flakes were mechanically exfoliated and integrated into electrical devices on SiO_2/Si and polycarbonate (PC) substrates. Owing to the thermal expansion mismatch between CrSBr and the polymer substrate, biaxial compressive strain is transferred to the flakes upon cooling to cryogenic temperatures. Efficient strain transfer is confirmed by temperature-dependent Raman spectroscopy, which reveals additional frequency shifts in the characteristic vibrational modes for samples on PC compared to SiO_2/Si, where thermal mismatch—and therefore induced strain—is negligible.

Magnetotransport measurements show that compressive strain induces a remarkable enhancement of magnetoresistance. In particular, the magnetic saturation field along the magnetic easy axis nearly doubles under strain, accompanied by a substantial increase in the magnitude of the negative magnetoresistance. Moreover, a slight reduction of the Néel temperature (~10 K) is observed in strained samples. To elucidate the microscopic origin of these effects, first-principles calculations were performed. The theoretical analysis reveals that compressive strain strengthens the interlayer antiferromagnetic exchange coupling and increases the magnetic anisotropy energy. These strain-driven modifications account for the experimentally observed increase in critical magnetic fields and changes in magnetoresistive response and critical temperature.

Overall, this work establishes thermal strain engineering as a robust and scalable strategy for precise control of magnetic and magnetotransport properties in two-dimensional van der Waals magnets, paving the way for their implementation in tunable spintronic devices.

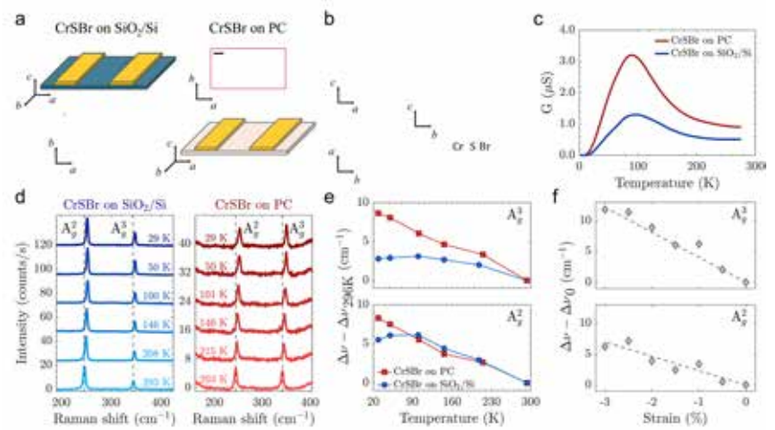


Fig 1
Raman shifts of vibrational modes confirms strain transfer from polymeric substrates. a) CrSBr devices fabricated on SiO_2/Si and polycarbonate (PC) substrates. b) Crystal structure of CrSBr. Arrows indicate the magnetization orientation. c) Conductance as a function of temperature for CrSBr on SiO_2/Si and PC d) Variable-temperature Raman spectra for CrSBr flakes on SiO_2/Si and PC. e) Thermal evolution of the (bottom) and (top) modes, relative to their respective positions at room temperature. f) Computed evolution of the and Raman modes frequency with applied biaxial compressive strain, from phonon calculations.

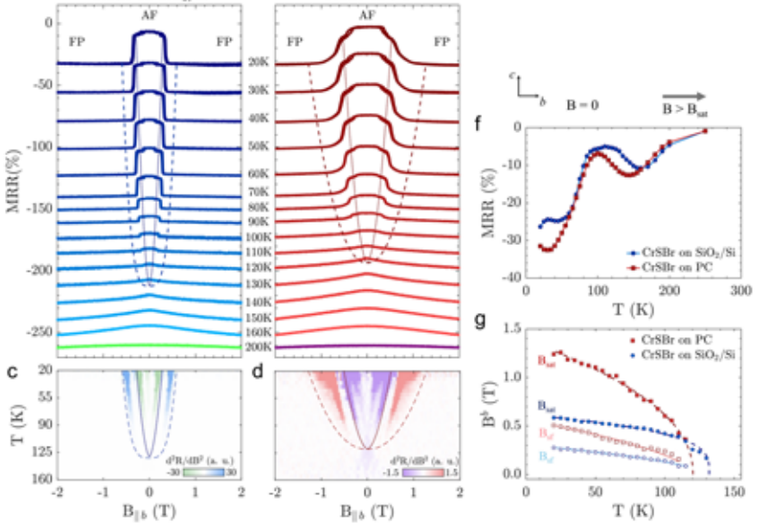
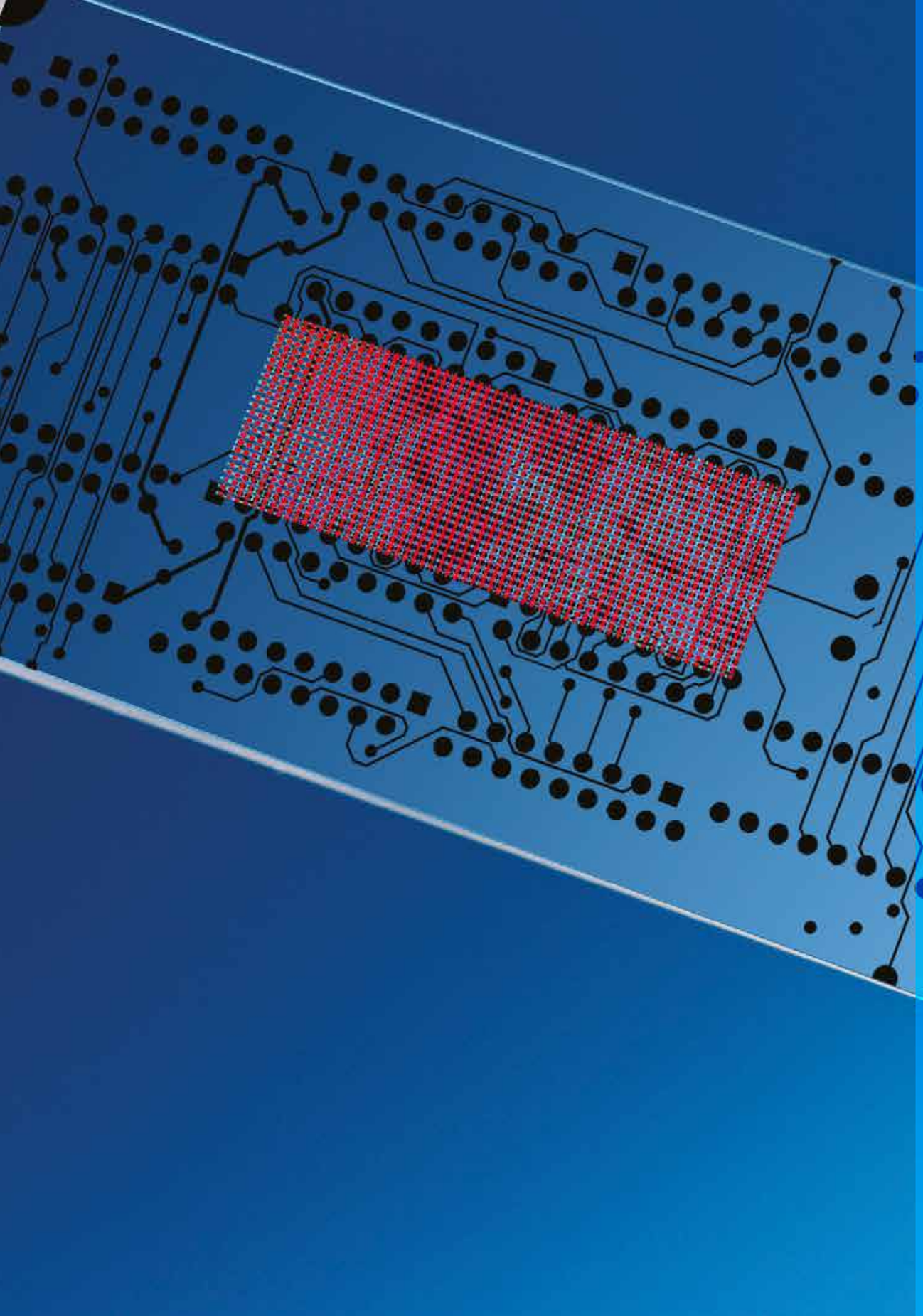


Fig 2
Magnetoresistance and saturation field increases on CrSBr devices on polycarbonate. a,b) Magnetoresistance ratio (MRR) for CrSBr flakes on SiO_2/Si (a) and PC substrates (b), as a function of temperature and applied magnetic field parallel to b-axis of CrSBr. Dashed lines indicate the saturation fields (B_{sat}), separating the ground antiferromagnetic (AF) state from the fully-polarized (FP) state. Dotted lines indicate the evolution of the spin-flop transition (B_{sf}). c,d) Second derivative of resistance versus temperature d^2R/dB^2 e) Crystal structure of CrSBr, with red arrows indicating magnetization orientation for the AF phase and the FP phase f) MRR at B = 3 T as a function of temperature for CrSBr on SiO_2/Si and PC substrates. g) Saturation field values as a function of temperature.



RESEARCH
LINE 4

MICRO & NANODEVICES

The multifunctional materials, nanostructures and surfaces being developed, allow the implementation in functional prototypes demonstrating the suitability of the materials for advanced applications. Force, deformation, magnetic, magnetostrictive and chemical sensors are being fabricated, among others. In addition, printed and flexible electronic devices are fabricated for wearables, point of care devices, interactive surfaces and structural health monitoring. Finally, microfluidic systems and organ-on-a-chip devices are being developed.

Gamma Correction and Color Space Transformations for Quantitative Analysis of Electrochemiluminescence Images Using Smartphone Camera

Rodríguez Muiña, S., Gajjala, R. K. R., Fernández Martín, E., & Del Campo, F. J. (2025). Chemical & Biomedical Imaging, 3(11), 767-778.

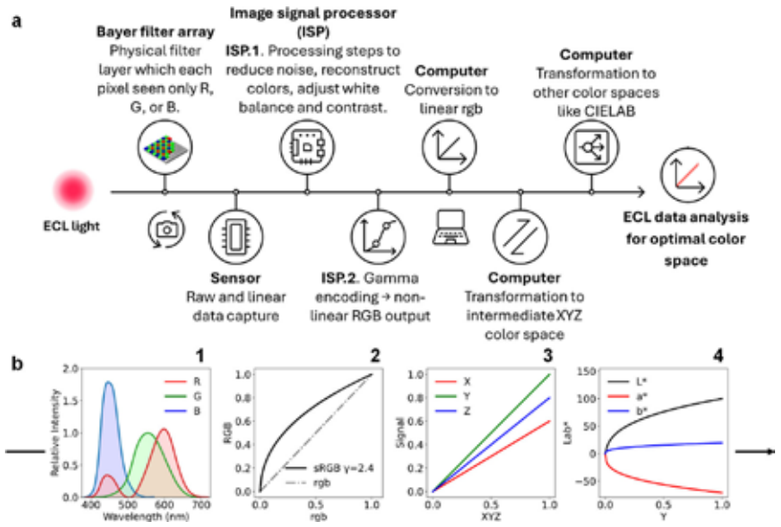


Fig 1.
(p. 2): processing pipeline camera → gamma → CIEXYZ → CIELAB
***Caption**: "Acquisition and processing workflow: from ECL emission captured by a smartphone sensor to gamma linearization and transformation into device-independent color spaces."*

> Quantitative analysis of optical signals (ECL, chemiluminescence, colorimetric assays) using smartphone cameras is often limited by nonlinear image encoding (gamma), device-to-device variability, and the lack of standardized workflows. This work presents a general methodology for quantifying luminescence from images/videos by combining synchronized electrochemical control, manual stabilization of acquisition settings, gamma linearization, and transformation into RGB/CIEXYZ/CIELAB color spaces. Using the $Ru(bpy)_3^{2+}$/TPrA ECL system as a model, we identify optimal channels to balance sensitivity and dynamic range, and show when linear vs nonlinear fitting is appropriate to expand the quantification range.

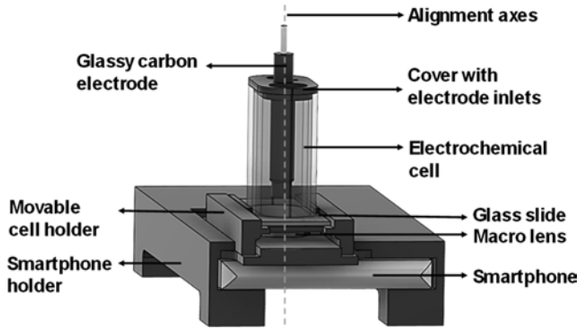


Fig. 2.
(p. 3): experimental setup / cell and alignment concept
***Caption**: "3D-printed cell and holder enabling controlled electrode–camera geometry and reduced ambient-light interference for reproducible ECL imaging."*

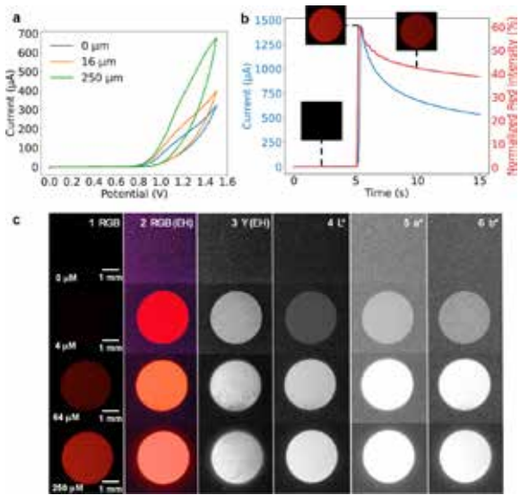


*Fig. 3. (p. 4): **electrochemical stimulus + time-resolved ECL + spatial maps Caption:***
"Coupled electrochemical and optical response of $Ru(bpy)_3^{2+}$/TPrA and visualization across color spaces, highlighting the ability to resolve spatial heterogeneities on the electrode."

Digital images are "nonlinear by design": most common image and video formats do not store intensities proportional to light, but rather gamma-encoded values optimized for human perception and file size. For quantitative imaging this becomes a major source of bias, producing artificially curved calibrations and poor reproducibility across devices. This paper proposes a robust, transferable workflow to quantify luminescent signals using smartphone cameras, using electrochemiluminescence (ECL) as a case study.

The methodology is built on three pillars. First, standardized acquisition by fixing camera settings manually (ISO, exposure, focus, white balance, and colour space), avoiding automatic processing that changes the response between measurements. Second, electrochemistry–imaging synchronization, enabling direct correlation between optical emission and electrochemical stimulus over time. Third, a traceable computational pipeline: automated frame extraction, electrode segmentation, and conversion of the selected channel using the inverse opto-electronic transfer function (OETF) to obtain linearized values (intensity proportional to photon flux and, under suitable conditions, to concentration).

As a demonstration, the work uses $Ru(bpy)_3^{2+}$/TPrA, with emission centred in the red (~620 nm), and compares performance across RGB (BT.709 and sRGB) and device-independent spaces CIEXYZ and CIELAB. The study shows that the gamma-encoded red channel R can provide strong apparent sensitivity at low concentrations but becomes nonlinear beyond a threshold; after linearization, the red channel r enables physically meaningful linear quantification across a substantially wider range. In CIEXYZ, luminance and chromaticity separation supports more consistent analysis; in CIELAB, channels such as a^* can amplify small changes (useful at low levels), but typically require nonlinear modelling to extend the usable range.

The paper concludes with practical guidance: (i) when a wide dynamic range is needed, gamma linearization and channels such as r or X are preferred; (ii) when maximum low-range sensitivity is the priority, selected gamma-encoded channels (e.g., R or a^*), used with a well-defined transfer function and calibration, can be advantageous. Overall, the work provides a standardizable, low-cost route to quantitative optical readout with direct relevance to biosensing, portable diagnostics, and image-based chemical analysis.

Sustainable Fully Inkjet-Printed Humidity Sensor Based on Ionic Liquid and Hydroxypropyl Cellulose

Rincón-Iglesias, M., Krebsbach, P., Correia, D. M., Mendes-Felipe, C., Lanceros-Méndez, S., & Hernandez-Sosa, G. (2025). ACS Applied Materials & Interfaces, 17(22), 32680-32690.

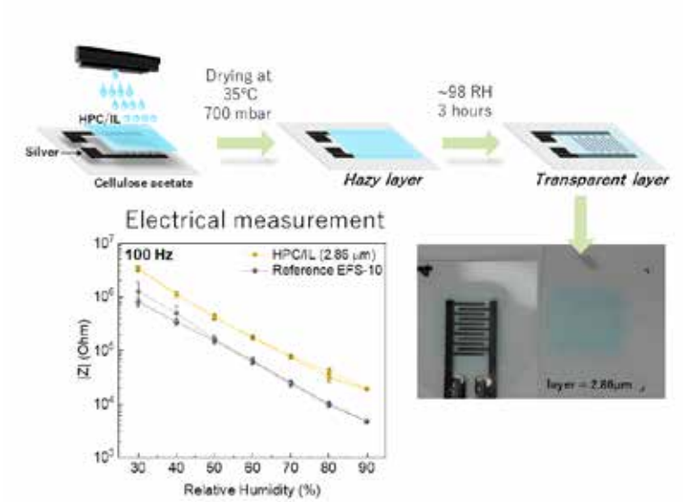


Fig 1.
Scheme of printed layers, drying conditions, and humidity post-processing conditions. Below is an image of an inkjet-printed sensor with an active layer thickness of 2.86 µm, alongside a graph showing its impedance variation as a function of relative humidity (30-90 RH%), compared with a commercial sensor.

Humidity sensors have gained significant relevance within the Internet of Things (IoT), where ubiquitous humidity monitoring is essential for environmental control, smart agriculture, food packaging, and healthcare, among others. However, the increasing number of electronic devices aggravates global e-waste, because many sensors are fabricated on non-degradable polymer substrates and often have short service lifetimes. In this context, the development of recyclable and biodegradable sensors processed through resource-efficient printing technologies is urgently required.

In this work, a fully inkjet-printed dual-response humidity sensor is presented, based on hydroxypropyl cellulose (HPC) and the ionic liquid bis(1-butyl-3-methylimidazolium) tetrachloronickelate ([Bmim]2[NiCl4]). HPC, a water-soluble cellulose derivative, was used as matrix due to excellent film-forming capacity, high transparency, and biodegradability. The ionic liquid provides both electrical and chromic response. Excellent physical compatibility between HPC and [Bmim]2[NiCl4] was observed, forming homogeneous films without phase separation even at 50 wt.% IL. The active layer was printed onto interdigitated silver electrodes on flexible cellulose acetate substrates using low-temperature inkjet printing, minimizing material consumption and waste.

A sustainable, dual-response sensor based on hydroxypropyl celluloseandtheionicliquidbis(1-butyl-3-methylimidazolium) tetrachloronickelate has been fully inkjet-printed. The printed sensor demonstrates a proportional electrical response, with high sensitivity (163), low hysteresis and a fast response time (0.8 s). Additionally, a visual response ranging from colourless to cyan is observed for relative humidity below 30 RH%. Fabricated from sustainable materials using energy- and material-efficient printing technology, this sensor has great potential for a variety of applications, including environmental monitoring, smart agriculture, fire safety, and quality control in the food industry.

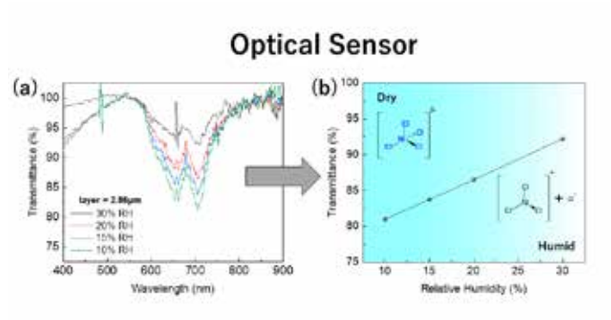


Fig. 2.
Breath monitoring with a surgical mask and a printed sensor connected to an LCR meter at 100 Hz.

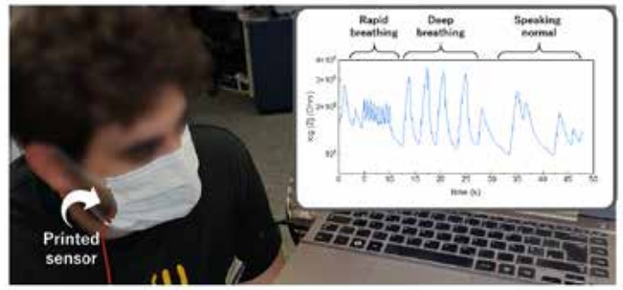


Fig. 3. *(a) The visible spectra of the inkjet-printed sensor between 30 and 10 RH%, and (b) the variation in transmittance at 708 nm (the maximum absorbance).*

Electrically, the printed sensor demonstrates a proportional impedance response (log scale) in the 30–90% RH range. At 100 Hz, the impedance decreases from 3 x 106 Ω at 30% RH to 2 x 104 Ω at 90% RH, yielding a high sensitivity of 163, comparable to a commercial reference sensor (Figure 1). The device exhibits low hysteresis (1.5% RH) and fast response and recovery times of 0.8 s and 7.2 s, respectively. The sensor also demonstrated stability under prolonged humidity exposure and successful breath monitoring when integrated into a surgical mask (Figure 2). The sensing mechanism arises from water absorption by both HPC and the ionic liquid, enhancing ion mobility and conductivity within the thin and uniform printed layer (2.86 µm). In addition to the electrical response, a visual color change is observed at low humidity levels. Below 30% RH, the material turns cyan due to the tetrahedral [NiCl4]2- complex in the dehydrated state. Upon hydration, coordination with water molecules forms the octahedral [Ni(H2O)6]2+ complex, changing to a colorless film. The color intensity varies linearly between 10 and 30% RH and is visible to the naked eye (Figure 3). Interestingly, this threshold coincides with the "30–30–30" rule associated with high wildfire risk, highlighting potential relevance for environmental monitoring.

TRANSVERSE
RESEARCH
LINE 1

NEUTRON SCIENCE

Neutron science is strongly applied in all activities of BCMaterials and it will continue to be one or the cornerstones of advanced materials characterization. SANS, diffraction, reflectometry and inelastic experiments are being performed in ANSTO (Australia) ILL (France), PSI (Switzerland) and ISIS (UK) in areas including magnetism, MOFs, energy generation and storage, soft matter and nanoparticles.

Investigation of the Interaction of Ionic Surfactants with Epoxy-Based Hydrogels by SANS

Krakovsky, I., Tropin, T. V., Ivankov, O. I., & Petrenko, V. (2025). Langmuir, 41(6), 3895-3908.

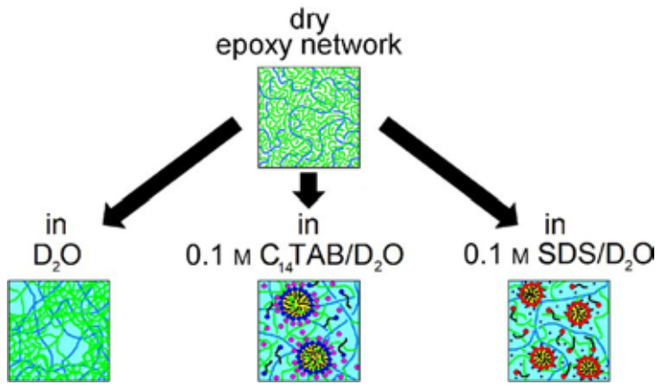


Fig 1
Behaviour of epoxy hydrogels in D2O and in mixture with cationic and anionic surfactants.

Macroscopically, polymer hydrogels are soft solids with high water content. At the microscopic level, in polymer hydrogels, a complex fluctuating three-dimensional (3D) network of interconnected polymer chains is expanded by highly mobile water molecules dispersed inside the network. Hydrogels have attracted much attention in modern technologies due to their potential applications as sensors, soft actuators, and biomedicines. Responsiveness to various external changes makes hydrogels dynamic materials, allowing changes in their properties in response to specific triggers.

In this study, small-angle neutron scattering (SANS) was used to study structure and interaction parameters in the systems. A new stoichiometric epoxy network was prepared using a longer POP (molar mass of ca. 4000 g·mol 1) and the same POE bis(glycidyl ether). Consequently, the cross-linking density of the present network is lower, and the POP and POE contents are 81 and 19 wt %, respectively. The effects of both the cationic (C14TAB) and anionic surfactants (sodium dodecyl sulfate (SDS)) on the composition and structure of the resulting hydrogels are investigated and compared (fig.1). The importance of POP block length was evaluated.

In the subcritical region, the effects of both surfactants are similar. In the supercritical region, the effects of C14TAB and SDS differ significantly. At the macroscopic level, the swelling degree increases for both surfactants, but much more strongly for SDS than for C14TAB. This is attributed to the smaller size and higher mobility of the sodium countercations relative to the bromine counteranions.

The details of the hydrogel structure were deduced by general analysis and fitting of the experimental SANS profiles to two model scattering functions exploiting the Percus Yevick hard-sphere (HS) model and rescaled mean spherical approximation (RMSA), respectively (fig.2 and fig.3). In the former model, valid for the hydrogels prepared in low concentrated surfactant solutions, spherical domains of average radius of ca. 39 45 A from a highly swollen network dispersed in a matrix of a poorly swollen network mixed with the bound alkyl surfactant tails were revealed. In the latter model, hydrogels prepared in surfactant solutions of sufficiently high concentrations consist of surfactant micelles dispersed in a matrix of a highly swollen network. The average radii of the C14TAB and SDS micelles formed in the hydrogels were ca. 28 and 17 A, respectively.

> Effect of two ionic surfactants (cationic C14TAB or anionic SDS) on the composition and structure of hydrogels obtained by swelling an epoxy amphiphilic polymer network were studied using a combination of gravimetry and small-angle neutron scattering (SANS). Hydrogels prepared in surfactant solutions of sufficiently high concentrations consist of surfactant micelles (with size 28 and 17 Å) dispersed in a matrix of a highly swollen network. The strong binding of surfactant tails with POP chains and dragging of large amounts of highly mobile counterions inside the hydrogels were responsible for the effects observed.

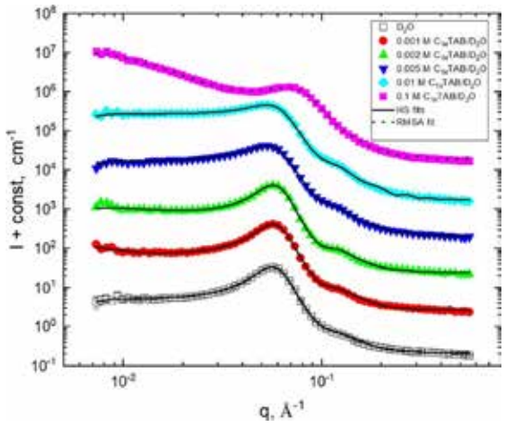


Fig 2
Experimental SANS profiles and best-fit curves for C14TAB hydrogels. Profiles are shifted for clarity.

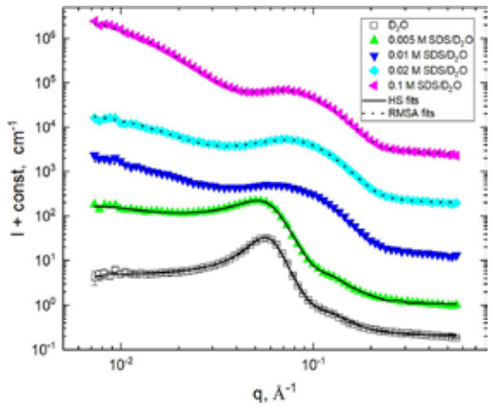


Fig 3
Experimental SANS profiles and best-fit curves for SDS hydrogels. Profiles are shifted for clarity.

Tuning Magnetic Interactions in Cu-doped Ni-Mn-Ga Alloys via Neutron Diffraction

Río-López, N. A., Lázpita, P., Doménech, D., Rodríguez-Velamazán, J. A., Chernenko, V. A., Plazaola, F., Seguñi, C., & Porro, J. M. (2025). Journal of Alloys and Compounds, 183639.

Magnetic Shape Memory Alloys (MSMAs) are vital for magnetocaloric and actuation applications. This study explores the Ni50Mn25-xGa25Cux system to understand how Cu doping affects structural and magnetic transitions. Using powder neutron diffraction and magnetometry, the researchers demonstrate that increasing Cu content elevates the martensitic transformation temperature (TM) by increasing structural distortion. Crucially, the study identifies that displaced Mn atoms lead to stronger antiferromagnetic exchange interactions, providing a precise mechanism to tune the alloys' magnetic properties for technological use.

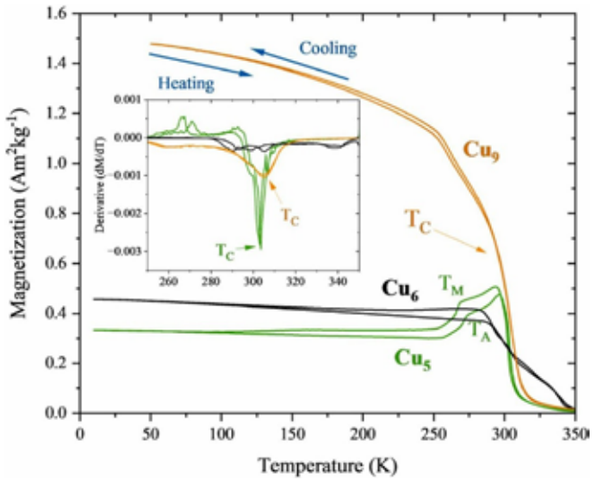


Fig 1
Temperature evolution of the magnetization for Cu5, Cu6 and Cu9 alloys, measured with a 0.005 T applied magnetic field, alongside with an example of the position of the Curie temperature (TC) for the Cu9 alloy and TC, the austenitic (TA) and martensitic (TM) transformation temperatures for the Cu6 alloy. The inset shows the first derivative of M(T).

The research investigates the Ni50Mn25-xGa25Cux (x=5, 6, 9) alloy series to elucidate how copper doping influences both structural and magnetic behaviours. Magnetic Shape Memory Alloys (MSMAs) are highly valued for their magnetocaloric effects and magnetic field-induced strains, properties that are governed by their specific transition temperatures. The primary objective was to draw a direct connection between atomic ordering and the observed physical properties through advanced characterization techniques.

Experimental procedures involved preparing polycrystalline powders via induction and arc melting, followed by thermal treatments. The researchers utilized Differential Scanning Calorimetry (DSC) to pinpoint structural transformation temperatures and SQUID magnetometry to evaluate magnetic transitions. Central to the study were powder neutron diffraction experiments conducted at the Institut Laue-Langevin (ILL; Grenoble, France), which provided a deep look into the crystal structures and atomic site occupancies of the austenite and martensite phases.

A key finding is the significant increase in the martensitic transformation temperature (TM) as Cu content rises. This elevation is attributed to a higher structural distortion (the c/a ratio), which

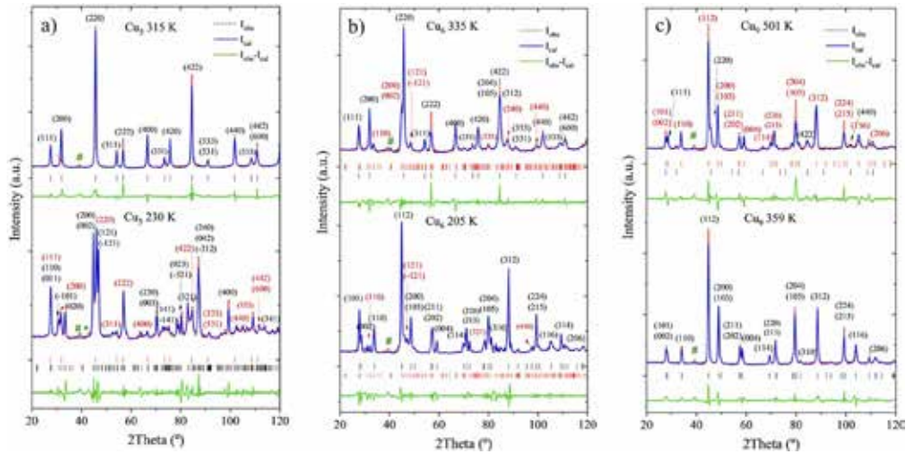


Fig 2
Neutron diffraction patterns and Rietveld (high temperature) or Le Bail (low temperature) refinements for the a) Cu5 cubic austenite at 315 K (2=11.8) and cubic austenite (red) + monoclinic martensite (black) at 230 K, b) Cu6 cubic austenite (black) (2=11.5) + monoclinic martensite (red) at 335 K and tetragonal (black) + orthorhombic martensite (red) at 205 K, c) Cu9 cubic austenite (black) (2=15.7) + tetragonal martensite (red) at 501 K and tetragonal martensite at 359 K. Red dots represent experimental points; blue lines are the fittings; and green lines correspond to the difference between the measurements and the fittings. The Miller indices corresponding to each reflection are also shown above each peak, with its colour indicating its correspondence to the austenite, tetragonal or monoclinic martensite phases. The asterisk marks the presence of a modulation peak and the number sign, of a background peak.

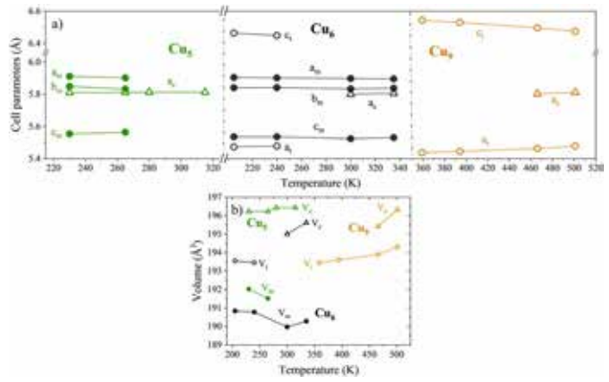
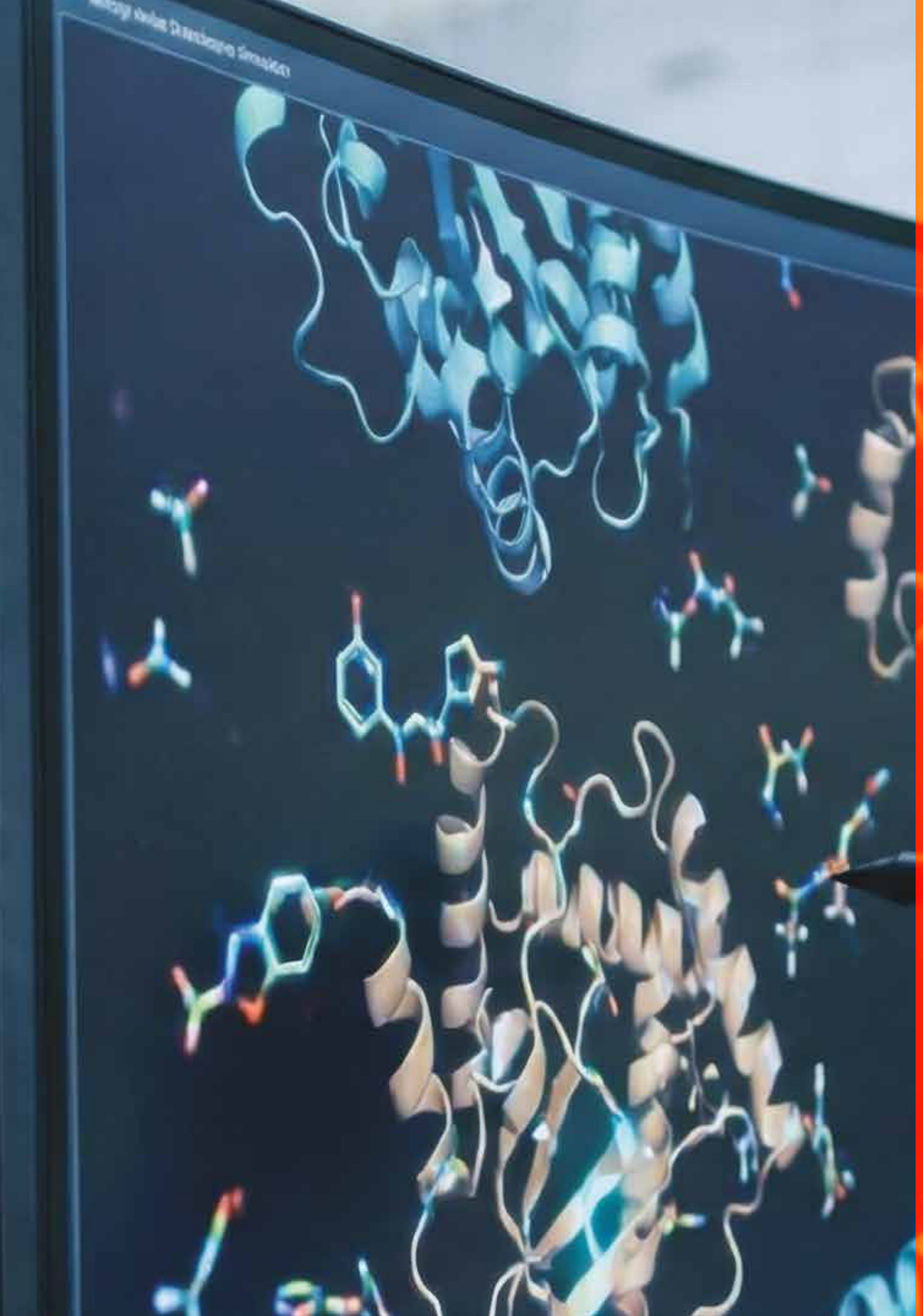


Fig 3
a) Lattice parameters' evolution with temperature, using the fcc cell as reference. Triangles represent the cubic austenitic parameters (ac); bold dots correspond to the monoclinic martensite (am, bm and cm), and circles to the tetragonal martensite (at=bt, ct). b) Unit cell volume evolution with temperature.

increases from 0.95 in the Cu5 sample to 1.20 in the Cu9 sample. Because the higher-temperature martensite is more structurally distinct from the austenite phase, more energy is required to induce the transition. Additionally, the Cu6 sample exhibited an intermartensitic transformation, moving from a modulated monoclinic phase to a non-modulated tetragonal one.

The study also reveals the intricate role of atomic site occupancy in determining magnetic properties. Rietveld refinements showed that Cu dopants primarily occupy Mn (4a) sites. As Cu concentration increases, Mn atoms are displaced to Ni (8c) and Ga (4b) sites. These displaced Mn atoms engage in antiferromagnetic exchange interactions, a phenomenon confirmed by comparing experimental saturation magnetization μsat with theoretical models. Model 2, which incorporates these antiferromagnetic couplings, showed excellent agreement with experimental data.

In conclusion, the work demonstrates that Cu doping allows for the systematic tuning of MSMA properties. By tailoring the atomic interactions through composition, it is possible to optimize these materials for high-performance heat exchangers and other magnetocaloric applications.



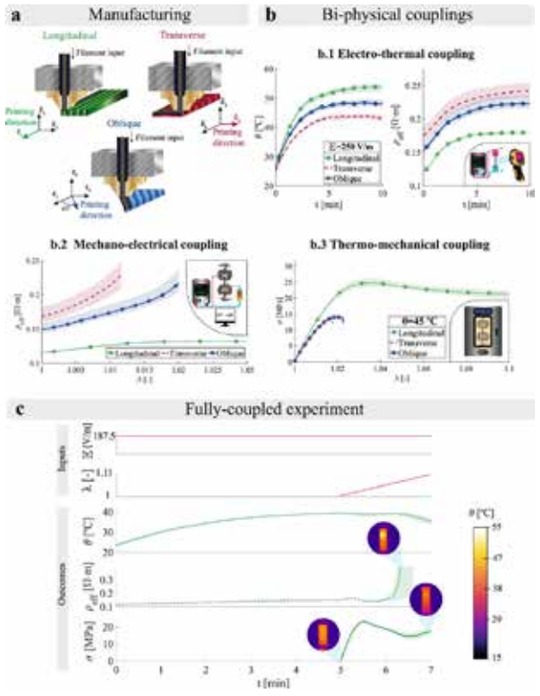
TRANSVERSE
RESEARCH
LINE 2

COMPUTATIONAL MATERIALS SCIENCE

Computational support has been over the years used in BCMaterials research spanning from DFT to molecular dynamics, from finite element simulation to artificial intelligence and machine learning for materials design. This research line supports effors on materials design, physical-chemical interactions understanding and modulation, and device implementation.

In-silico platform for the multifunctional design of 3D printed conductive components

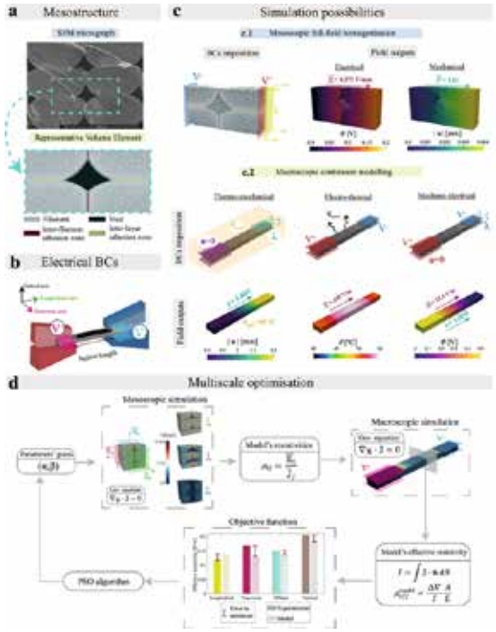
Crespo-Miguel, J., Lucarini, S., Garzon-Hernandez, S., Arias, A., Martínez-Pañeda, E., & Garcia-Gonzalez, D. (2025). Nature Communications, 16(1), 1359.



> This work presents a validated multiscale computational platform for the design of 3D-printed conductive thermoplastic components with coupled thermal, electrical, and mechanical functions. Experiments conducted with polylactic acid/carbon black samples printed in longitudinal, transverse, and oblique directions reveal strong orthotropic behavior and thermo-electro-mechanical coupling. A computational multiscale multiphysics framework is developed to link mesoscale voids and adhesion zones to the macroscopic response, allowing the optimization of multifunctional devices such as a heatable cartridge for direct ink printing.

Fig 1
Multiphysics characterization of FFF samples
Experimental characterization showing the effects of longitudinal, transverse, and oblique printing orientations on the coupled thermo-electro-mechanical behavior of the PLA/CB samples.

The article presents an integrated experimental and computational strategy for predicting the multifunctional response of conductive thermoplastic parts produced by fused filament fabrication (FFF). The material studied is polylactic acid (PLA) filled with carbon black (CB), and the main conclusion is that print orientation significantly influences electrical conductivity, thermal behavior, and mechanical performance. Longitudinal, transverse, and oblique filament directions generate different current paths, adhesion conditions, and failure mechanisms, as the printed mesostructure contains voids and imperfect bonds between filaments and layers. The authors first establish a set of experimental data by separating the couplings in pairs. They measure the electrothermal behavior under Joule heating, the mechanical-electrical behavior during tensile loading, and the thermomechanical behavior at controlled temperatures. They then perform fully coupled tests in which the electric field, displacement, and temperature evolve together. These results show a clear interdependence between the variables: temperature changes conductivity, deformation alters resistivity, and Joule heating modifies ductility



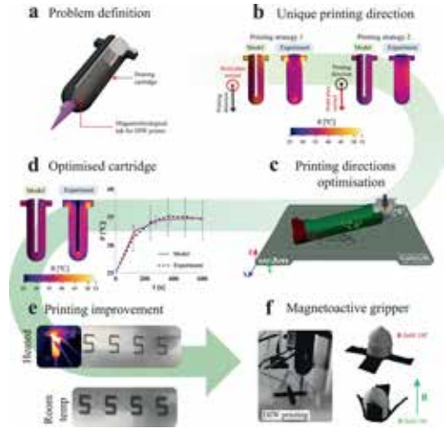


Fig 2
Multiscale in silico platform for PLA/CB conductive thermoplastics
Overview of the two-scale computational framework, linking mesoscale FFF features (like voids and filament adhesion zones) to the macroscopic multiphysics continuum model.

Fig 3
Heatable cartridge optimized for DIW printing
Practical application of the model to optimize local print directions in a 3D-printed heatable cartridge, resulting in a more homogeneous temperature field for DIW.

and stress evolution. In particular, the response differs considerably when the load is aligned with the direction of filament deposition or is transverse to it. To explain and generalize these trends, the article presents a two-scale in silico platform. At the mesoscopic scale, representative volume elements obtained by scanning electron microscopy images are used in a full-field homogenization scheme to estimate effective properties, explicitly accounting for filaments, voids, and adhesion zones. At the macroscopic scale, a continuous multiphysics model solves coupled electrical, thermal, and mechanical problems, incorporating orthotropic constitutive behavior, Joule heating, and convection. The framework is validated through thermomechanical, mechanical-electrical, electrothermal, and fully coupled tests, with good results. Finally, the model is applied to optimize local print directions in a 3D-printed heatable cartridge for direct ink writing (DIW). The optimized design produces a more homogeneous temperature field and improves the printability of a magnetorheological ink, demonstrating the practical value of the platform for designing multifunctional components.

Fuzzy Band Structure of Quantum Dots by Bloch Orbital Expansion: Unconventional Insights into Geometric-Electronic Structure Relations

Hens, Z., Llusar, J., & Infante, I. (2025). ACS nano, 19(8), 8227-8237.

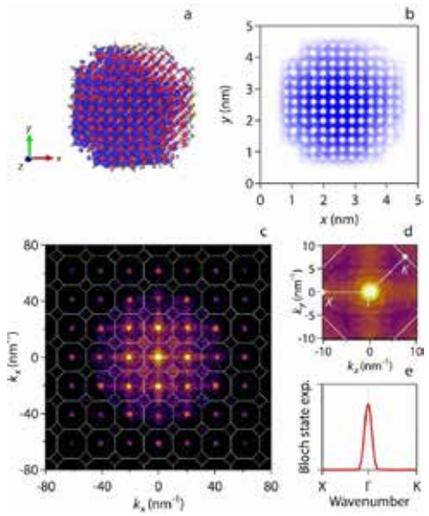


Fig 1
Concept of Bloch Orbital Expansion. A quantum dot orbital calculated in real space (a) is transformed to reciprocal space (b) and folded into the first Brillouin zone to generate a fuzzy band representation (c-d). This transformation enables direct comparison between finite nanocrystals and bulk semiconductor band structures.

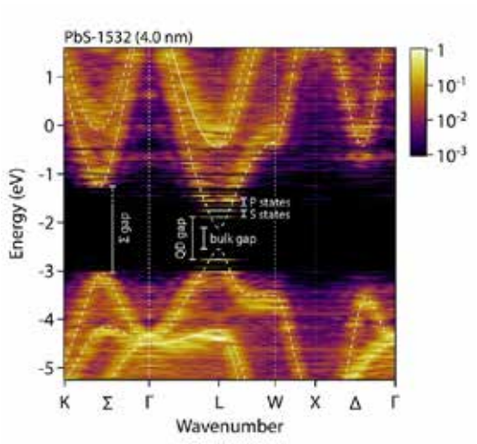


Fig 2
Fuzzy band structure of a 4 nm PbS quantum dot obtained through Bloch Orbital Expansion. The color map represents the spectral weight of the quantum dot orbitals in momentum space. The dashed lines indicate the bulk PbS band structure. The agreement highlights the direct link between confined nanocrystals and extended solids.

Quantum dots (QDs) are semiconductor nanocrystals that lie at the boundary between bulk solids and molecules. While their atoms form a periodic lattice similar to the bulk material, their nanoscale size induces discrete electronic levels due to quantum confinement. Understanding how atomic structure, and especially surface termination, influences their electronic properties is essential for optimizing their performance in optoelectronic applications.

In this work, we introduce and apply a method termed Bloch Orbital Expansion (BOE) to reinterpret electronic states obtained from density functional theory (DFT) calculations on atomistic QD models. Instead of analyzing molecular orbitals solely in real space, we transform them into reciprocal space and project them onto bulk Bloch states. This procedure produces a so-called "fuzzy band structure" that enables a direct comparison between finite nanocrystals and the band structure of the corresponding bulk semiconductor.

This approach makes it possible to clearly distinguish between delocalized states derived from bulk bands and surface-localized states associated with trap-like features. We demonstrate that surface reconstruction or appropriate chemical passivation can suppress the admixture of surface states within the band gap, restoring the expected quantum-confined electronic structure. Conversely, insufficiently reconstructed or poorly passivated polar facets lead to mid-gap states and a breakdown of well-defined band-like behavior.

We apply BOE to representative II–VI, III–V and IV–VI semiconductor quantum dots, including PbS, InAs and CdSe systems. The method reveals how quantum confinement manifests as size-dependent band broadening in reciprocal space, and how orbital envelope symmetry can be directly identified from momentum-space signatures.

Importantly, we extend the method to realistic core/shell heterostructures. The fuzzy band structure allows us to extract band alignment between core and shell materials directly from atomistic DFT calculations, without relying on adjustable bulk parameters. This provides a new strategy to analyze band offsets and carrier confinement in nanocrystal heterostructures.

Overall, BOE establishes a conceptual bridge between solid-state band theory and ab initio simulations of finite nanocrystals, offering a powerful framework to connect surface chemistry, atomic structure and electronic properties in semiconductor quantum dots.

> We introduce Bloch Orbital Expansion (BOE) as a new tool to interpret the electronic structure of semiconductor quantum dots obtained from density functional theory. By transforming real-space orbitals into momentum space, BOE produces a "fuzzy band structure" that connects atomistic models with bulk semiconductor bands. This approach reveals how surface termination, reconstruction and core/shell architectures determine band alignment, orbital symmetry and the presence of trap states in nanocrystals.

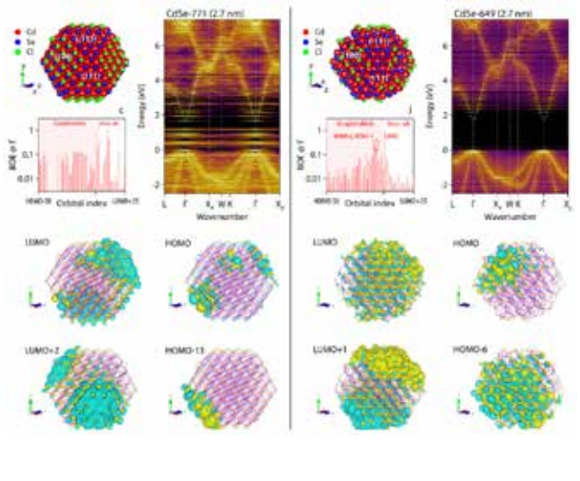


Fig 3
Influence of surface reconstruction on the electronic structure of CdSe quantum dots. Without reconstruction (left), numerous in-gap surface states appear. After geometric reconstruction (right) of polar facets, the fuzzy band structure becomes well-defined and surface-localized states are strongly suppressed.

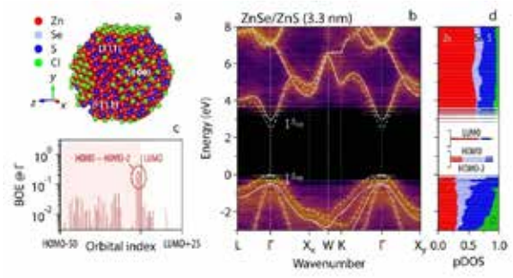


Fig 4
Fuzzy band structure (b) of a ZnSe/ZnS core/shell quantum dot (a). The analysis allows direct extraction of valence- and conduction-band offsets between core and shell materials from atomistic calculations, revealing type-I band alignment (b-d). BOE analysis (c).

RESEARCH
AREA 1

BIOMEDICINE & BIOTECHNOLOGY

Related to the aging of population and the strong needs on early detection of illnesses, advanced biomedical approaches are definitely needed. Advanced multifunctional materials, advanced manufacturing and nanoscience and nanotechnology are providing new tools in order to tackle those important challenges. In this context, BCMaterials is focusing, among others, on the development of materials and new approaches for nanoparticle based biomedicine, from hyperthermia to point of care devices, as well as on the development of active scaffolds and microenvironments for tissue engineering.

Effect of Nanoparticles Type and Content on the Antimicrobial Activity of Magnetoelectric Polymer-Based Composites

Moreira, J., Fernandes, M. M., Correia, V., Correia, D. M., Tubio, C. R., Lazic, V., & Lanceros-Mendez, S. (2025). Macromolecular Bioscience, e00429.

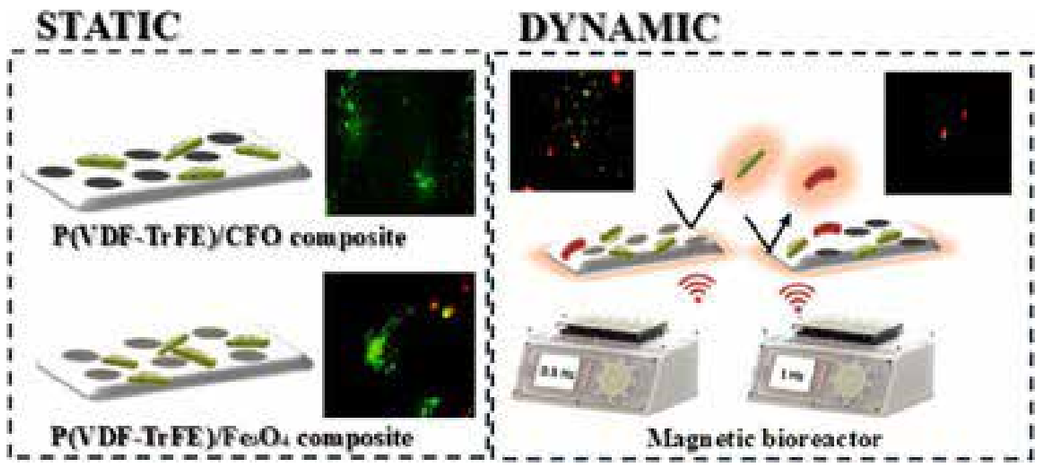


Fig 1
Graphical abstract

To address the growing health issue, antimicrobial materials have gained considerable attention in both industry and healthcare for their potential to protect surfaces, particularly high-traffic surfaces and medical devices. Among the different approaches, smart materials based on piezoelectric polymers like poly(vinylidene fluoride-co-trifluoroethylene) [P(VDF-TrFE)] have been explored for their antimicrobial potential when exposed to physical stimuli. Therefore, in this study, different magnetoelectric nanocomposites exhibiting antimicrobial activity upon magnetic stimulation were developed. The nanocomposites, composed of P(VDF-TrFE) with different contents (10 and 20% wt) of magnetostrictive CoFe2O4 (CFO) or Fe3O4 NPs, were developed to respond to a variable magnetic field, mechanically stimulating the piezoelectric component of the material and inducing surface potential variations. The antimicrobial properties of these samples were evaluated by exposing them to different magnetic frequencies (0.3 and 1 Hz) in a custom-made magnetic bioreactor. The results show that this approach enables a direct correlation between particle composition, magnetoelectric performance, and antimicrobial efficacy. For example, the growth of Escherichia coli (E.coli) and Staphylococcus aureus (S. aureus) was significantly inhibited, particularly in the nanocomposite with 20% CFO NPs, under magnetic stimulation at 1 Hz (bacterial cell viability ≈15%) compared to static conditions (bacterial cell viability ≈35%). This study highlights the potential of magnetic stimulation, in combination with magnetoelectric materials, as an effective strategy for the development of antimicrobial surfaces.

Antimicrobial materials are essential for the development of coatings for high traffic surfaces to prevent the adhesion and proliferation of microorganisms, playing a crucial role in infection control. As an effective strategy for the development of antimicrobial surfaces, in this study, magnetoelectric P(VDF-TrFE) nanocomposites containing magnetic nanoparticles (NPs) were developed to generate electroactive microenvironments under magnetic stimulation. The approach highlights the potential of magnetically activated surfaces to inhibit microbial adhesion and support infection control in medical and public settings.

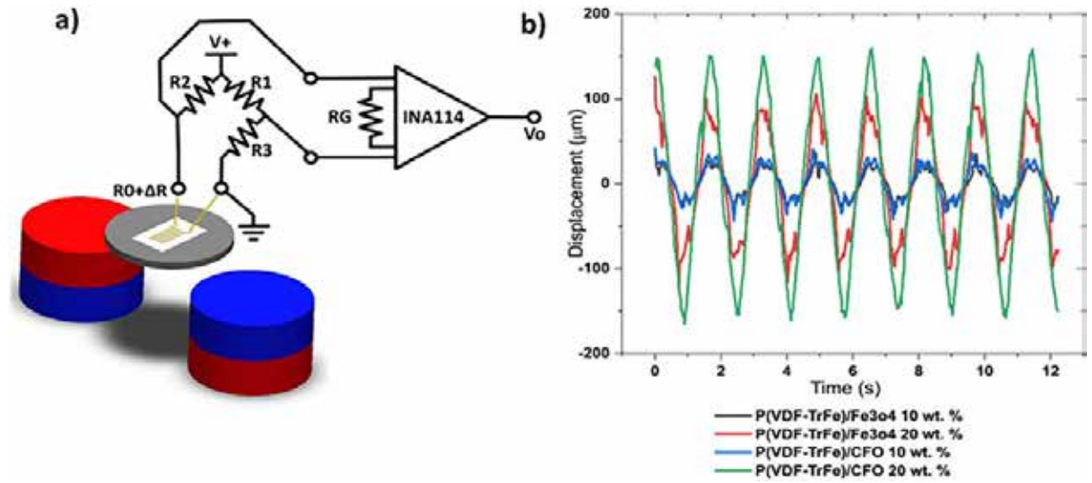


Fig 2
a) Schematic representation of the magnetic stimulus operating method and the measurement method applied to determine the electromechanical variation of the samples. (b) Evaluation of the deformation under a magnetic field with cyclic variation.

Expanding the Applicability of Electroactive Polymers for Tissue Engineering Through Surface Biofunctionalization

Leiva, B., Irastorza, I., Moneo, A., Ibarretxe, G., Silvan, U., & Lanceros-Méndez, S. (2025). Biomimetics, 10(2), 126.

> The relevance of PVDF-based materials for tissue engineering applications comes for its electroactive properties, however, its synthetic nature and hydrophobicity limit the applicability of this polymer for certain purposes involving cell attachment. Here, we describe a method for the functionalization of PVDF films with biomolecules. After the chemical modification, and independently of its polarization state, the PVDF films covalently bind equivalent amounts of cell-binding proteins, while retaining their piezoelectric activity, representing a very promising method for the functionalization of PVDF-based tissue engineering approaches.

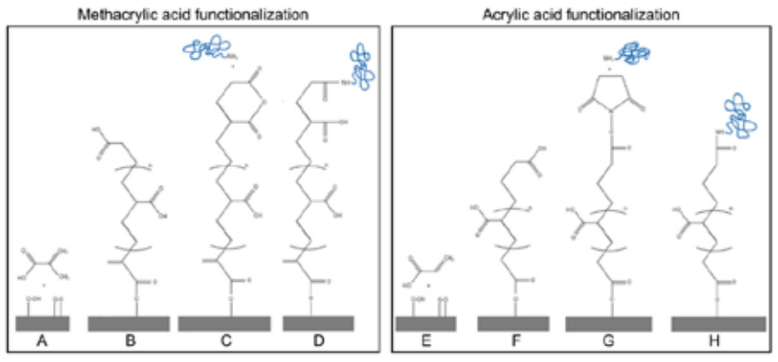


Fig 1
Schematic representation of the PVDF functionalization strategy with methacrylic (A-D) and acrylic acid solution (E-H).

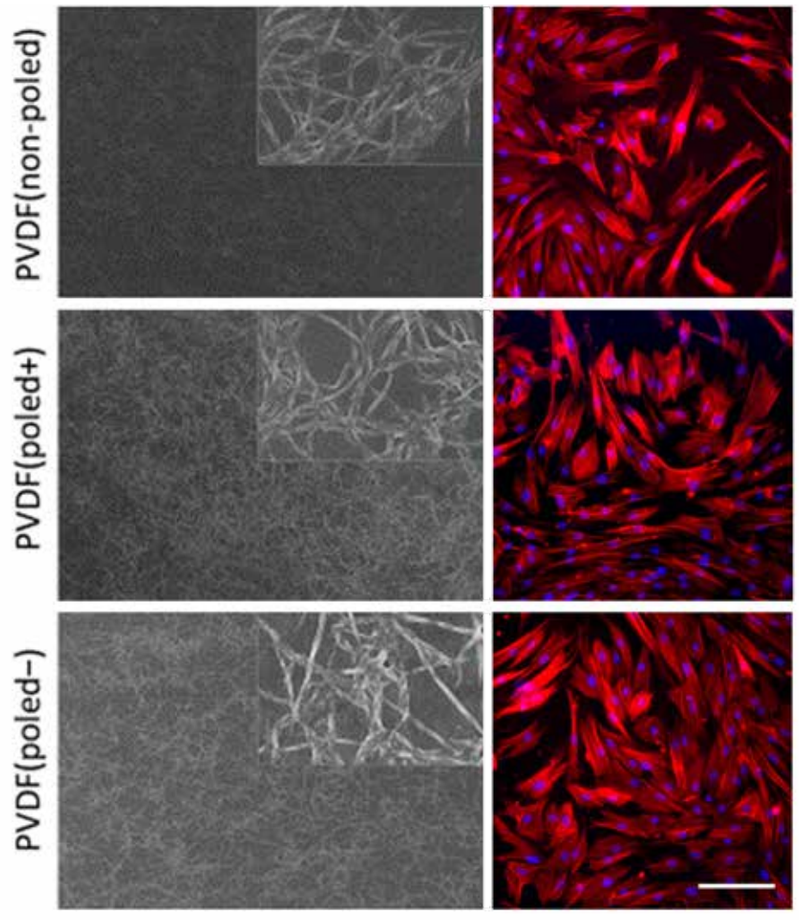


Fig 2
Left column: Scanning electron microscopy micrographs of collagen type I immobilized in PVDF films with net zero (upper image), positive (middle) and negative surface potential (bottom). Right column: Human dental pulp stem cells adhering to the PVDF surfaces.

Among synthetic piezoelectric materials, polyvinylidene fluoride (PVDF) is a semi-crystalline thermoplastic fluoropolymer that shows good biocompatibility, excellent mechanical properties, chemical stability, and easy processability into a number of different structures. This renders the polymer a highly attractive choice for the fabrication of biomedical implants for tissue reconstruction, particularly bone. However, the synthetic composition and inherent hydrophobicity of PVDF raise considerable challenges that significantly restrict its use in biological contexts.

With these limitations in mind, in the present work, we describe the use of two different acrylic acids, namely methacrylic and acrylic acid, to functionalize the surface of -phase PVDF films with different polarities. We activated the exposed carboxylic groups of the acids using a carbodiimide/ N-hydroxysuccinimide (EDC/NHS) reaction for the covalent binding collagen type I to the surface. In the study, we describe the physicochemical and biological characterization of the functionalized PVDF surfaces (Figure 1).

The described covalent immobilization of collagen type I on -phase PVDF membranes creates a biomimetic composite that emulates bone in two key aspects of this tissue: it replicates the electroactive characteristics of natural bone through the piezoelectric properties of PVDF while simultaneously presenting a biologically favourable surface that promotes cellular attachment (Figure 2). This modification of PVDF addresses previous limitations associated with this polymer for biomedical applications, expanding both its functionality and biological compatibility and opening new possibilities for advanced tissue engineering approaches. In addition, this approach allows the piezoelectric stimulation of cells attached to otherwise identical surfaces, thereby facilitating the analysis of the transduction mechanisms of these types of signals.

RESEARCH
AREA 2

ENVIRONMENTAL PREVENTION, REMEDIATION & MONITORING

The strong technological advances of recent years are leaving important footprints in our environment. In this scope, three main issues must be solved in the near future: environmental friendlier technologies, sensors for environmental monitoring and remediation of contaminated scenarios. In these areas, BCMaterials is strongly focusing on the development of prevention (environmental friendly materials and processes), monitoring (environmental sensing) and remediation strategies for water and air.

Hybrid biopolymer/metal–organic framework 3D-sponges towards the capture of the 'big five' heavy metals

García, M. C., Salazar, H., Britto, S., Tomchuk, O., Martins, P. M., Pradhan, A., Cassio, F., Lanceros-Méndez, S., De la Caba, K., Guerrero, P., Petrenko, V., & De Luis, R. F. (2025). Chemical Engineering Journal, 169442.

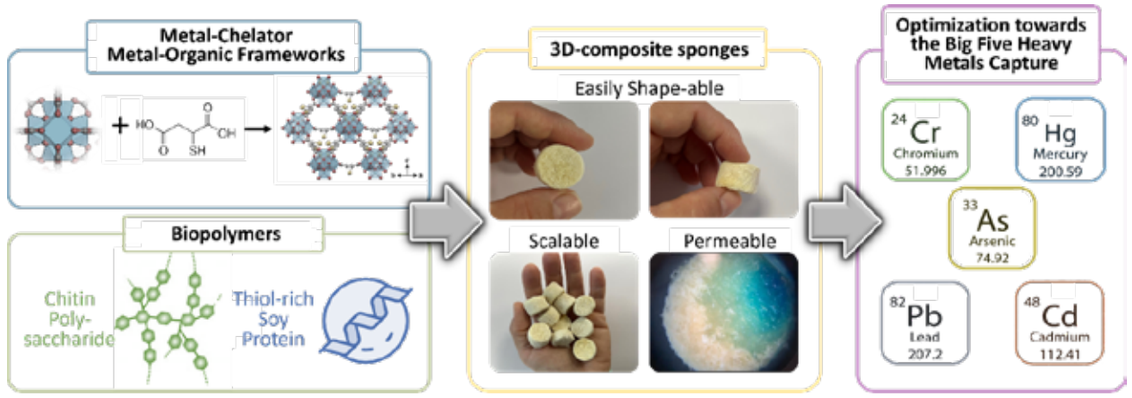


Fig 1
Strategy employed in this research.

Access to clean water in isolated regions remains a major challenge, particularly due to contamination by the five most prevalent heavy metals: Hg(II), Pb(II), Cd(II), As(III/V), and Cr(VI). This is a global concern, especially when considering isolated areas that lack access to water treatment facilities. Here is where portable filtering systems based on sorbent materials can make the difference. Nevertheless, traditional sorbents are limited in their ability to capture all the "big five" heavy metals, since they occur as cationic, neutral, or anionic species under standard condition.

To address this challenge, we have integrated a thiol rich Zr(IV)- Metal-Organic Framework (MOF), namely BCM-1, into a soy protein (SPI) and chitin (CHI) sponge in order to engineer a 3D-hybrid water filter. The synthesis of BCM-1, and its integration into 3D-composite sponges has been done in a green and scalable manner in order to obtain more than 10 grams of the final fitters in one process, as illustrated in the Figure 1.

The components and the composite systems were thoroughly characterized by conventional means. Additionally, neutron imaging was used to reveal the 3D-interconnected micro- to macroporous structure of the filters, while Small-Angle X-ray Scattering (SAXS) confirmed the presence of BCM-1 as monodisperse nanoparticles (As illustrated in the Figure 2). The 3D-sponge combines mechanical stability, high permeability, and broad chemical affinity, allowing the efficient removal of all five heavy metals through simple adjustments of its activation conditions. Adsorption experiments demonstrated over 90% removal for most target metals depending if the hybrid-sponge is employed as synthesised, or after activating at pH=1. When tested with 1 ppm solutions, they exhibit adsorption efficiencies for Hg(II), Pb(II), Cd(II), As(V), and Cr(VI) of 60.8/100%, 94.4/74.8%, 15.7/69.1%, 100/38.2%, 5.7/100%, and 13.5/97.4%, before and after the activation of the 3D-sponge, respectively. The metrics are consistently maintained over three adsorption/desorption cycles in surface water samples (Figure 3).

On the whole, this work provides a scalable and sustainable approach to combine biopolymers and MOFs for real-world water remediation applications and highlights the key role of their protonation state on their absorptive properties

Access to clean water in isolated regions is challenged by heavy metal contamination (Hg, Pb, Cd, As, Cr) and the lack of water treatment facilities. To address this, a thiol-rich Zr(IV)-Metal-Organic Framework (BCM-1) was integrated into soy protein–chitin 3D sponges, creating scalable hybrid filters. Characterization confirmed an interconnected macroporous structure with monodisperse BCM-1 nanoparticles stabilized into the 3D-biopolymeric scaffold. The filters efficiently remove all five metals, achieving over 90% adsorption under optimized conditions, with performance maintained over multiple cycles in real water matrixes, offering a sustainable solution for water remediation.

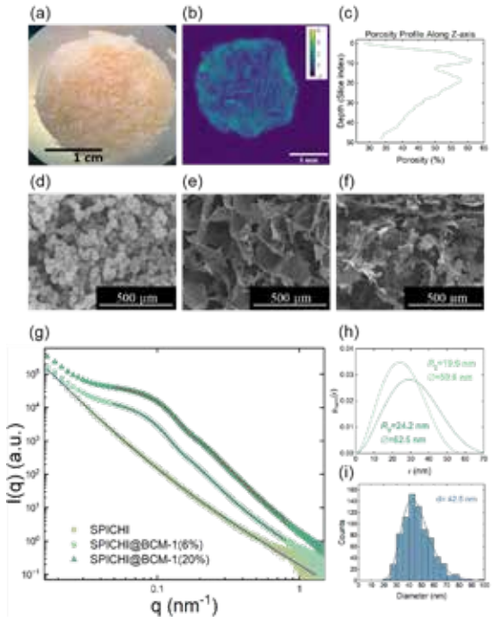


Fig 2
(a-b) Optical and Neutron tomography of the 3D-sponges. (c) Macroporosity distribution of the filters (d-f) SEM images of (d) BCM-1, (e) SPICHI and (f) SPICHI@BCM-1; (g) SAXS data for SPICHI and SPICHI@BCM-1 filters; (h-i) Particle size distribution obtained from the analysis of the SAXS data and SEM images.

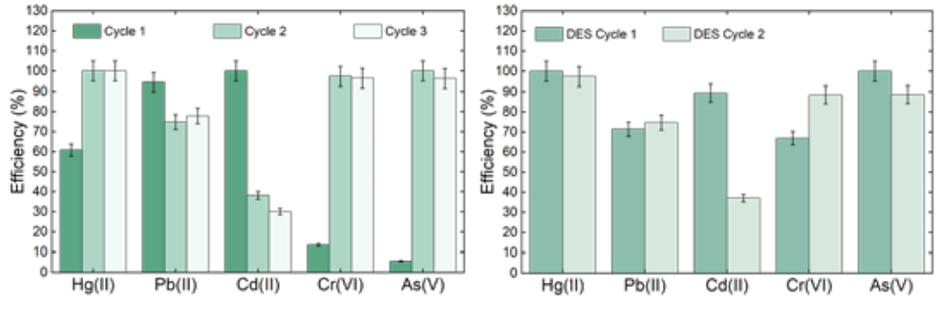


Fig 3
Reusability of the SPICHI@BCM-1 (20%) over three consecutive (left) adsorption and (right) desorption cycles. All the experiments were conducted with [M]: 1 mg/L, t= 240 min and pH ≈ 6, 5 mL of metal solution.

Engineering BiSI-based catalysts for optimized sonophotocatalytic degradation of contaminants of emerging concern: Functionalization, defect engineering, and heterojunctions

Zarandona, A., Sebastian-Garate, E., Gonçalves, B. F., Sáiz, J., Lanceros-Mendez, S., Zhang, Q., & Salazar, H. (2025). Environmental Technology & Innovation, 104545.

Contaminants of emerging concern (CECs) in wastewater threaten ecosystem and human health. Bismuth sulfur iodide is an effective sonocatalyst but weak photocatalyst, requiring modification. Four strategies – Ag doping, sulfur vacancies, and heterojunctions with carbon nitride and graphene oxide – were explored for the degradation of carbamazepine using sonocatalysis, photocatalysis, and sonophotocatalysis. All enhanced performance, especially GO@BiSI under sonophotocatalysis (90.4%). Sulfur vacancies and C_3N_4-based heterojunction showed strong synergy, emphasizing a design-by-function approach.

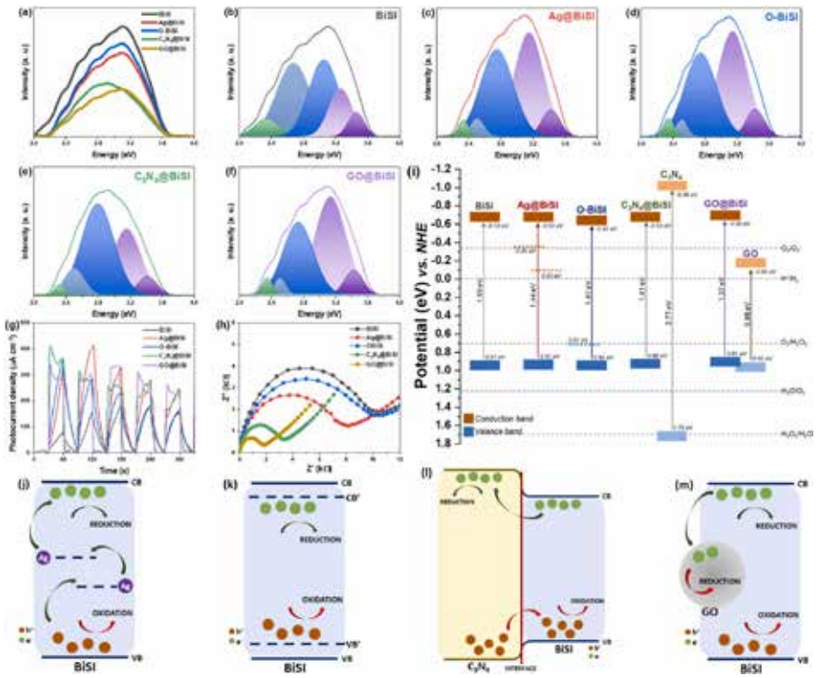


Fig 1
(a) PL emission spectra of all catalysts; (b–f) deconvoluted PL emission spectra of the modified catalysts; (g) photocurrent measurements and (h) EIS Nyquist plots of the modified catalysts; (i) schematic band edge positions of catalysts alongside the redox potentials; schematic diagram of the mechanism of enhanced performance for (j) Ag@BiSI, (k) O-BiSI, (l) C_3N_4@BiSI, and (m) GO@BiSI.

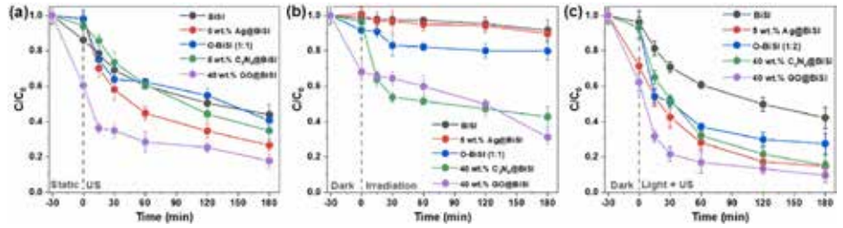


Fig 2
Effect of the BiSI modification on the (a) sonocatalytic, (b) photocatalytic, and (c) sonophotocatalytic degradation of CBZ

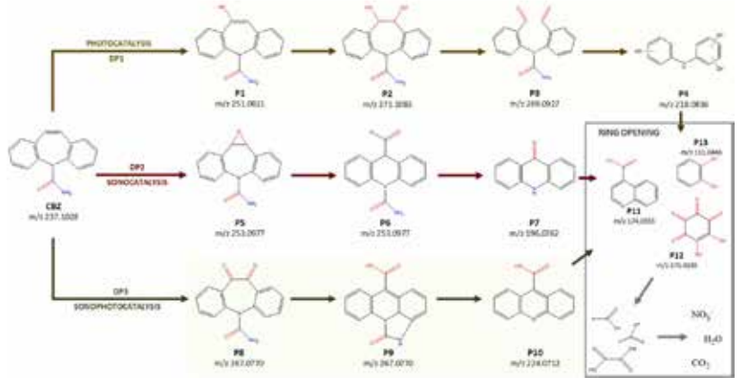


Fig 3
Degradation pathways of CBZ by sonocatalysis, photocatalysis, and sonophotocatalysis using the modified catalysts.

Contaminants of emerging concern (CECs), particularly pharmaceuticals like carbamazepine (CBZ), pose grave risks to aquatic ecosystems due to their stability and bioaccumulation. Advanced oxidation processes (AOPs), specifically the hybrid sonophotocatalysis method, offer a promising alternative by merging ultrasonic energy and light absorption to enhance reactive oxygen species (ROS) production. This research stands out by employing a design-by-function strategy to engineer bismuth sulfur iodide (BiSI) through four distinct modification routes: silver (Ag) ion surface doping, sulfur vacancy defect engineering, and heterojunctions with carbon nitride (C_3N_4) and graphene oxide (GO). The novelty of this work further relies on established control over degradation pathways to selectively drive the generation of non-toxic by-products.

Morphological, structural, and physical-chemical characterization confirmed that each modification successfully enhanced charge separation and CBZ degradation. All modified catalysts outperformed pristine BiSI across sonocatalysis, photocatalysis, and sonophotocatalysis methods. The GO@BiSI composite achieved the highest CBZ removal efficiency of 90.4% under sonophotocatalytic conditions. A noticeable synergistic effect was achieved for the hybrid sonophotocatalytic method, with synergy indices reaching 1.70 for O-BiSI and 1.56 for C3N4@BiSI, highlighting kinetics that exceed the sum of individual methods. Electrochemical analysis revealed up to a 5.2-fold increase in photocurrent density for modified catalysts and significant photoluminescence quenching, confirming suppressed electron-hole recombination and longer charge carrier lifetimes. An innovative finding of this research is the selective control over degradation pathways. The study correlated degradation pathways according to the degradation method and catalyst used, and identified a degradation pathway exclusive to the sonophotocatalytic method. While single sonocatalysis and photocatalysis generate intermediates that can be more toxic than CBZ, the sonophotocatalytic-driven pathway selectively produces non-harmful by-products. Finally, the engineered materials exhibited structural stability and reusability, providing a sustainable and effective solution for wastewater remediation.

RESEARCH
AREA 3

ENERGY GENERATION & STORAGE

One of the grand challenges facing humankind is related to energy. Energy generation and storage are among the key issues of modern society, increasingly dependent on mobility. BCMaterials specifically focus on solar energy conversion in applications such as perovskite and kesterite based solar cells. We also work on the development of energy harvesting systems, mainly based on mechanoelectric (piezoelectric and triboelectric) and thermo-electric systems for self-powered and wearable sensors. Finally, materials and concepts are being developed for Li and Na batteries, as well as new approaches for solid electrolytes and printable batteries.

Improving lithium-ion battery safety through separators with thermal shutdown characteristics induced by thermal expansion microspheres

Monteiro, I. F., Silva, M. M., Fidalgo-Marijuan, A., Gonçalves, R., Costa, C. M., & Lanceros-Mendez, S. (2025). Journal of Power Sources, 631, 236311.

Battery separators with thermal shutdown were developed using PVDF-HFP and 0–15 wt% thermally expansive microspheres via solvent casting with thermally induced phase separation at 20 °C and 80 °C. Porosity ranged from 54% to 5%, and Young's modulus decreased from 474 to 365 MPa with 15 wt% microspheres. The 15 wt% membrane showed high electrolyte uptake (84%), 0.08 mS·cm^{-1} conductivity, good cycling stability, and 146 mAh·g^{-1} at C/8-rate. At 100 °C, microsphere expansion collapsed the structure of the separator, reducing capacity to 0 mAh·g^{-1}. The presented approach allows to improve battery safety by properly addressing thermal runaway.

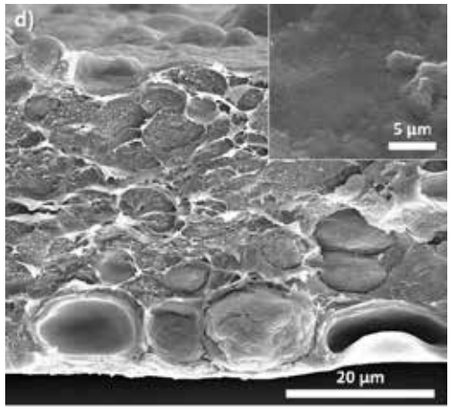


Fig 1
SEM image of the cross-section and surface (inset) of the membranes with 15wt.% of microspheres obtained after solvent evaporation at room temperature.

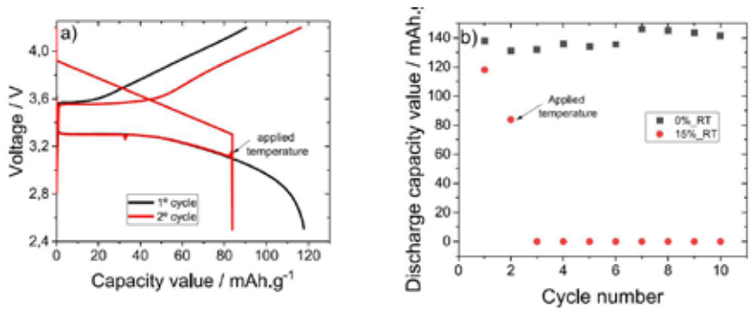


Fig 2
a) Charge/discharge profiles for half-cells with PVDF-HFP membranes with 15 wt.% microsphere content at C/5 with the temperature of 100 °C applied during 5 minutes, b) discharge capacity value as a function of cycle number for neat PVDF-HFP and PVDF-HFP membrane with 15 wt.% of microspheres.

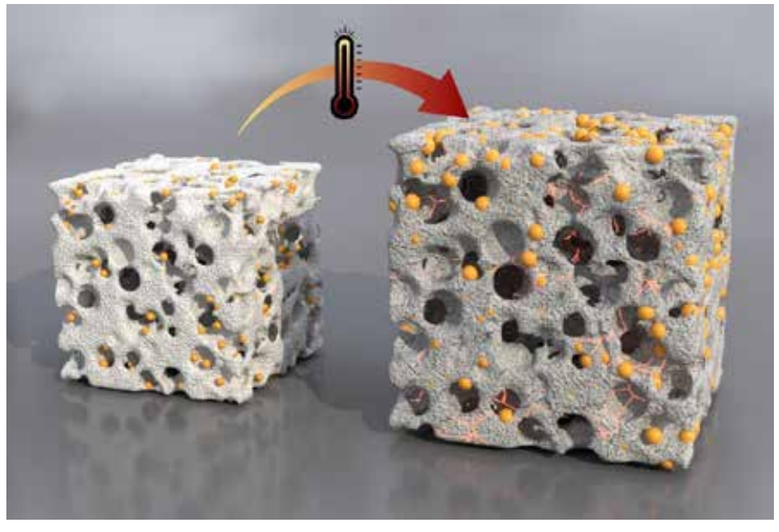


Fig 3
Schematic representation of the thermal shutdown behaviour.

This work presents the development of lithium-ion battery separators with thermal shutdown capability to enhance battery safety and mitigate thermal runaway. The separators are based on poly(vinylidene fluoride-co-hexafluoropropylene) (PVDF-HFP) incorporating thermally expandable microspheres at different loadings (0, 5, 10, and 15 wt%). Membranes were fabricated through solvent casting combined with thermally induced phase separation at two evaporation temperatures (20 °C and 80 °C), enabling control over morphology and porosity. They exhibited a porous microstructure, with porosity values ranging from 54% to 5% depending on microsphere content and processing temperature. Increasing microsphere content reduced porosity and slightly decreased mechanical strength, with Young's modulus decreasing from 474 MPa for neat PVDF-HFP to 365 MPa for membranes containing 15 wt% microspheres. The crystalline phase composition and degree of crystallinity remained nearly constant across samples. (Fig_1)

Electrochemical characterization showed rapid electrolyte uptake and good compatibility with the liquid electrolyte. The membrane containing 15 wt% microspheres and processed at room temperature demonstrated the best overall performance, with 84% electrolyte uptake, ionic conductivity of 0.08 mS· cm-1, lithium transference number of 0.37, low tortuosity (2.7), and a MacMullin number of 145. In Li/C–$LiFePO_4$ half-cells, this separator delivered a discharge capacity of 146 mAh·g^{-1} at C/8 and maintained 44 mAh·g^{-1} at C-rate after 100 cycles, with only 5% capacity fading and ~100% coulombic efficiency, indicating excellent cycling stability and reversibility. (Fig_2)

The key innovation lies in the thermal shutdown mechanism. When the temperature reaches approximately 100 °C, the microspheres expand, disrupting the membrane structure by collapsing pores and blocking ion transport. This leads to an abrupt drop in discharge capacity from 120 mAh·g^{-1} to 0 mAh·g^{-1}, effectively stopping battery operation and preventing further heat generation. In contrast, membranes without microspheres did not exhibit this shutdown behavior. (Fig_3)

Overall, the study demonstrates a simple, scalable, and cost-effective strategy to integrate intrinsic thermal shutdown functionality into PVDF-HFP separators. The approach maintains good electrochemical performance under normal operation while significantly improving battery safety under high-temperature conditions, offering a promising solution for safer lithium-ion battery systems.

Design of Spiro-Substituted Phthalocyanine Hole-Selective Layers for Perovskite Solar Cells

Gassara, M., Ferrer, L., Lezama, L., Molina, D., Ortiz, J., Kazim, S., Santos, A., & Ahmad, S. (2025). Solar RRL, 9(17), 2500418.

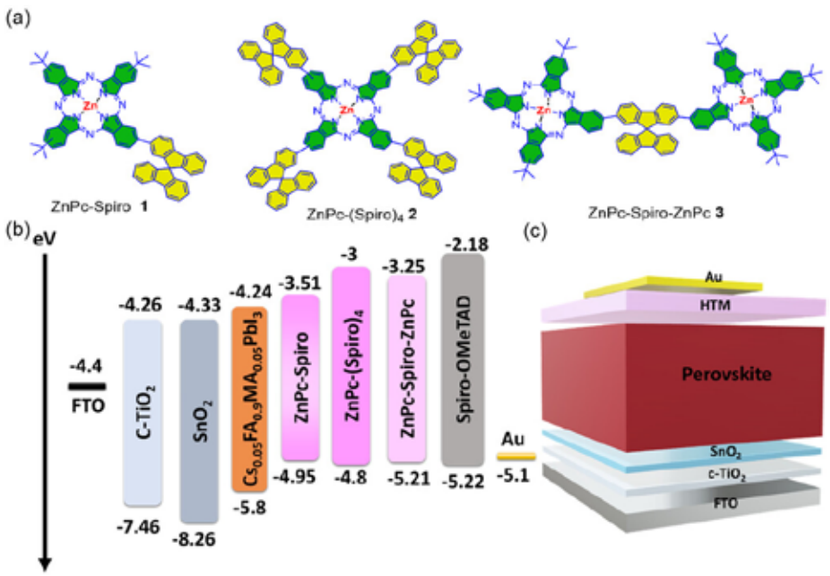


Fig 1
(a) Molecular structure of the developed hole-selective layers, (b) energy level diagram, and (c) the device architecture employed.

The development of p-type semiconductors that can transport holes efficiently is strategic for the performance and reliability of perovskite solar cells. We developed Spiro-fused zinc phthalocyanine derivatives where at the β-position of the phthalocyanine core Spiro units are annelated. The number of Spiro substituents significantly impacts the electro-optical properties, and by modulating the electrical properties, spin density distribution, and solubility can be tuned. We noted ZnPc-(Spiro)$_4$ 2 exhibited higher concentrations of unpaired charge carriers, attributed to transformed electronic environments and boosted spin density localization. This is consistent with the fabricated solar cell performance, where ZnPc-(Spiro)$_4$ 2 gave competitive performance, not only due to elevated hole mobility and charge carrier density, but also with the high solubility and uniformity as a layer. This work highlights that strategic Spiro functionalization in ZnPc derivatives serves as a pivotal factor in optimizing interfacial properties, device performance, and its potential for the development of solar cells by bridging molecular design with device efficiency, but also overcoming the two major challenges associated with solubility and band alignment through a symbiotic approach of the two cores. Notably, ZnPc-(Spiro)$_4$ 2 exhibited higher concentrations of unpaired charge carriers, attributed to transformed electronic environments and boosted spin density localization. Our results highlight that strategic Spiro functionalization in ZnPc derivatives serves as a pivotal factor in optimizing interfacial properties, device performance, and its potential for the development of solar cells by bridging molecular design with device efficiency.

The design and development of hole-selective layers remain strategic for enhancing the performance and reliability of perovskite solar cells. We introduce phthalocyanines annelated with Spiro-core substituent at the β position as a molecular semiconductor to be employed as hole-selective layers. The placement of the Spiro unit improves the molecular packing, film uniformity, and energy level alignment, enhancing the hole extraction ability of the phthalocyanine and suppressing charge recombination at the perovskite/ hole-selective layer interface. Our findings highlight the symbiotic benefits of zinc phthalocyanine with Spiro substitution to deliver a power conversion efficiency of 18.91%, approaching the performance of Spiro-OMeTAD-based devices. This work opens the path of an innovative molecular design strategy and its potential with further optimization of the newly developed Spiro substitution in zinc phthalocyanines in perovskite solar cells.

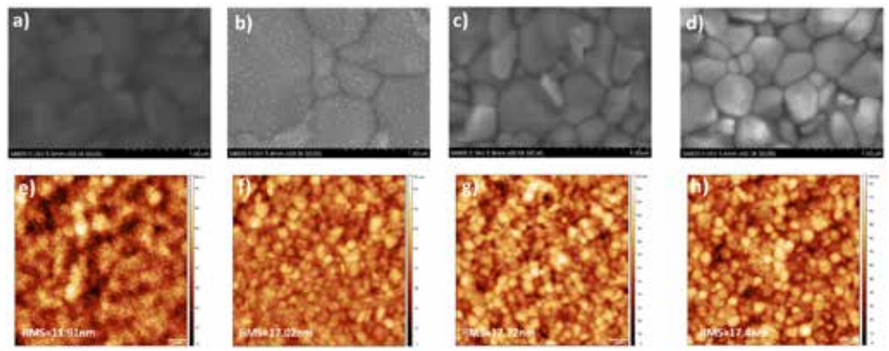


Fig 2
Surface microstructure, SEM images of perovskite with (a) Spiro-OMeTAD, (b) ZnPc-(Spiro)$_4$ 2, (c) ZnPc-Spiro 1, (d) ZnPc-Spiro-ZnPc 3, and AFM images of perovskite with (e) Spiro-OMeTAD, (f) ZnPc-(Spiro)$_4$ 2, (g) ZnPc-Spiro 1, and (h) ZnPc-Spiro-ZnPc 3.

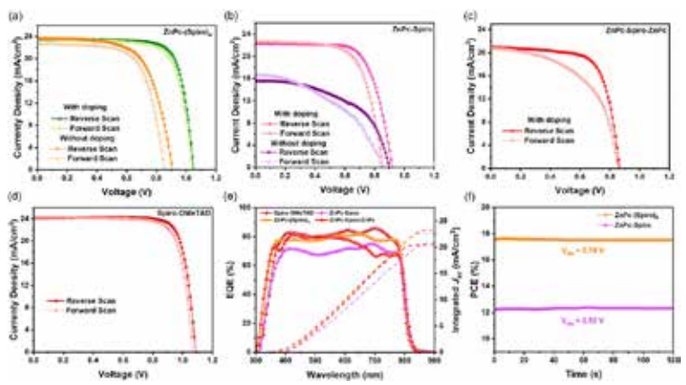


Fig 3
(a) J–V curves of the ZnPc-(Spiro)4 2, (b) J–V curves of the ZnPc-Spiro 1, (c) J–V curves of the Spiro-ZnPc-Spiro based PSCs, (d) J–V characteristics of Spiro-OMeTAD, (e) IPCE spectra of the devices with ZnPc-Spiro, ZnPc-(Spiro)$_4$, ZnPc-Spiro-ZnPc and Spiro-OMeTAD, and (f) steady-state power conversion.

RESEARCH
AREA 4

DIGITALIZATION & EMERGING TECHNOLOGIES

Technological advances rely on both new materials and processing/manufacturing technologies. BCMaterials is working on the development of smart and multifunctional materials with improved processability and integration through advanced manufacturing processes, including additive manufacturing. Self-sensing, self- cleaning and self-repairing materials will be developed for printing technologies. Data providing and data management are at the core of the digitalization of society. Materials for sensors and actuators are therefore being developed and integrated in a variety of applications, including smart cities, smart interiors, industry 4.0 and wearables, among others.

Ionic Liquid-Enhanced 3D Printed Flexible Resin for Pressure-Sensing Applications

Pereira, N., Castro, A. S., Mendes-Felipe, C., Correia, D. M., & Lanceros-Méndez, S. (2025). Advanced Materials Technologies, e01516.

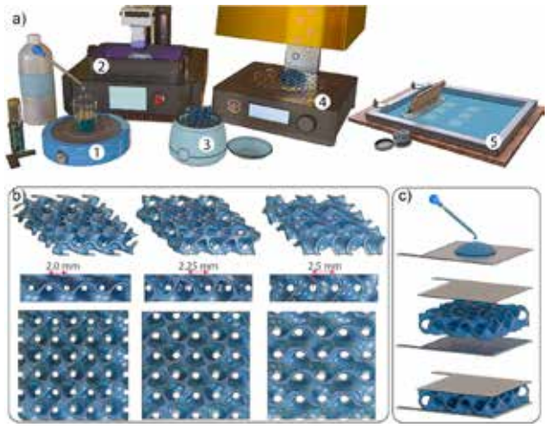


Fig 1
a) Representation of the sensor production process.
b) Schematic of the designed gyroids.
c) Representation of the pressure sensor assembly process.

Flexible pressure sensors are key components in wearable electronics, electronic skin, soft robotics, and human–machine interfaces. Among different transduction mechanisms, iontronic capacitive sensors are particularly attractive due to their high sensitivity derived from electric double layer (EDL) formation at the dielectric/electrode interface. However, scalable fabrication of structurally tunable iontronic materials remains challenging. In this work, stereolithography (SLA) 3D printing is combined with ionic liquid modification of a commercial photopolymer resin to develop customizable, high-performance pressure sensors.

A flexible iontronic sensor was fabricated by incorporating 1-butyl-3-methylimidazolium thiocyanate ([Bmim][SCN]) into Liqcreate Flexible X resin at 5 and 20 wt.% to tune ionic conductivity and enhance EDL formation. Triply periodic minimal surface (gyroid) architectures with pore spacings of 2.0, 2.25, and 2.5 mm were printed to control structural density and mechanical response.

Photopolymerization studies confirmed efficient curing, although higher ionic liquid content slightly reduced double bond conversion. Rheological measurements showed that all formulations remained within the printable viscosity range for SLA processing, with the 20 wt.% formulation displaying favorable flow behavior. SEM and EDX analyses confirmed homogeneous ionic liquid dispersion and high structural fidelity after printing and cleaning.

The incorporation of ionic liquid reduced Young's modulus and tensile strength due to plasticization effects, while the gyroid architecture enabled controlled deformation. Electrically, increasing ionic liquid content enhanced ionic conductivity and dielectric constant, strengthening EDL formation and improving capacitive response. The densest structure (G200) with 20 wt.% IL exhibited the best performance.

Under compression up to 50% deformation, the optimized sensor achieved a pressure sensitivity of 0.065 kPa ^{1} over a 60 kPa range, with excellent linearity (R^2 = 0.98), fast response (100 ms), recovery time of 55 ms, and stable operation over 500 cycles. Demonstrations including game control and foot-pedal sensing validated its applicability in human–machine interaction systems.

This work presents a simple, scalable, and cost-effective route to enhance commercial resins with ionic liquids, combining additive manufacturing versatility with high iontronic sensing performance.

Iontronic materials enable high-performance pressure sensors through electric double layer (EDL) formation at dielectric/electrode interfaces. In this work, a pressure sensor was fabricated via SLA 3D printing using Liqcreate Flexible X resin in gyroid structures with varying densities. Ionic liquid ([Bmim][SCN]) was added at 5 and 20 wt.% to tune sensitivity. The 20 wt.% formulation with lower porosity showed the best performance, reaching 0.065 kPa^{-1} over 60 kPa, demonstrating a simple strategy to enhance commercial resins for customizable sensors.

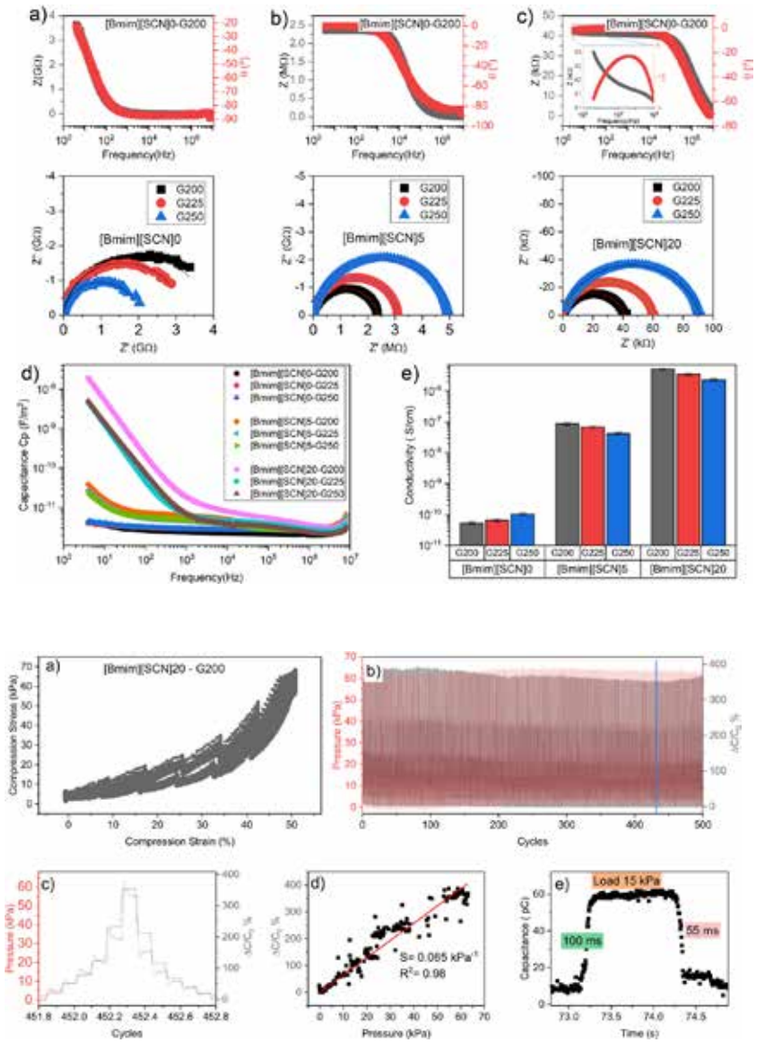


Fig 2
Bode diagrams (top) and Nyquist plot (bottom) for the Resin/IL gyroids a) [Bmim][SCN]0, b) [Bmim][SCN]5, c) [Bmim][SCN]20. d) Capacitance as a function of frequency. e) Ionic conductivity of the samples as a function of concentration and gyroid structure density.

Fig 3
a) Sensor response of the [Bmim][SCN]20-G200 up to 50% maximum deformation: b) compression stepping cycle over 500 cycles, c) magnification of the cycle behavior, d) sensitivity over the pressure range of 60 kPa. e) Response curve to pressure for calculation of the response time.

3D-Printed Linear Variable Differential Transformer (LVDT) for Cost-Effective Displacement Sensing

Maestu, J. F., Pereira, N., Tubio, C. R., & Lanceros-Méndez, S. (2025). Advanced Materials Technologies, 10(21), e00981.

This work presents a fully 3D-printed Linear Variable Differential Transformer (LVDT) for cost-effective displacement sensing. The device combines fused filament fabrication (FFF) for the housing and magnetic core with 5-axis piezo-jet printing of silver conductive coils on curved surfaces. Two core configurations were evaluated: a printed magnetic PLA composite and a commercial MnZn core, achieving sensitivities of 3.86 ± 0.07 μV·mm-1 and 1054.3 ± 11.32 μV·mm-1, respectively. Integrated with AD598-based conditioning and ESP32 Bluetooth Low Energy (BLE) communication, the system demonstrates wireless force sensing with 3.18 ± 0.22 mV·N-1 sensitivity.

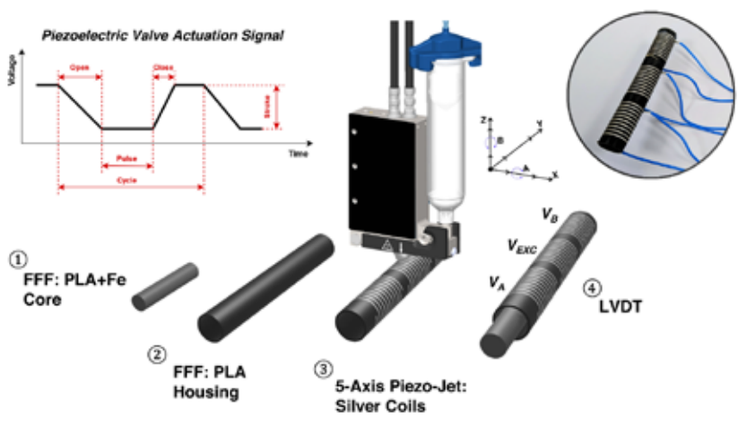


Fig 1
Manufacturing process of the fully printed LVDT combining FFF for the housing and magnetic core with 5-axis piezo-jet printing of silver conductive coils on curved surfaces. The inset shows the piezoelectric valve actuation profile.metal coating.

This work presents the development of a fully 3D-printed Linear Variable Differential Transformer (LVDT) conceived as a scalable, customizable, and cost-effective solution for displacement and force sensing in IoT and Industry 4.0 environments. The device integrates two complementary additive manufacturing techniques: fused filament fabrication (FFF) for the structural housing and magnetic core, and 5-axis piezo-jet printing for the direct deposition of silver conductive coils onto curved surfaces (Figure 1). This approach enables geometric flexibility, reduced assembly steps, and simplified fabrication compared to conventional wound-coil LVDTs.

The electrical response of the printed coils was first characterized, demonstrating stable inductance and resistance within the 10-200 kHz frequency range, ensuring compatibility with industrial excitation standards. Two magnetic core configurations were evaluated: a commercial MnZn ferrite rod and a magnetic PLA composite core produced via FFF. The complete electromechanical behaviour of the printed LVDT is shown in Figure 2. The MnZn-based configuration achieved a sensitivity of 1054.3 ± 11.32 μV mm-1, whereas the fully printed magnetic PLA core exhibited a sensitivity of 3.86 ± 0.07 μV mm-1. Although the sensitivity difference spans three orders of magnitude, the fully printed configuration preserves linearity and functional stability. Cyclic and dynamic

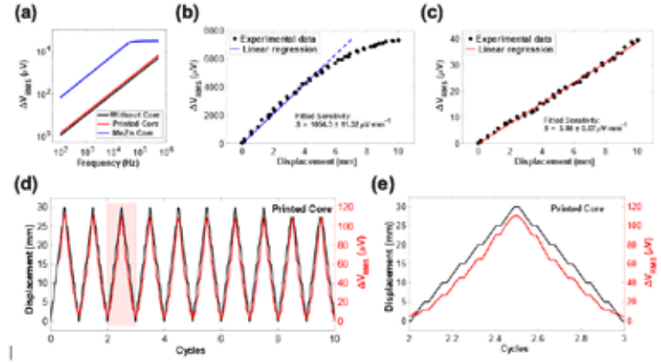


Fig 2
Electromagnetic induction response of the printed LVDT sensor using either a commercial MnZn core or a printed magnetic core. (a) Frequency response comparison. Fitted sensitivity of the printed LVDT with the (b) MnZn and the (c) magnetic PLA printed core. (d-e) Dynamic inductive response over 10 deformation cycles under varying maximum displacements up to 30 mm.

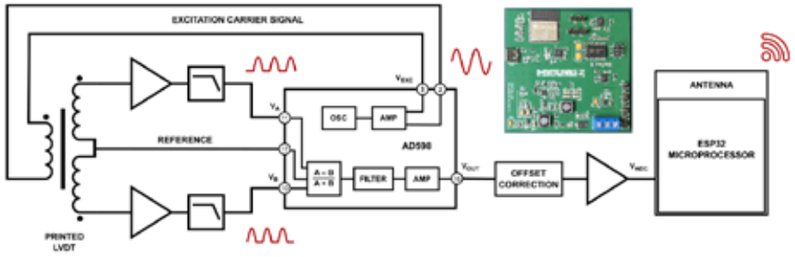


Fig 3
Block diagram of the electronic signal conditioning system based on the AD598, including amplification, low-pass filtering and offset correction stages. Wireless data transmission has also been implemented via ESP32 with Bluetooth Low Energy protocols. The inset image corresponds to the fabricated printed circuit board (PCB).

displacement tests also confirmed repeatable operation and consistent signal evolution under varying deformation amplitudes.

To enable real-world applicability, a complete signal conditioning circuit was implemented using the AD598 integrated circuit (Figure 3), complemented by amplification and offset correction stages. Furthermore, wireless data transmission was achieved through an ESP32 microcontroller with Bluetooth Low Energy (BLE), enabling real-time monitoring and integration into smart systems.

As a functional demonstrator, the LVDT was embedded into a ring-weigh scale structure for pressure sensing applications (Figure 4). Mechanical loading-unloading experiments and finite element simulations confirmed elastic behaviour up to 50 N. The calibrated voltage-force response showed strong linearity (R^2 = 0.99) with a sensitivity of 3.18 ± 0.22 mV N-1. Additional proof-of-concept applications were also demonstrated, highlighting potential use in force-feedback systems, biomedical grip monitoring, and industrial motor displacement sensing.

Overall, the study demonstrates the integration of advanced additive manufacturing, conventional signal conditioning electronics, and wireless communication into a functional, low-cost LVDT platform tailored for next-generation smart sensing applications.

OUTPUT
SAMPLES

STATE-OF-THE-ART REVIEWS

Publishing review articles in peer-reviewed journals is not just an academic exercise. It is a strategic activity for BCMaterials that strengthens the scientific background of our research. Reviews are also a useful tool for other researchers as entry into a topic. Producing high-quality reviews, reinforces our center as a reference point in Materials Science, demonstrating deep understanding of our different areas of expertise.

Biobased polymers for advanced applications: Towards a sustainable future

Gonçalves, R., Serra, J., Reizabal, A., Correia, D. M., Fernandes, L. C., Brito-Pereira, R., Iizundia, E., Costa, C.M. & Lanceros-Méndez, S. (2025). Progress in Polymer Science, 162, 101934.

> Biobased polymers are essential for a sustainable future, as they can replace petroleum-derived materials with renewable alternatives such as silk, chitosan or cellulose. This review highlights their role in the circular economy and Industry 4.0, with key applications in biomedicine, flexible sensors, water purification, and energy devices. Manufacturing techniques such as 3D printing and electrospinning enable high-performance bio-composites, turns these materials essential to meet the global sustainability goals and reduce all negative environmental impacts of synthetic materials.

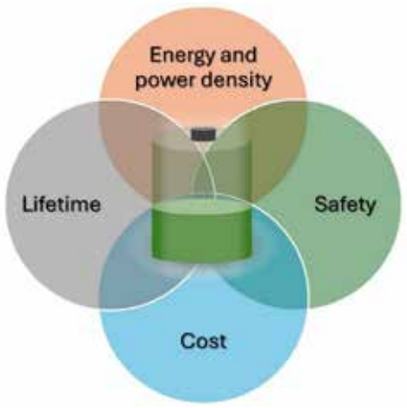
The wide range of battery systems: From micro- to structural batteries, from biodegradable to high performance batteries

Costa, C. M., Salado, M., Ferrara, C., Ruffo, R., Mustarelli, P., Mao, R., ... & Lanceros-Mendez, S. (2025). Progress in Materials Science, 154, 101506.

> Research and technology related to energy storage systems is a rapidly evolving area based on the objective challenges posed by energy transition, the need to power an increasing number of very different portable electronic devices, and the rapid implementation of the electric car, among the most relevant aspects. In this scope batteries are among the most interesting systems for a wide range of those applications.

Thus, new battery chemistries area being explored, beyond lithium, and printed batteries, microbatteries, organic batteries or batteries following the life-cycle of a specific application (from disposable point-of-care systems to smart packaging or agriculture 4.0) are being developed.

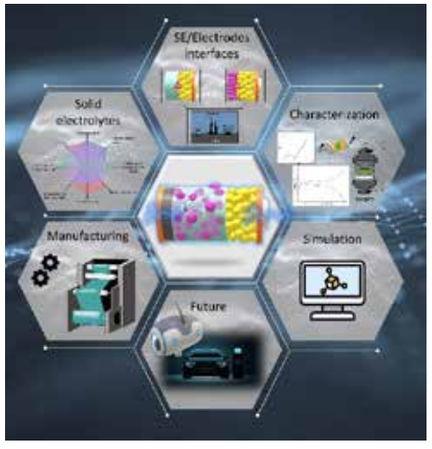
In this scope, this review does not pretend to be just a summary of the relevant state of the art, but to critically analyze and provide a roadmap for future development in order to positively contribute to the implementation of the wide range of battery types in the areas for which they are more appropriate, contributing to the energy transition in the most efficient and sustainable way.

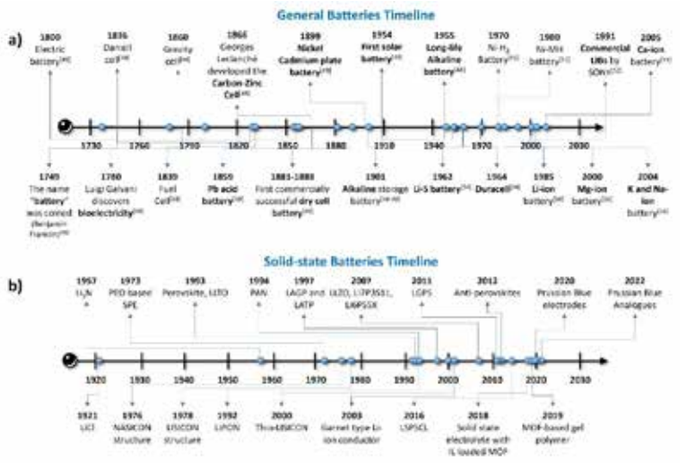


An overview of solid-state lithium metal batteries: Materials, properties and challenges

Costa, C. M., Macedo, V. M., Salado, M., Fernandes, L. C., Zhao, M., & Lanceros-Méndez, S. (2025). EnergyChem, 100169.

> Lithium-ion batteries still have some relevant drawbacks despite their extensive use, mainly in terms of durability and safety concerns related to the use of liquid electrolytes. Given the unique capability of Li metal, i.e. 3860 mAh.g-1, solid-state lithium metal batteries based on solid electrolytes emerge as an efficient way to circumvent current battery constraints.





The review deals with lithium metal batteries and the materials and materials combinations that can be used in the different components. Thus, the main challenges in this highly relevant field will be highlighted. For each battery component, the main physical and chemical properties that determine the main function are described and the main steps to properly tackle the challenges will be also indicated. Thus, in the case of electrodes, the main physical-chemical issues that are addressed are: adhesion, mechanical stability, slurry dispersion, rate capability, activity of the interfaces, diffusion length of Li+, absorption of the electrolyte and electrochemical stability, transfer of Li ions, thermal stability, chemical stability and the role of the functional groups.

In the case of solid electrolytes, the main physical-chemical issues that are addressed are: effect of thickness, structural stability, mechanical properties, thermal stability, chemical stability, ionic conductivity, electrical resistivity, and auto-shutdown ability.

Further, issues related to modeling, advanced characterization and manufacturing of the batteries are presented. Finally, the future needs are clearly indicated.

Magnetoactive and electroactive biobased and biopolymer composites

Garcia, A., Tubio, C. R., Seoane-Rivero, R., Rubio-Peña, L., & Lanceros-Mendez, S. (2025). Sustainable Materials and Technologies, 45, e01485.

> In the scope of a more sustainable economy, composite materials based on non-renewable fossil fuel resources must undergo a rapid reduction and being gradually replaced by more sustainable composites, including biobased ones, aiming to improved environmental friendliness and biodegradability. This review highlights the application of biobased polymer composites in the field of magnetoactive and electroactive smart materials, which are some of the most useful and extended composite materials currently used in sensor, actuator and related applications.

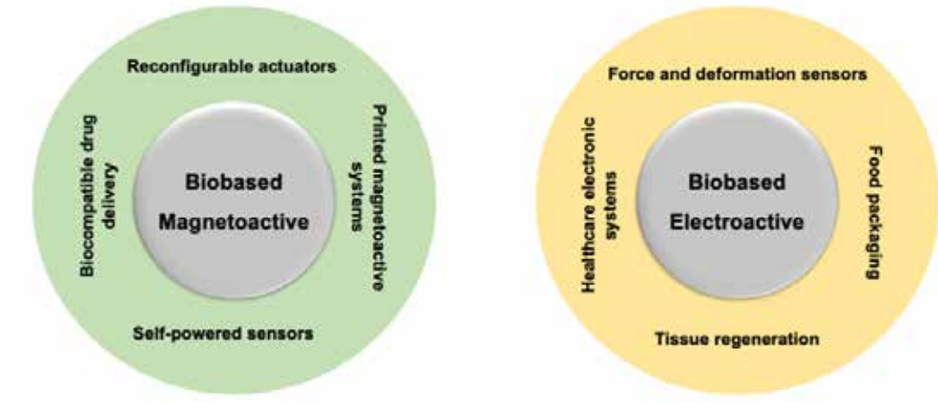


Fig.
Representative current and prospective application areas of biobased electroactive and magnetoactive composites.

Peptide-Perovskite Based Bio-Inspired Materials for Optoelectronics Applications

Kazim, S., Haris, M. P., & Ahmad, S. (2025).
Advanced Science, 12(9), 2408919.

> The growing demand for environmentally friendly semiconductors that can be tailored and developed easily is compelling researchers and technologists to design inherently bio-compatible, self-assembling nanostructures with tunable semiconducting characteristics. Peptide-based bioinspired materials exhibit a variety of supramolecular morphologies and have the potential to function as organic semiconductors. Such biologically or naturally derived peptides with intrinsic semiconducting characteristics create new opportunities for sustainable biomolecule-based optoelectronics devices.

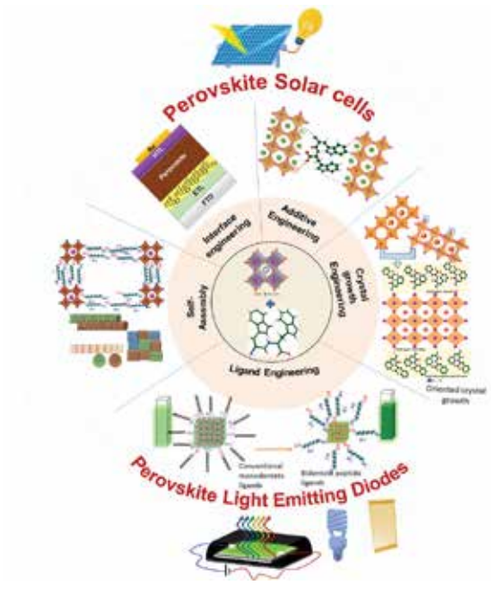


Fig 1
Potential applications of short peptides explored in the self-assembly process and perovskite optoelectronics

Affably, halide perovskite nanocrystals are emerging as potentially attractive nano-electronic analogs; in this vein, creating synergies and probing peptide-perovskite-based bio-electronics are of paramount interest. The physical properties and inherent aromatic short-peptide assemblies that can stabilize and passivate the defects at surfaces assist in improving the charge transport in halide perovskite devices. This review sheds light on how these peptide-perovskite nano-assemblies can be developed for optical sensing, optoelectronics, and imaging for biomedical and healthcare applications. The charge transfer mechanism in peptides, together with the outlook of the electron transfer mechanism between perovskite and short peptide chains, which is paramount to facilitate their entry into molecular electronics, is discussed.

Zero-waste valorization of agricultural products: the model case of mixed fermentation in kombucha

Konjevod, M., Alonso, R. M., Taha, A. Y., Lanceros-Méndez, S., & Sáiz, J. (2025).
Environmental Challenges, 101225.

> Large-scale horticultural production and poor handling methods have led to massive fruit and vegetable waste, creating environmental and food-safety problems. Yet this biomass contains valuable compounds and can be valorized, fitting within Circular Economy. Mixed fermentation, can flexibly transform diverse residues into useful products. Its fermentation yields fermented drinks, bioactive compounds, animal food, compost or bacterial cellulose, a remarkable and versatile material that is lightweight, strong, biodegradable, and useful in medicine, sustainable packaging, cosmetics, and fashion.

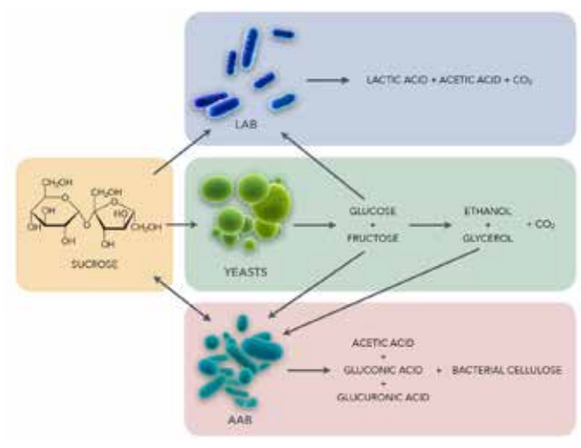


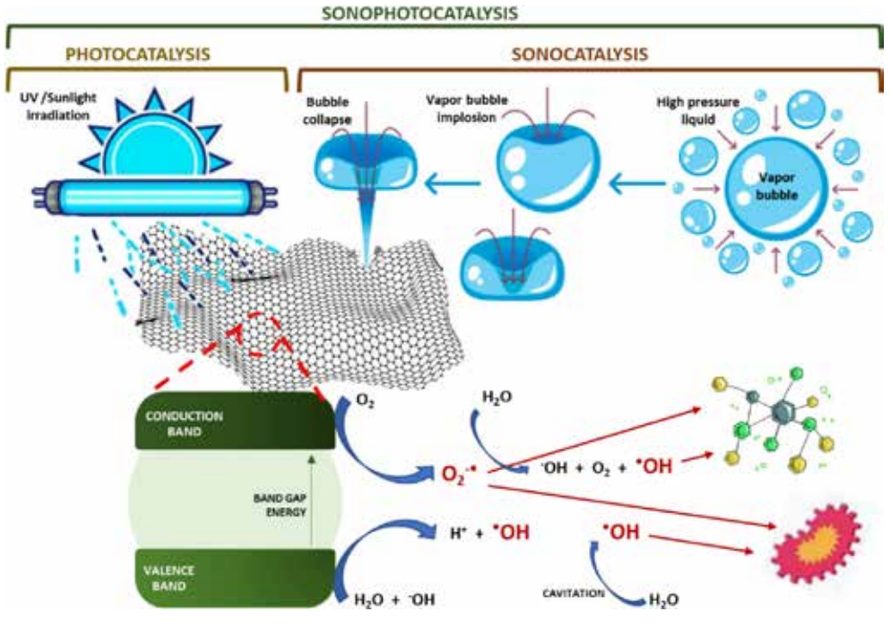
Fig 1
Kombucha metabolism

Fig 2
Graphical abstract

Unlocking the potential of sonophotocatalysis for enhanced water remediation

Salazar, H., Zarandona, A., Zhang, Q., & Lanceros-Méndez, S (2025). Chemical Engineering Journal, 505, 159173.

Water contamination by CECs and antibiotic-resistant bacteria threatens health and ecosystems. This review addresses sonophotocatalysis to enhance CECs degradation and bacteria disinfection. Mechanisms, ROS generation, and charge carrier separation are analyzed, alongside key strategies to enhance the performance such as doping, heterojunctions, and reactor optimization. Finally, the novelty of this review relies on the deep analysis of the challenges, opportunities, and prospects associated with scaling up sonophotocatalysis for industrial applications, underscoring its potential for water remediation and sustainable environmental management.



Microneedles for Continuous, Minimally Invasive Monitoring: A Technology Overview

Conejo-Cuevas, G., Aller Pellitero, M., Ruiz-Rubio, L., & del Campo, F. J. (2025).. Advanced Sensor Research, 4(7), 2500057.

Microneedles are small piercing structures, with sizes in the micron-to-millimeter range, designed to penetrate painlessly the outer skin layer, known as stratum corneum, providing minimally invasive access to interstitial fluid (ISF), which enables the monitoring of biochemical parameters in real-time. This review covers recent progress to date in the area of electrochemical sensing using microneedles, and provides an overview of fabrication materials and processes, as well as applications. The main body of the review focuses on the fabrication of microneedle structures and their transformation into electrochemical biosensors for continuous monitoring. To this end, the main recognition elements and electrode functionalization ways are described, paying closer attention to aptamers and continuous aptamer-based sensing, whose importance, merits, and limitations are highlighted. In addition to covering the main current applications, the review discusses the future threats and opportunities of microneedle-based in vivo monitoring.

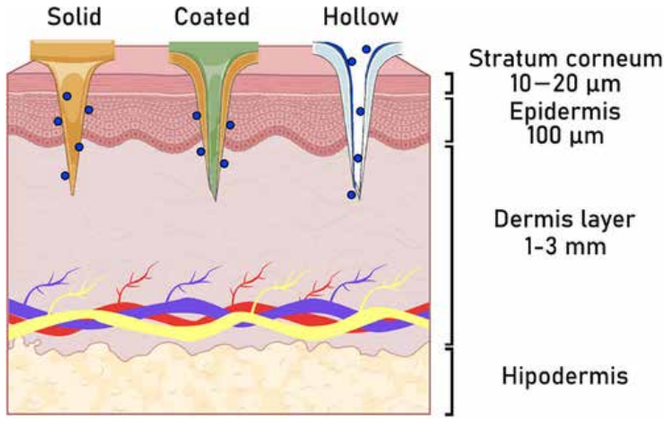


Fig 1
Diagrammatic representation of the different types of microneedles used in electrochemical sensing.

The main body of the review focuses on the fabrication of microneedle structures and their transformation into electrochemical biosensors for continuous monitoring. To this end, the main recognition elements and electrode functionalization ways are described, paying closer attention to aptamers and continuous aptamer-based sensing, whose importance, merits, and limitations are highlighted. In addition to covering the main current applications, the review discusses the future threats and opportunities of microneedle-based in vivo monitoring.

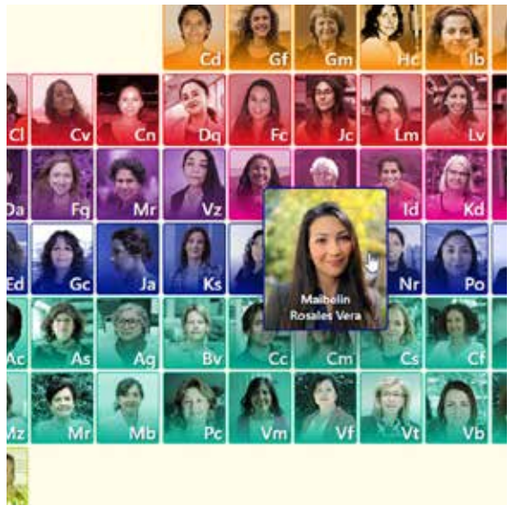
PRICES & AKNOWLEDGMENTS

Qi Zhang Appointed Visiting Professor at NUAA (China)

Our Ikerbasque Research Professor, Qi Zhang, was appointed visiting professor at Nanjing University of Aeronautics and Astronautics (NUAA) in April. Zhang, who has an extensive research career in the field of functional materials for energy, received this important recognition during a visit by BCMaterials representatives to the university.

Eudomar Henríquez, author of the 'GEFES article of the year'

Our post-doctoral researcher Eudomar Henríquez,was acknowledge as the author of the 'GEFES article of the year 2024-20025' selected by the Division of Condensed Matter Physics (GEFES) of the Spanish Royal Society of Physics. This recognition celebrates young talent, scientific excellence, and the diversity of research lines within the GEFES community. The awarded article was "Strain Engineering of Magnetoresistance and Magnetic Anisotropy in CrSBr", published by the Advanced Materials magazine.



Maibelin Rosales, in the Periodic Table of Chilean Female Scientists

Maibelin Rosales, MSCA post-doctoral researcher, was selected as one of the 118 researchers recognized in the Periodic Table of Chilean Female Scientists. The table has been created by the Legislative Bulletin of Women and Gender of the Library of the Chilean National Congress. The main objective was to highlight and recognize the work of the selected scientists in 10 areas of knowledge, including: Physics, Chemistry, Mathematics, Astronomy, Medicine, Biology, Engineering, Geology, Environmental Sciences...

Fuelium, Most Circular Start-up at the Basque Circular Summit

Fuelium, start-up in which our Ikerbasque Research Associate Professor Juan Pablo Esquivel is one fo the co-founders, was awarded as the Most Circular Startup at the Basque Circular Summit, held in Bilbao in April. Fuelium was acknowledged for their eco-designed paper batteries for use in single-use devices in in vitro diagnostics and personal care.

World's top 2% most influential scientists

10 BCMaterials researchers in this annual list published by the Standford University (USA).

Senentxu Lanceros-Méndez

Javier del Campo

Koro de la Caba

Qi Zhang

Shahzada Ahmad

José Luis Vilas

Volodymyr Chernenko

Pedro Guerrero

Joel Villatoro

Erlantz Lizundia

PRICES & AKNOWLEDGMENTS

Gabriel Cabral, Best Poster Presentation at International Advanced Polymer Conference

Gabriel Cabral, Best Poster Presentation Award for the work "Hydrophobic/hydrophilic bifunctional cryogel for the SPE-LC-MS analysis of PFAS in water" at the International Conference on Advanced Polymer Science & Engineering in Tenerife. Roberto Fdez. de Luis, Maibelín Rosales, Senentxu Lanceros-Méndez, Erlantz lizundia and Jorge Saiz were some of the other BCMaterials authors.

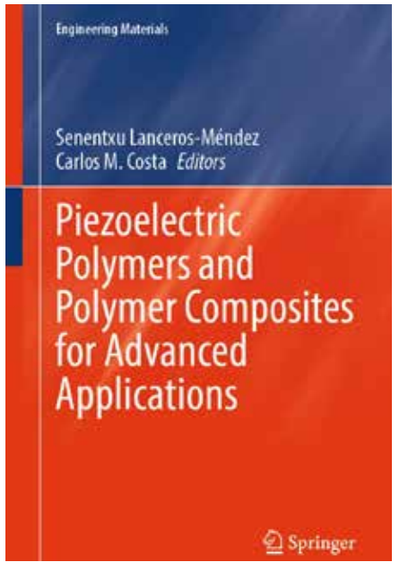
Richard Schönlein, 2nd Prize at the 'Think Big' Awards

The 'Think Big' Awards, granted by Zitek—the entrepreneurship support programme of the Bizkaia Campus of the University of the Basque Country (UPV/EHU)—recognized the 'Sensoleaf' proposal, developed by BCMaterials postdoctoral researcher Richard Schönlein, with the second prize in 2025. 'Sensoleaf' aims to develop an ultra-thin, flexible, and environmentally friendly sensor made from corn-derived materials.

1st place in the Nanoartography Science Photography Contest

'The Bear's Refuge' image, taken by Maibelin Rosales and edited by the student Ingrid Morales, was awarded First Place at NanoArtography Science photography contest2025. The image, taken in the context of the MERLIN project, represents a nanoscale structure with a width of 0.0005 mm, transforming scientific data into a visual narrative.

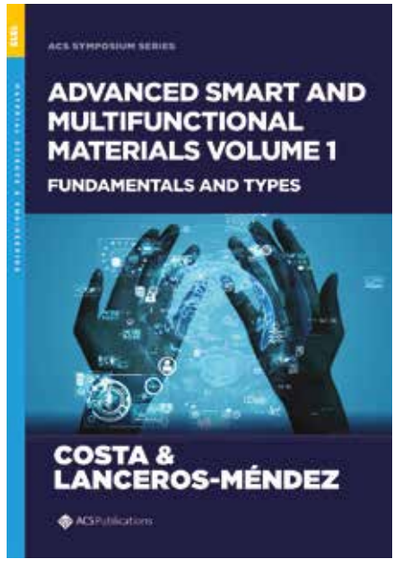
PUBLISHED BOOKS

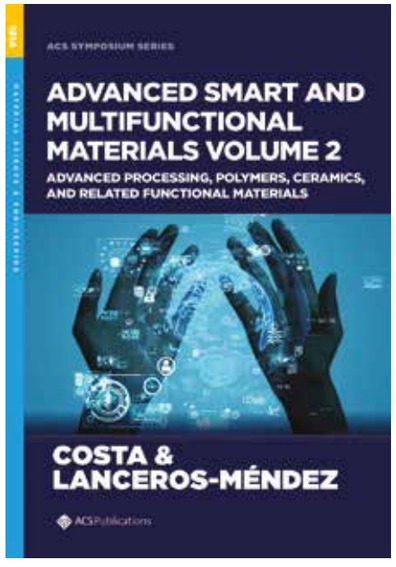


Piezoelectric Polymers and Polymer Composites for Advanced Applications

Editors: Senentxu Lanceros-Méndez, Carlos M. Costa. Springer ISBN 978-3-031-88735-2

This book provides a comprehensive exploration of piezoelectric polymers and composites, detailing their structures, fabrication, and applications across fields such as biomedical, electronic, and environmental science. Addressing the demands of Industry 4.0 and the Internet of Things, it delves into the most relevant materials like Polyvinylidene Fluoride and Poly-l-Lactic Acid, highlighting their properties, functionality, and versatility in energy harvesting, sensing, actuation, and biomedical applications, among others. Each chapter introduces fundamental concepts, recent advancements, and future directions, serving as both a reference for current knowledge and a guide for ongoing research in piezoelectric materials science.





Advanced Smart and Multifunctional Materials. Volumes 1 & 2

Editors: Senentxu Lanceros-Méndez, Carlos M. Costa. ACS Symposium Series; American Chemical Society: Washington, DC

Advanced Smart and Multifunctional Materials (Vols 1 & 2), emphasizes the latest developments in this field. Suitable for diverse technological applications, readers will explore functional characteristics and applications of materials with electroactive, magnetoactive, optical, and self-healing responses, among others. Researchers and engineers in a variety of areas, including physics, chemistry, materials design, development and integration, electronics, or healthcare, as well as industry professionals will benefit from this comprehensive resource in the fields of smart and multifunctional materials.

TRAINING ACTIVITIES

As a research center of excellence, BCMaterials is committed, mostly together with the UPV/EHU but also with other regional, national and international institutions, with the training of the next generation of scientist. This is our duty, but mostly our conviction and pleasure. We offer our expertise, laboratories and human resources to motivate, guide and advise the next generation of scientist in all our areas of expertise. Thus, BCMaterials offers a complete PhD program to graduate students from all around the world who wish to start a research career in a materials science-related field at a top international research institution. BCMaterials collaborate with various official master and graduate programs, and we offer different internship possibilities.

10

FINAL DEGREE
Projects Defended

Student	Title	BCMaterials Supervisors
Adriana Mª Lorenzo García	Konplexu metal-organikoz eta polioxometalatoz osatutako material hibridoen propietate fotokatalitikoak	Oscar Castillo
Alejandro Calero Jurado	Desarrollo de materiales avanzados para electrónica conformable	Nikola Perinka
Asier Santamarta	Producción de bio-membranas de celulosa bacteriana para la purificación de aguas	Jorge Saiz
Clara Jiménez	Fabrication of microneedles using rapid prototyping methods	Javier del Campo
Edurne Oliván Sánchez	Magnetically responsive polymer hydrogels and films for tissue regeneration	Andrey Shibaev, Gotzone Barandika
Giseva del Solar Arrien	An innovative Ti(IV)-and porphyrin-based MOF for photocatalysing chemical reactions	Anna Sinelshchikova
Ibai Irizar	Urdin prusiarraren analogoak anodo gisa Na-ioi bateria urtsuetan	Juan Pablo Esquivel
Justine Trimaille	Characterization of screen-printed electrochromic materials	Javier del Campo
Lander Ruiz	Development of a biocompatible bioink using 3D printing for the formation of an in vitro chronic wound model	Koro de la Caba
Mikel González Devesa	Na-ioi bateria urtsuetarako urdin Prusiar anodoa baten diseinu eta optimizazioa	Juan Pablo Esquivel

MASTER SCHOLARSHIPS

BCMaterials offers Master Scholarships to perform research in areas as diverse and challenging as materials for sensors and actuators, which are critical for the Internet of Things and Industry 4.0; materials for advanced biological and biomedical applications; materials for energy (both generation and storage) or materials for environmental monitoring and remediation.

Universidad del País Vasco Euskal Herriko Unibertsitatea

UC UNIVERSIDAD DE CANTABRIA

Master in **New Materials**

Its objective is to provide a solid training in the most current methodologies for the synthesis, characterization, properties and applications of new materials, in fields as diverse as biomaterials, nanomaterials, intelligent materials, materials for energy, electronics, catalysis, etc.

Universidad del País Vasco Euskal Herriko Unibertsitatea

Master in **Environmental Contamination and Toxicology**

The master will train the students as a professionals in the biological assessment of the health of ecosystem, both marine and fresh water, and terrestrial.

Universidad del País Vasco Euskal Herriko Unibertsitatea

Master in **Biomedical Research**

The master offers updated training on the molecular, cellular and physiological mechanisms involved in the development of the disease, necessary to carry out research that leads to the achievement of valid results and conclusions on topics of biosanitary interest.

15

MASTER
Thesis Defended

Student	Title	BCMaterials Supervisors
Alejandra Cancilleri García	Desarrollo de materiales para sensores y transistores impresos para detección química y bio-detección	Nikola Perinka, José Luis Vilas Vilela
Aritz Zuluaga Murillo	Burdina (III) eta dibentzenaziklohexafanodikarboxilato estekatzailean oinarritutako sare metal-organikoaren sintesia, ezaugarriketa eta aplikazioa co2-aren fotoerredukzioan	Garikoitz Beobide
Carmen Caminero Gonzalez	Electroactive scaffolds for breast cancer model development	Janire Sáez, Lourdes Basabe
Carolina Iglesias	Impresión de estructuras y dispositivos de alta definición basadas en materiales compuestos magnéticos	Nikola Perinka, Jon Gutiérrez
Eneko Sebastián Garate	Material bidimentsionalen bidezko nitratotik amoniorako bihurketa sonofotokatalitikoa	Hugo Salazar, Patricia Lázpita
Hegoa Craamer	Development of protein-based solutions for 3D printing constructs for further neural regeneration applications	Pedro Guerrero
Hugo José Lozano Fuster	Desarrollo de tintas funcionales para la fabricación de dispositivos fotoelectroquímicos	Javier del Campo, Leire Ruiz-Rubio
Ibán López Rodríguez	Determinación de la adsorción y liberación de fármacos en disolución de un material poroso con adenina	Antonio Luque
Jon Bazkoare Etxebarria Gana	Estructuras supramoleculares metal-organicas. impacto de sus características porosas en la captura y liberación de fármacos	Oscar Castillo
José Pedro Pimentel Ribeiro	Nova geração de membranas poliméricas fotocatalíticas com porosidade costumizável	Senentxu Lanceros-Méndez
Lucia Juan-Bordera	Conductivity in protein-based biomaterials	Reyes Calvo
Maider Pinillos Fernández	Búsqueda de la interacción de canje en bicapas FeMn/NiFe crecidas por evaporación térmica	José María Porro, Rafael Morales
Raul Llano Insausti	Cristales iónicos porosos (PICs) basados en la combinación de policationes metal-orgánicos de titanio y heteropolioxowolframatos para la reducción fotocatalítica de CO2	Oscar Castillo
Rui Pedro Martins Raimundo	Desenvolvimento de materiais imprimíveis para aplicação em fotodetetores	Senentxu Lanceros-Méndez
Samuel Borges Sequeira	Métodos de descarregamento de baterias por via húmida para processos de reciclagem	Senentxu Lanceros-Méndez

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PHD

Thesis Defended

Student	Title	BCMaterials Supervisors
Amaia Zarandona Rodríguez	BiSI-Baser Catalysts for Water Remediation by Hybrid Advanced Oxidation Processes	Qi Zhang, Senentxu Lanceros-Méndez
Ander Garcia Diéz	Printable Magnetically Responsive Materials and Devices	Carmen Rial, Jon Gutierrez
Corina Rodríguez Esteban	Gd(III)-based molecular qubits and magnets: from bulk to the surface	Itziar Oyarzabal
Esraa Samy Abu Serea Sewlam	Unraveling the power of gold nanostars. From the ultrasmall and multicomponent nanostars to their use in advanced applications	Javier Reguera, Senentxu Lanceros-Méndez
Eudomar Henríquez-Guerra	Strain engineering of quantum phenomena in 2D materials	Reyes Calvo
Joana Catarina Dias	Physical active antimicrobial surfaces for preventing the spread of pathogenic microorganisms	Senentxu Lanceros-Méndez
Leire Celaya Azcoaga	Biomolecule-based porous zirconium metal-organic materials. Structure-property relationships	Oscar Castillo, Roberto Fernández de Luis
Lía Campos Arias	Development of Electrically Conductive Nanocomposites for Flexible and Conformable Printable Electronics	Nikola Perinka, Jose Luis Vilas Vilela
Natalia A. Río López	Relation between microstructure and properties in magnetic shape memory alloys studied by neutron diffraction	José María Porro
Orysia Zaremba	Metal-Organic Framework Composites: Design, Synthesis and Applications	Stefan Wuttke, Erlantz Lizundia
Pedram Ghorbanzade	Investigating the role of interphases in composite electrolytes by solid-state NMR	Senentxu Lanceros-Méndez
Rafaela Marques Meira	Electroactive polymer materials based heart-on-a-chip as a novel approach for cardiac tissue engineering	Senentxu Lanceros-Mendez
Ricardo José da Silva Lima	Advanced sensing polymer composites with self-healing capabilities for high responsibility applications	Senentxu Lanceros-Méndez
Rita de Magalhães Polícia	High-performance printable luminescent and chromic materials for improved device integration	Senentxu Lanceros-Méndez
Rubén Teijido Fernández	Sustainable Anti-Corrosion Coatings Based on Biomaterials for Marine Applications	Leire Ruiz-Rubio, Qi Zhang
Sara Martín Iglesias	Mechanisms regulating the cell response to the surface electric potential of biomaterials	Unai Silvan, Senentxu Lanceros-Méndez
Wai Kin Yiu	Impact of Doping and Interfacial Band Bending of Charge Transport Layer in Inverted Perovskite Solar Cells	Pablo Docampo and Graeme Cooke
Xiangyiang Yu	Rationalization of Microfluidic for Metal-Organic Framework nanoparticles synthesis	Stefan Wuttke
María Calles Carcía	Chelating Metal-Organic Frameworks and Their Polymer-Composites For Water Remediation	Viktor Petrenko, Roberto Fernández de Luis
Kaiyuan Chen	Ultra-wide temperature dielectric stability and polar nanoregions dynamics in 0.6Bi(Mg0.5Ti0.5)O3-0.4Ba0.8Ca0.2TiO3-based ceramics	Senentxu Lanceros-Méndez, Qi Zhang
Paula Rodríguez Lejarraga	Tailoring electroactive biomaterial–protein interfaces and interactions to drive cell behavior	Viktor Petrenko
Teresa Carranza	Development of bio-based inks and 3D printed biomimetic structures for tissue engineering	Koro de la Caba, Pedro Guerrero
David Batet	Paper-based electronic sensors towards sustainable point-of-care diagnostics	Juan Pablo Esquivel

TRAINING ACTION

FUNCTIONAL PRINTING COURSE

From June 25 to 27, BCMaterials hosted a specialized course on functional printing, organized in collaboration with the Functional Print Cluster. The course brought together nearly 40 participants from companies, technology centers, and vocational training institutions. It offered comprehensive theoretical and practical training in functional manufacturing and printed electronics using advanced materials.

BCMATERIALS
BASQUE CENTER FOR MATERIALS, APPLICATIONS & NANOSTRUCTURES

FUNCTIONAL PRINT CLUSTER
PRINTED INTELLIGENCE

THREE-DAY PROGRAM

Included various disciplines related to functional printing processes, synthesis, ink formulation, inkjet printing, and the design, development, and implementation of functional devices.

EUROPEN LANSCAPE TALK AND VISIT TO GAIKER TECHNOLOGY CENTER

Amaya Igartua, Coordinator of Materials Initiatives at the TEKNIKER research center and co-secretary of the European Materials Platform (EUMAT). Igartua delivered a presentation on the landscape of advanced materials in Europe. The program also included a visit to the Gaiker technology center.

03

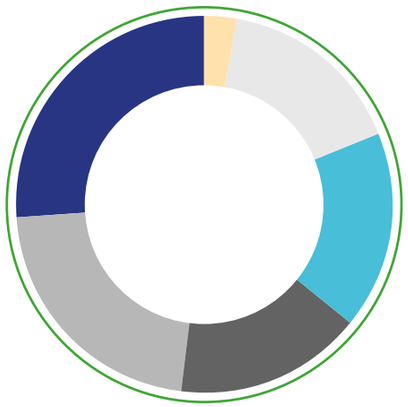
PROJECTS & TECH-TRANSFER

Research projects represent the core of our activities as, most often in collaborative endeavours, set a specific framework for scientific or technological advances. Research projects represent also timely innovations for the generation of knowledge and technology transfer for the benefit of society.

FOUNDING SOURCES & RESEARCH PROJECTS

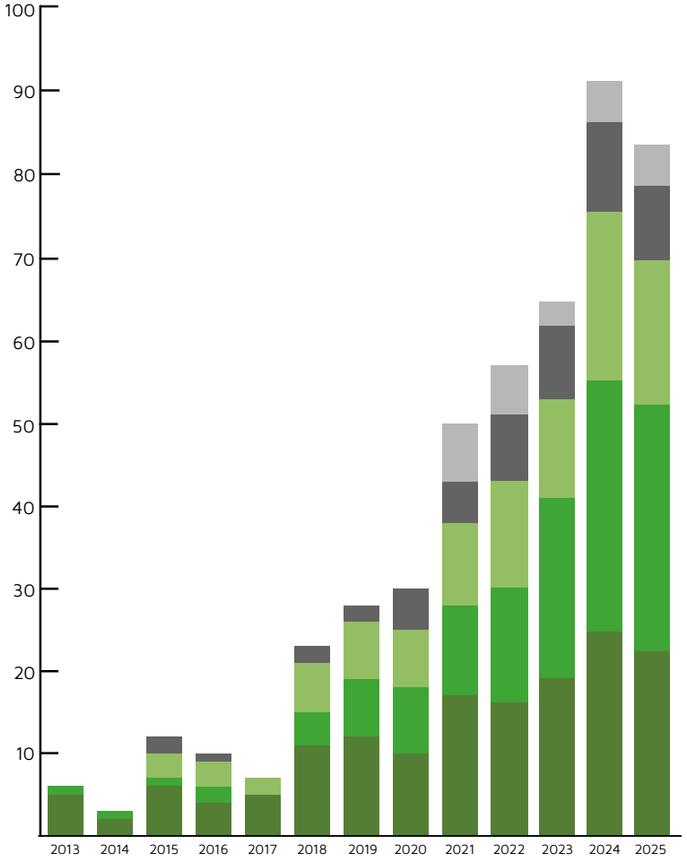
FOUNDING **SOURCES**

- 3% Invoicing
- 16% Private
- 17% BERC
- 16% Basque Government
- 22% National funding
- 26% International



ONGOING **PROJECTS**

- Regional projects
- Spanish projects
- International projects
- Private projects
- Other projects



PROJECT **PROPOSALS**

129

PROPOSALS
Submitted

- 20% Accepted
- 20% Pending
- 60% Rejected

FINANCIAL **BODIES**

European Commission

GOBIERNO DE ESPAÑA MINISTERIO DE CIENCIA E INNOVACIÓN

GOBIERNO DE ESPAÑA MINISTERIO DE EDUCACIÓN, FORMACIÓN PROFESIONAL Y DEPORTES

AGENCIA ESTATAL DE INVESTIGACIÓN

Plan de Recuperación, Transformación y Resiliencia

EUSKO JAURLARITZA GOBIERNO VASCO

ikerbasque Basque Foundation for Science

BFA DFB Bizkaiko Foru Aldundia Diputación Foral de Bizkaia

euskampus

PROJECT MEETINGS & EVENTS

Selfaquasens European Project's Mid-Term Meeting

BCMaterials headquarters hosted in June the mid-term meeting of the MSCA Staff-Exchange European project 'Selfaquasens'. Participants showed nice progress towards the final goal of the project, which is to create self-sensing membranes able to remove pollutants from water, recover valuable elements and monitor the whole process.

INORMS2025 CONFERENCE
BCMaterials Project & Tech Transfer manager, Raquel González participated at the International Network of Research Management Societies Conference for project managers.
Madrid (Spain), May 2025

VISIT OF VOCATIONAL EDUCATION CENTERS PARTICIPATING AT THE REFOREST 4.0 PROJECT. *Students and professors from Labpaper Tolosa, Kimika Don Bosco, Malerreka and Salestianos Pamplona visited BCMaterials facilities.*
Leioa, May 2025

PIEZO 2D MSCA STAFF-EXCHANGE EUROPEAN PROJECT MID-TERM MEETING *with the participation of our post-doctoral researcher Hugo Salazar.*
Riga (Latvia), June 2025

BIDEKO PROJECT'S CONSORTIUM MEETING*. Two days to share progress towards ecodesigned batteries with the circular economy scheme in mind. This project is funded by the Spanish government.*
Leioa, October 2025

50 attendees at the BIOntier European project 2nd General Assembly

On April 1 and 2, BCMaterials hosted the second general assembly of the Horizon Europe BIOntier project. Nearly 50 representatives from the 25 consortium entities attended the event. The meeting aimed to review the initial progress of the various work packages and the six use cases included in the project. BIOntier's goal is to develop the next generation of biocomposites for high-performance industrial applications in areas like automotive, aerospace, the hydrogen economy, and water treatment.

BASQUE REGIONAL PROJECTS

Acronym	Title	Call	Duration
ADMAG	Additive Manufacturing of Molecule-based Magnets	PIBA	2023-2025
BISUMII	Bio-Inspired Surfaces for Machine Elements II	Elkartek	2024-2025
BIWIN2	Bioprocesos y procesos sostenibles, con potencial escalabilidad, para la obtención de materiales de interés industrial (biopoliésteres y bio-refuerzos) a partir de biomasas residuales	Elkartek	2025-2026
ECLICARE2	Bioensayos Electroquemiluminiscentes para Diagnóstico Personalizado	Innovacion euroregional	2024-2026
ENHARPE	Nuevos sistemas de energy harvesting para dispositivos de baja potencia autoalimentados mediante soluciones impresas y materiales sostenibles	Elkartek	2024-2025
FRONT24	FRONTIERS 2024- Superficies multifuncionales en la frontera del conocimiento	Elkartek	2024-2025
HAPTIC	Investigación en materiales y tecnologías hápticas, materiales, electrónica y control	Elkartek	2025-2026
IMAGRA	Investigación en técnicas de Modelado y Análisis multifísico para identificación y determinación de mecanismos de deterioro de GRAsas lubricantes	Elkartek	2025-2026
INNOSENSE	Desarrollo de soluciones innovadoras para su aplicación a biosensórica de sustancias químicas	Elkartek	2024-2025
LITHOGRAPHY	Equipamiento para litografía sin máscara y caracterización superficial en micro- y nanofabricación avanzada.	Programa Transferencia Tecnológica Linea 2 DFB	2025-2026
METALIA	Integración de la Metalurgia y la IA para acelerar y alcanzar nuevos límites en el desarrollo de aleaciones con menos CRMs	Elkartek	2025-2026
MOSINCO	Monitorización sin contacto de composites, desde su fabricación hasta su fin de vida	Elkartek	2024-2025
ONKOLINEFERTI III	Programa experimental nacional de preservacion de fertilidad en varones prepuberes con cancer o sindromes geneticos. futuras terapias celulares con celulas madre para la restauracion de la fertilidad masculina	Promoción de la actividad investigadora sanitaria	2022-2026
SMART4S	Sensorización inteligente mediante micro y nanotecnologías en entornos industriales	Elkartek	2025-2026

SPANISH NATIONAL PROJECTS

Acronym	Title	Call	Duration
BIOELECTROSURF	Bioimitación de superficies electroactivas a través de la ingeniería de patterning de parches	Proyectos I+D+I-AEI	2023-2026
BUBBLEMAT	Burbujas para imprimir materiales híbridos y aleaciones de alta entropía	ATRAE	2025-2029
CLOCKBITS	Explotación de las transiciones de reloj atómico para el diseño químico de qubits moleculares 2d	Consolidacion Investigadora	2025-2027
DAMIS	Dynamically adaptive microenvironment for spinal cord regeneration	Proyectos I+D+I-AEI	2023-2026
EVOLMOF	Mimicking directed evolution of metalloenzymes into Metal-Organic Frameworks	Proyectos I+D+I-AEI	2022-2025
HERMES	Harnessing Energy thRough new Materials, procEsses, and architectureS in Self-powered Biosensing	Proyectos I+D+I-AEI	2024-2027
HERMES_ PREDOCTORAL	Harnessing Energy thRough new Materials, procEsses, and architectureS in Self-powered Biosensing	PROYECTOS I+D+I-AEI_ predoctoral	2024-2027
INTERACTION	Interface tuning of perovskite solar cells through MXenes	Proyectos I+D+I-AEI	2022-2025
JDC HUGO	Hugo Salazar	Juan de la Cierva	2023-2025
JDC RICARDO	Ricardo Pereira	Juan de la Cierva	2024-2026
JDC SUBHAJIT	Suhajit Dutta	Juan de la Cierva	2023-2025
LITASPIN	Corrientes de spin inducidas por luz en materiales antiferromagnéticos bidimensionales	CONSOLIDACION INVESTIGADORA	2024-2026
MAGCALORICH	Búsqueda de materiales magnetocalóricos mejorados para la licuefacción de hidrógeno aprovechando la anisotropía magnética	Proyectos I+D+I-AEI	2023-2026
MODULES	Síntesis de alcoholes como precursores de combustibles de aviación integrando plasma en frío y termo-catálisis a baja temperatura	Proyectos I+D+I-AEI	2025-2028
NABICO	Baterías secundarias basadas en ion de sodio biodegradables y compostables	Proyectos I+D+I-AEI	2023-2026
NANOBUB	Micropatrones de ensamblajes de nanopartículas con microburbujas inducidas por láser	Proyectos I+D+I-AEI	2025-2028

SPANISH NATIONAL PROJECTS

Acronym	Title	Call	Duration
PHONON	Metodología de polvos para el desarrollo de perovskitas de Pb-Sn de banda estrecha para la fabricación de células solares	Proyectos I+D+I-AEI	2025-2028
PHONON_ PREDOCTORAL	Metodología de polvos para el desarrollo de perovskitas de Pb-Sn de banda estrecha para la fabricación de células solares	Proyectos I+D+I-AEI_ predoctoral	2025-2028
RAMON Y CAJAL	Davide Spirito	Ramón y Cajal	2024-2029
RAMON Y CAJAL	Jorge Saiz	Ramón y Cajal	2024-2029
RAMON Y CAJAL	José María Porro	Ramón y Cajal	2025-2030
RAMON Y CAJAL	Pablo Simón	Ramón y Cajal	2025-2030
RAMON Y CAJAL	Sergio Lucarini	Ramón y Cajal	2025-2030
RAMON Y CAJAL	Santiago Rodríguez	Ramón y Cajal	2025-2030
REFOREST 4.0	Revalorización de residuos forestales para la agricultura 4.0. - reforest 4.0	Proyectos de innovación e investigación aplicadas y transferencia del conocimiento en la formación profesional	2024-2025
RETROFIT	Fuentes de energía portátiles hechas a medida para dispositivos electrónicos sostenibles	Proyectos de Colaboración Público-Privada	2024-2026
SpinRed2	Exploring spintronic potential for low-power consumption devices	Redes de Investigacion	2023-2025
STEMIN2D-OS	Enhancing Structural, Electric, Magnetic, and Optoelectronic properties in 2D materials by Strain-Engineering	Proyectos I+D+I-AEI	2024-2027
SUMMIT	Modelos SUrrogados para la simulación Multifísica y Multiescala de materiales electroactIvos y magnetoacTivos usando computación de alto rendiminto	Proyectos I+D+I-AEI	2025-2028

EUROPEAN & OTHER INTERNATIONAL PROJECTS

Acronym	Title	Call	Duration
BIONTIER	Breaking Frontiers in sustainable and circular biocomposites with high performance for multi-sector applications	Horizon-JU-CBE-2023-IA-07	2024-2027
C2FUe-LS	Turning recycled carbon into valuable fuels for all transport sectors by marrying selective plasma and bio-/chemo-catalysis at mild conditions	Horizon-CL5-2024-D3-02-02	2025-2028
ECLECTIC	ECLectic: ElectroChemiLuminescence doctoral network for early sepsis diagnosis	MSCA-DN	2023-2027
EPROT	Engineered Conductive Proteins for Bioelectronics	Pathfinder Open	2024-2025
FLUFET	FLow detection of virUses by graphene Field Effect Transistor microarrays	Pathfinder Open	2024-2027
GIANCE	Graphene AlIIANCE for Sustainable Multifunctional Materials to Tackle Environmental Challenges	Horizon-CL4-2022-DIGITAL-EMERGING-02-20	2023-2027
HFSP	Modeling electric fields at the heart of enzyme catalysis and function	Human Frontiers Science Program	2022-2025
HFSP-S4S	Science 4 Scientist Special program	Science4Scientist HFSP	2022-2025
MERLIN	PlasMonic photo-thErmo-catalyzed composite membranes for Remediation of persistent poLlutants IN water	HE-MSCA-PF	2024-2026
NETSKINMODELS	European Network for Skin Egineering and Modeling	Cost Action	2022-2026
PASS	Photocurable Solid-State batteries with self-healing property and smart-functionalities	HE-MSCA-PF	2025-2027
PIEZO2D	Piezoelectricity in 2D-materials: materials, modeling, and applications	Horizon-MSCA-2022-SE-01-01	2023-2027
RETROTRAFO	Development of knowledge and technology to implement retrofilling in power transformers using biodegradable or recycled fluids and fostering circular economy	MSCA-DN	2024-2028
ROCHE	Multilayer approach for solid-state batteries	H2020-MSCA-GF	2022-2025

EUROPEAN & OTHER INTERNATIONAL PROJECTS

Acronym	Title	Call	Duration
SELFAQUASENS	Advanced manufacturing of self-sensing bio-based membranes for environmental detoxification and revalorization	Horizon-MSCA-2022-SE-01-01	2023-2027
TRACK THE TWIN	Tracking Nanomaterial Performance, Towards Digital Twins of Quantum Dots Under Loading	MSCA-DN	2024-2028
UNICORN	Hybrid Nanocomposite Scintillators for Transformational Breakthroughs in Radiation Detection and Neutrino Research	Pathfinder Open	2023-2027

HIGHLIGHTS: NEW EUROPEAN PROJECTS

C2FUELS

The EU-funded C2FUe-LS project aims to develop a novel plasma catalysis system powered by renewable electricity, green hydrogen, and CO2. The process operates under moderate conditions and eliminates the need for additional purification. It utilizes cold plasma along with a mixture of biocatalysts, chemocatalysts, or nanocatalysts housed in porous, modular structures, making it more efficient and selective. The goal is to produce clean fuels such as ethanol for sectors like aviation and shipping, as well as basic chemical components.

PASS

This MSCA Post-Doctoral Fellowship Project aims to develop solid environmentally friendly solid-state using UV curable materials. This main goal divides in three steps: a) the design, development and optimisation of UV-curable materials with tailored made properties, including self-healing capabilities to develop solid-state electrolytes (SSEs); (b) assemble those SSEs in a battery, and (c) understand the role of materials and interfaces (hybrid materials interfaces and solid electrolyte/electrode interfaces) in the ionic transport in order to unravel a possible kinetic mechanism in solid-state batteries.

PRIVATE PROJECTS

Acronym	Title	Call	Duration
CEIT	CINTAS MAGNETICAS	CEIT	2025
DEMOSENSE	Oferta de desarrollo de escalado y demostración de nuevo sistema de monitorización de husillos a bolas online en entorno real	Hazitek	2024-2025
GENESINK	Optimization INKS from GENESINK	Genesink	2025-2026
MARVEL FUSION	Recubrimiento de material NEOTECH	Marvel Fusion	2024
MELEXIS 2	verifying the feasibility of GMI sensor based on Melexis IMC soft magnetic materials	Melexis	2024-2025
OSASUNK0	Investigación y desarrollo framework Km0 para habilitar y acelerar el desarrollo y gestión del ciclo de vida de dispositivos médicos embebidos que garanticen la seguridad funcional"	Hazitek	2023-2025
UNIKARE	Fabricación de Electrodos Serigrafiados	Hazitek	2024
UNIVERSITY OF MINHO	CARACTERIZACION DE MATERIALES	University of Minho	2025
WISH	Wireless structural health monitoring of lightweight additively manufactured aluminum with multifunctional aerospace properties (WISH)	European Space Agency (ESA)	2025-2026

IKUR STRATEGY IMPACT

IKUR is the Basque strategy promoted by the Education Department of the Basque Government to boost the Scientific Research in specific strategical areas and to position them at international level.
BCMaterials is strongly aligned with and committed
to contribute to the success of this importat strategic endeavour, which in turn has been also very positive for our development.
Further, the IKUR strategy has been not just a platform for scientific and technological excellence, but also for fruitful collaborations and the formation of new generation of excellent scientists.

Acronym	Title	IKUR Strategical Line	Duration
ARK	Advanced machine-learning platform for atomistic simulations of Reactivity and Kinetics	HPC&AI	2025-2026
MUFFINMAT	MUlti-FIdelity Bayesian PINNs for next generation of advanced MATerials	HPC&AI	2025-2026
BIOELEC	BraIn-On-chip with integrated ELECtrical stimulation and advanced readout capabilities: towards neural process understanding, modulation and regeneration	Neurobioscience	2025-2026
MAGMAENA	Magnetic materials for energy applications	Neutrionics	2025-2026
MEDIDAS NEUTRON	Support for experimental campaigns at neutron facilities	Neutrionics	2025-2026
SCREEN4SENS	Development of smart and multifunctional inks for screen-printable sensor prototypes and applications for a sustainable digitalization	Neutrionics	2025-2026
SMARTSPE	Solid polymer electrolytes with smart capabilities: towards next generation batteries	Neutrionics	2025-2026
MOLBITS	MOLecular quBITS: from bulk to the surface	Quantum Technologies	2025-2026
Q-PROT	Engineering quantum effects in protein-based systems for spintronics, quantum information, and bio-sensing (Q-Prot)	Quantum Technologies	2025-2026
SPINSHALL	Design and manufacturing of novel magnetic topological materials with Spin-Seebeck and spin-Hall effects	Quantum Technologies	2025-2026

CLUSTERS NETWORK

BCMaterials' strategic commitment to technology transfer is also reflected in its participation in clusters at the European, national, and regional levels. We are members of some of the leading associations and platforms related to the development and applications of new materials in critical sectors. We contribute our expertise as an international center of excellence to these clusters and establish a network that enriches our work through collaboration with their partners.

IAM-I - The Innovative Advanced Materials Initiative

IAM-I is the international non-profit association leading the IAM4EU partnership, aiming to build a Europe-wide, cross-sector R&I ecosystem that accelerates the market uptake of sustainable advanced materials. It brings together stakeholders across the full materials value chain to support innovation for a digital and circular economy. Key goals include supporting the green and digital transition, strengthening EU industrial competitiveness, and achieving sustainable, circular value chains by 2030.

MATERPLAT - Spanish Technological Platform for Advanced Materials and Nanomaterials

HEGAN is a private non-profit association that brings together the Basque Aeronautical and Space sector, created with the purpose of generating collaboration and influence through the deployment of cooperative actions that respond to the strategic challenges of the Members, to help them grow sustainably and create value for the Aerospace Cluster and the Society. This cluster aims to strengthen the competitiveness, innovation, and international presence of its members, focusing on sustainable aviation (decarbonization, SAF, H2), industry 4.0, and digitalization. Their 2025-2028 strategy focuses on building a capable, global industry, boosting R&D&I, and reinforcing value chain cooperation.

BIO-BASED INDUSTRIES CONSORTIUM (BIC)

The Bio-based Industries Consortium (BIC) is a non-profit organisation originally set up in 2013 to represent the private sector in a Public-Private Partnership (PPP) with the European Commission, focused on strengthening the bio-based industries sector in Europe. BIC's Industry Members cover the whole value chain, from primary production to market. Members represent diverse sectors, such as agriculture and agri-food, aquaculture and marine, chemicals and materials (including bioplastics), forestry, pulp and paper and technology providers and waste management and treatment. BIC's Associate Members include research organisations, academia and trade associations.

FUNCTIONAL PRINT CLUSTER

Functional Print is the leading Functional Printing Cluster in Europe. It is formed by group of companies, technology centers, knowledge centers (universities and vocational training), business groups and other agents whose activity is related to the support and development of functional printing and additive manufacturing. This cluster promotes growth and competitiveness through business and technological cooperation and collaboration to boost one of the most innovative sectors with the greatest prospect for industrial growth.

CLUSTER GAIA (Basque Association of Applied Knowledge and Technology Industries)

The Gaia Cluster aims to be a benchmark in collaborative innovation, fostering globally competitive, technology-based solutions (IoT, AI, cybersecurity) in consulting, engineering, and ICT. Operating under a 2021-2027 Strategic Plan, this organization focuses on three key pillars: Smart Industry, Smart Territory, and Smart Society. The Gaia cluster members specialize in different technological areas such as consulting, engineering, electronics, computing, telecommunications, and gamification.

BASQUE PAPER CLUSTER ASSOCIATION

The Basque Paper Cluster Association is a non-profit organisation founded in 1998. Made up of the main organisations in the paper value chain in the Autonomous Community of the Basque Country. Its mission is to contribute to the competitiveness and transformation of the Basque paper industry, as well as to the improvement of its image through cooperation, networking and the harnessing of synergies. This cluster aims to highlight the environmental sustainability, industrial innovation and wealth generation profile of the Basque paper industry.

HEGAN - Basque Aerospace Cluster

HEGAN is a private non-profit association that brings together the Basque Aeronautical and Space sector, created with the purpose of generating collaboration and influence through the deployment of cooperative actions that respond to the strategic challenges of the Members, to help them grow sustainably and create value for the Aerospace Cluster and the Society. This cluster aims to strengthen the competitiveness, innovation, and international presence of its members, focusing on sustainable aviation (decarbonization, SAF, H2), industry 4.0, and digitalization. Their 2025-2028 strategy focuses on building a capable, global industry, boosting R&D&I, and reinforcing value chain cooperation.

BASQUE HEALTH CLUSTER

The Basque Health Cluster is the reference network for the health sector in the Basque Country, generating opportunities and solutions (one stop shop), fostering initiatives to boost the competitiveness of our associated companies and agents through collaboration, innovation and connection with global markets, with a single purpose: to drive a solid, competitive and sustainable health ecosystem in the Basque Country.

FACILITIES & SERVICES

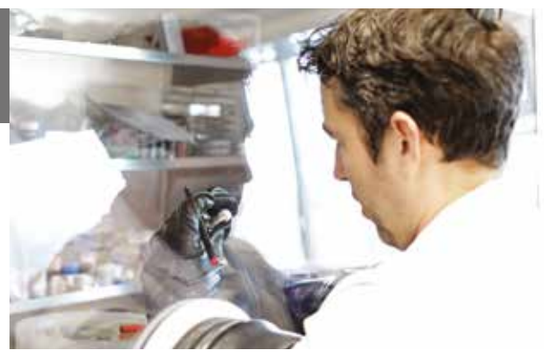
04

As a research center of excellence, BCMaterials runs advanced infrastructures for materials synthesis, processing, characterization and integration into proof-of-concepts devices. Those facilities are open to all our collaborators and services are also provided whenever we can be useful to the scientific, technological or industrial sectors.

OUR LABS

Chemistry synthesis laboratory

Prepared for the synthesis of nanoparticles, polymers and related materials.

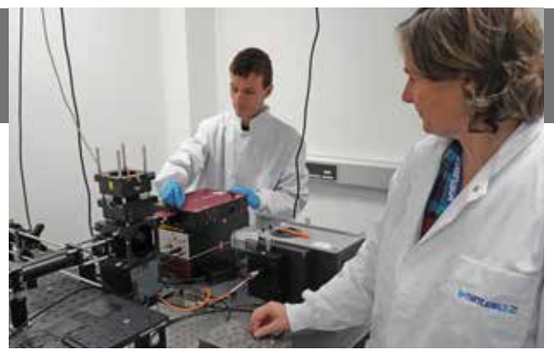


Energy laboratory

Equipment for the development and research of perovskite solar cells. The laboratory also includes facilities dedicated to energy storage systems, focusing on the development of various battery components, with particular emphasis on solid-state batteries.

Biomedical and biotechnological materials

This laboratory includes the necessary equipment for cell culture under different conditions, including the ones related to the advanced materials (stimuli responsive) and bioreactors that are developed within these research areas.

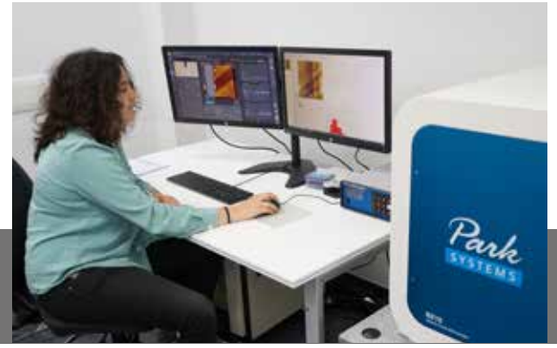


Optoelectrical device characterization

This lab contains all necessary equipment for the optoelectronic characterization of materials as well as for research in 2D materials at low temperatures. .

Metallurgy and ceramics lab

Laboratory devoted to research in metallurgy and ceramic materials, mostly with processing facilities and with a strong focus on magnetic and dielectric materials. A melt spinner is one of the main equipment in this laboratory, together with the necessary furnace and mill facilities, among others.

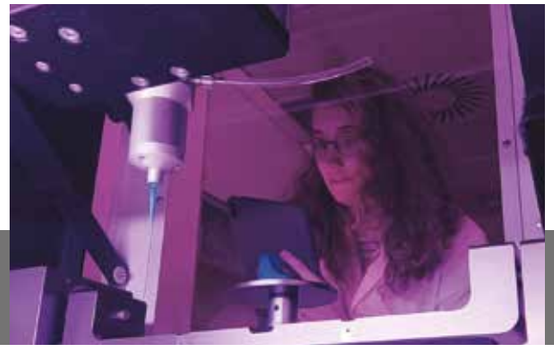


Functional materials characterizations I. Electricity and electronics lab

As a center developing materials for digitalization, among other application areas, BCMaterials develops application prototypes in areas including sensors and actuators of soft robotics. Thus, this lab contains the necessary infrastructure for electrical and electronics development, not only for the electrical characterization of the materials, but also for developing interface electronics. Further, if contains materials characterization equipment including thermal characterization, X-ray diffraction, and Atomic Force Microscopy facilities with different modes, such as piezo, magnetic and Kelvin prove.

Environmental Materials and Processes

This laboratory includes both synthesis and functional characterization facilities. With respect to synthesis, the main focus is metal organic frameworks and related materials as well as metallic and oxide nanoparticles. Characterization includes particle characterization techniques (e.g. BET) and functional characterization for photocatalytic degradation of pollutants, absorption processes for water cleaning and materials recovery, and hydrogen production, among others.



Additive Manufacturing

A lab containing different additive manufacturing technologies, including ink-jet, screen-printing, direct ink writing, melt-electrowriting, and photocuring technologies. 2D and 3D printing technologies and the development of novel printable materials provide a strong basis for research spanning from fundamentals to applications, including technology transfer..

OUR LABS

Functional surfaces and coatings

Thin film deposition technologies by magnetron sputtering, together with polymer coating technologies, such a spray coating are included in this lab.

Functional materials characterization II:

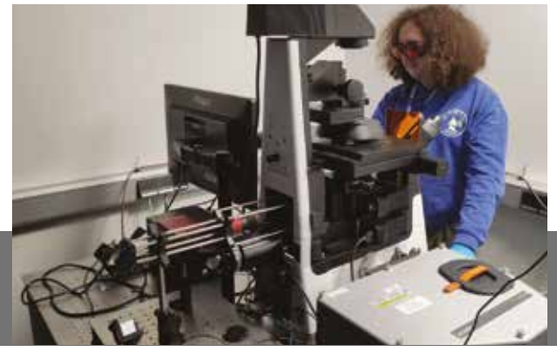
This laboratory comprises facilities for chemical sensors characterization, in particular for VOC detection, as well as magnetic functional characterization, including magnetoelectric and magnetomechanical; mechanical and piezoelectric characterization is algo performed in this lab, together with voltamety and electrical impedance testing.

Multifunctional Nanochemistry

Laboratory fully devoted to the synthesis of metal organic frameworks and small molecules, now is being expanded to the development of biohybrids.

Functional Materials characterization III

Mostly devoted to electrochemical testing it also contains equipment for electrical and optical characterization of 2D and related materials.



Colloidal Nanoparticle laboratory

This is a new laboratory being implemented with the necessary equipment for the assembly and characterization of nanoparticles..

Clear room

The last laboratory to be implemented will expand our scientific and technological capabilities to microfabrication and microelectronic facilities. At the core of the laboratory is the optical UV lithography and inspection system, together with the complementary systems to achieve high resolution structures and devices.

MATERIALS **SYNTHESIS**

Synthesis of advanced and multifunctional materials is one of the cornerstones of materials innovations. State of the art facilities for chemical and physical synthesis of materials are available at different laboratories of BCMaterials. We design, synthesize and modify organic and inorganic, crystalline and amorphous materials. Mesoporous materials, nanoparticles, metallic, ceramic and polymer materials are synthesized with tailormade properties and functionalities.

Methods available

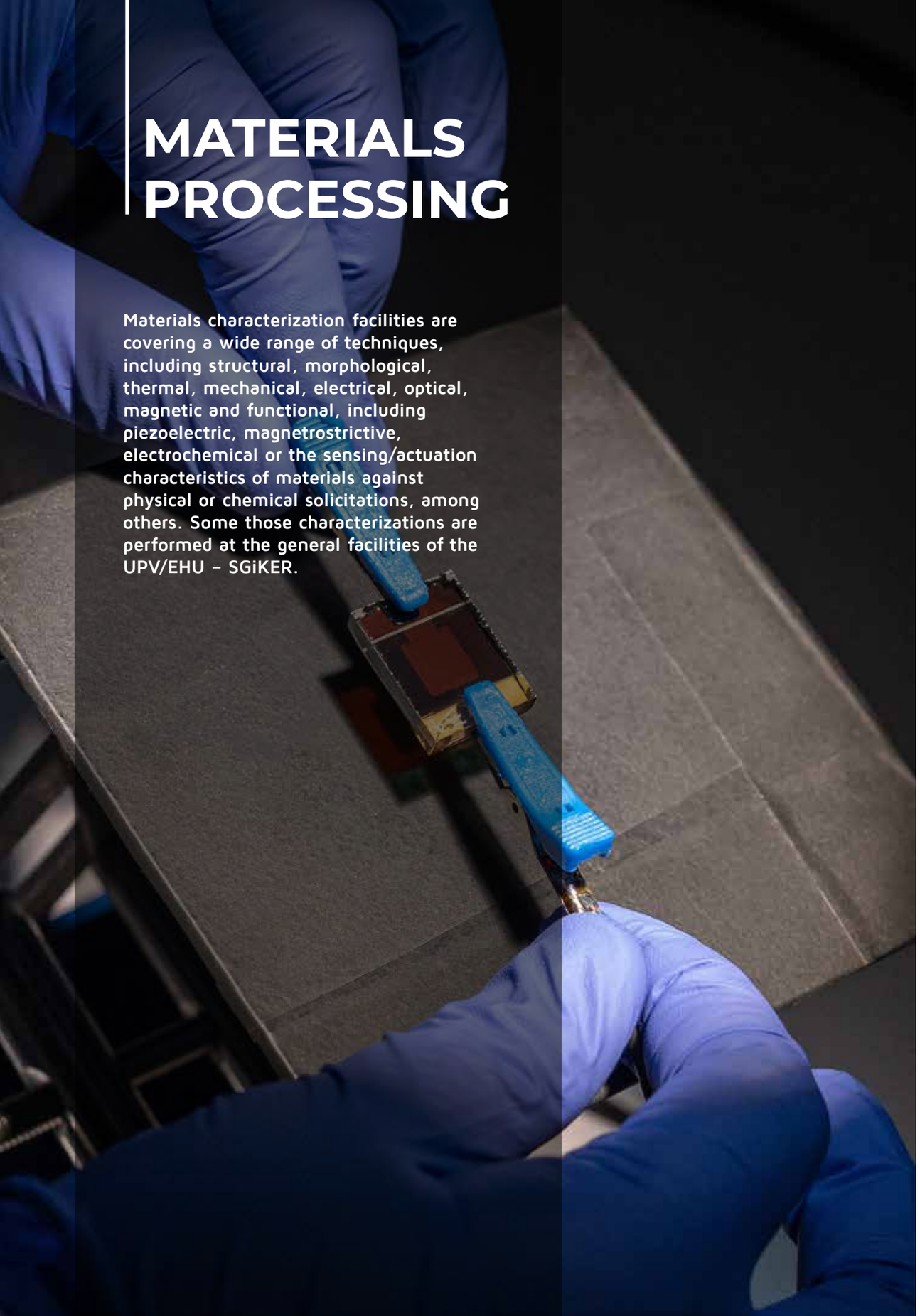
Among many others, our labs offer the possibility to use:

- Hydrothermal synthesis of wide scope of inorganic and hybrid materials and nanoparticles.
- Synthesis of mesoporous materials.
- Synthesis of monocrystalline and amorphous metals, and ceramics. It includes both Synthesis and thermal treatments.
- Synthesis of polymers and hydrogels.
- Floating Zone Optical Furnace.
- Crystal System Corp./ FZ-T-P1200-H-I-S 2013.
- Anton Parr Monowave 400 equipped with autosampler MAS24: High throughput synthesis of nanoparticles.
- Sigma 3-30KS: Centrifuge for isolation of nanoparticles.
- Büchi C-850 FlashPrep: Purification of small molecules.
- Büchi Rotavapor R-300: Distillation of solvents.
- CEM Discover Microwave reactor equipped with stirring control and internal camera: Microwave synthesis with programmable power, temperature, and pressure programs.
- Berghof BR-100 Hydrothermal reactors
- IKA Rotary evaporator RV 8 pro V-C
- Synthesis of noble-metal nanoparticles of varying size, morphology, and surface chemistry
- MBraun Glovebox with thin film fabrication facility for optoelectronic device fabrication, e.g. solar cells, memristors or memdiodes

Some of our **services**

We provide advice and support for the design and synthesis of materials with tailor made properties for specific applications including:

- Tailored physical properties: magnetic, electrical, mechanical or thermal, among others.
- Functional properties: photocatalytic, piezoelectric, magnetostrictive, magnetocaloric, among others.
- Advanced properties: self-healing, electrochromic, thermochromic, among others.



MATERIALS PROCESSING

Materials characterization facilities are covering a wide range of techniques, including structural, morphological, thermal, mechanical, electrical, optical, magnetic and functional, including piezoelectric, magnetrostrictive, electrochemical or the sensing/actuation characteristics of materials against physical or chemical solicitations, among others. Some those characterizations are performed at the general facilities of the UPV/EHU – SGiKER.

Methods available

Among many others, our labs offer the possibility to use:

- Design and processing of composite polymer-filler materials.
- Design and processing of inks for screen, ink-jet and direct write printing.
- Processing of thin films by physical and chemical deposition techniques.
- Processing of materials in the form of filament, wires and films.
- Processing of materials in the form of nano- and micro particles.
- Mill Mini Rotary Tube Furnace.
- Melt Spinner.
- Plasma portable system for processing substrates and thin films.
- Turbomolecular pumped coater.
- A variety of printing and coating techniques.
- Thermal evaporator.
- Laser-based deposition of nanomaterials on solid substrates
- Moorfield nanoPVD metal evaporation system capable of depositing metallic films

Some of our **services**

We provide advice and support for the design and processing of materials with tailor made properties for specific applications including:

- Tailored physical properties: magnetic, electrical, mechanical or thermal, among others.
- Functional properties: photocatalytic, piezoelectric, magnetostrictive, magnetocaloric, among others.
- Advanced properties: self-healing, electrochromic, thermochormic, among others.
- Plasma cleaning processes and activation (functionalization) of surfaces.

MATERIALS CHARACTERI-ZATION

Materials are processed in a variety of shapes and forms either to explore their intrinsic properties, to tune them and/or to make them compatible with a variety of applications.
From bulk materials to thin-films, from single phase to hybrid materials and composites, materials are processed in our laboratories.

Methods available

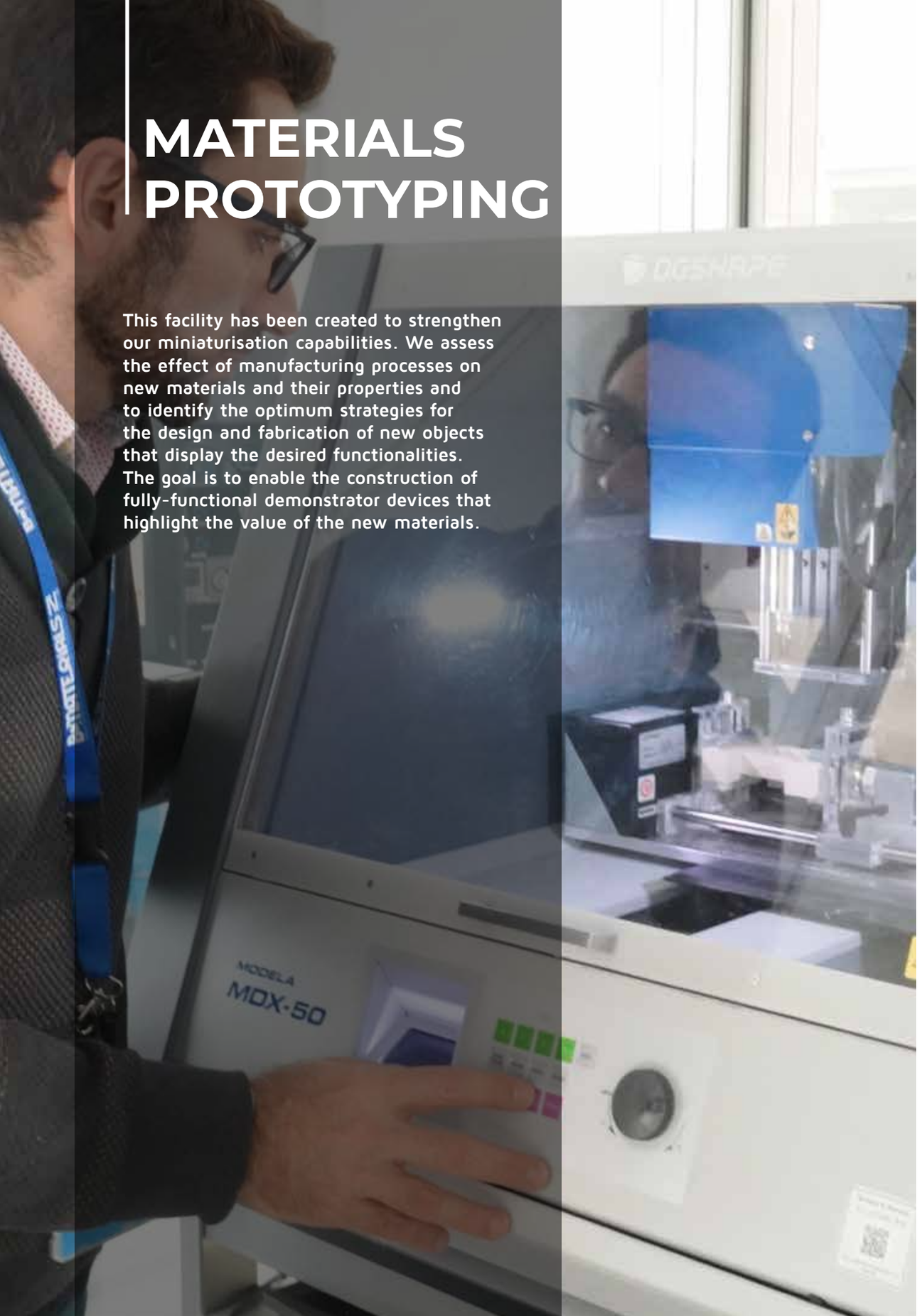
Among many other, our labs offer the possibility to use:

- AttoDRY800 optical cryostat. Temperature control of samples in vacuum between 4 and 300 K (-270 and 27°C).
- Spectrograph + CCD Camera. High resolution optical spectroscopy in the visible range.
- Gas and vapor adsorption analyser: 3P vapor 100C station is adapted to acquire vapor and gas adsorption isotherms in the micro to mesopore range. Measuring and analysis of the adsorption and porous properties of porous materials as zeolites, activated carbons, MOF and COFs, or porous polymeric or composite systems.
- Fluorescence microscope. Live imaging of cells on flat materials.
- X-Ray Diffractometer. Empyrean 810-02997231. Measuring of different kinds of samples: powders, thin films, nanomaterials, solid objects at different temperatures, inert atmosphere...
- Atomic Force Microscope (AFM). NX10 ES10005-291122. Nanoscale imaging for a wide range of applications: cell biology, analytical chemistry, electrophysiology, neuroscience...
- VSM-Vibrating Sample Magnetometer. Microsense, LLC EZ7-20150305 MicroSense. To measure magnetic moment and coercivity of thin films or studying the magnetic properties of liquids, powders, or bulk samples.
- Perkin Elmer- Diamond DSC N536-0021 (P/N) Melting, Crystallization, Glass Transition, Polymorphism, Purity, Specific Heat, Kinetic Study and Curing Reaction.
- The Ossila Contact Angle Goniometer provides a fast, reliable, and easy method to measure contact angles and surface tensions of liquid droplets.
- Tensile strength tester Shimadzu Instruments AGS-J 500N. High precision and high reliability in material testing Forces are measured with a precision better than ±1% of indicated values, within the range from 1/1 to 1/250 of the rated force.
- Complex impedance equipment Agilent-Keysight E4980. Offering fast measurement speed and outstanding performance at both low and high impedance ranges.
- Custom made photothermal instrument equipped with high power red and near-IR lasers (LUMICS, 672, 784 and 808 nm of 4W of optical power), optical coupling lenses, thermometer based on phototherrmal IR camera (FLIR), thermal based power sensor, and control software.
- The VMP3 is a research-grade multi-channel potentiostat. With its modular chassis design, up to 16 independent potentiostat channels can be installed. The VMP3 can be equipped with additional capabilities, including low current measurement, impedance and high current via plug-in modules.
- Custom made Magnetoelastic measurement system: Automated experimental system for measuring magnetoelastic resonance from 10Hz up to 150 MHz and a field resolution of 8 A/m and maximum magnetic field of 11 kA/m.
- Gamry 1010 Potentiostat.
- Andor Kymera spectrograph + Newton 970 EMCCD for high sensitivity Raman and photoluminescence spectroscopy.
- Cary 60 UV-Vis spectrometer with QNW t2 Sport cuvette holder for temperature control and stirring.
- Wavelabs LED solar simulator with controllable illumination intensity and wavelength profile.

Some of our **services**

We provide advice and support for the characterization of a wide variety of materials properties, including the interpretation of the results and the possible ways to tune/modify those properties. Those characterizations include:

- Structural, morphological, thermal, mechanical, electrical, optical, magnetic, among others.
- Functional, including piezoelectric, magnetrostrictive, electrochemical, among others.



MATERIALS PROTOTYPING

This facility has been created to strengthen our miniaturisation capabilities. We assess the effect of manufacturing processes on new materials and their properties and to identify the optimum strategies for the design and fabrication of new objects that display the desired functionalities. The goal is to enable the construction of fully-functional demonstrator devices that highlight the value of the new materials.

Methods available

Among many others the methods available are:

3D printing (DLP and FDM), CNC milling (Roland MODELA MDX-50), CO2 laser cutting and engraving (Epilog Mini 18 CO2 laser engraver), blade cutting (Roland GS-24 CAMM-1) and thermoforming with suitable CAD/CAM software.

TECAPRIT-TPE100 with open inking system, semi-automatic pad printer for prototyping and manufacturing of microstructures.

Any combination of processes is possible, including with printing methods such as screen-printing and inkjet-printing.

Some of our **services**

Among the services that we can offer we have:

- 3D printing of thermoplastic polymers and functional polymer thermoplastic composites by FDM/FFF.
- 3D printing of functional water- and solvent-based inks by direct ink writing.
- 3D printing of functional UV curable resins by selective laser sintering (SLS).
- 2D printing of functional inks by screen printing and inkjet printing.

05

OUTREACH ACTIVITIES

Outreach activities are divided between the dissemination events we do for scientists to share, receive and discuss the generated knowledge and technological advances and the outreach activities in which we take part to make society part of our research. Regardless the public target we address, outreach and dissemination are key in the activities and working philosophy of BCMaterials.

AT

BCMATERIALS

NM4BL 2025

ANNUAL WORKSHOP

Elena Jubete, fro m CIDETEC, presented the talk 'Current ecosystem on Advances Materials and their application in Critical Environments' for Mobility

The 2025 edition of BCMaterials' annual workshop 'New Materials for a Better Life!" gathered nearly one hundred participants on November 19 in Leioa to review the latest advances and discuss critical materials, their applications, and their performance in demanding environments.

The program brought together leading experts from the Basque academic, research, and industrial ecosystem, who addressed the topic across four thematic areas:

- General framework: critical materials, relevance and regulation framework Availability: from mining to recycling
- Application areas: Aeronautics and Aerospace
- Application areas: Energy and Industry

As usual, the workshop had an important institutional support. The opening session was led by Adolfo Morais, Deputy Minister of Science and Innovation; Cristina Peña, Director of International Projects and coordinator with research centers at UPV/EHU's Vice-Rectorate for Research; and Senentxu Lanceros-Méndez, Scientific Director of BCMaterials.

97
ATTENDEES

11
AFFILIATIONS

11
PRESENTATIONS

Image of the 2025 seminar's opening session, with representatives of the Basque Government and the University of the Basque Country

Juan Ignacio Burgaleta, CEO of Satlantis, explained the needs of the aerospace industry, specially satelites industry, for new materials

ECLectic

NETWORK WORKSHOP

WORLDWIDE EXPERTS PAEL

Paul Francis
Deakin University (Australia)
Francesco Paolucci
Univ. di Bologna (Italy)
Neso Sojic
Univ. de Bordeaux (France)
Eduardo Laborda
Univ. de Murcia (Spain)
Honglan Qi
Shaanxi Normal Univ.(China)
Robert Forster
Dublin City Univ. (Ireland)
Luca Prodi
Univ. di Bologna (Italy)
Jeffrey E. Dick
Purdue University (USA)
Weiliang Guo
Najing Normal Univ. (China)
Guobao Xu
Chang Chun Institute of Applied Chemistry (China)

On April 3 and 4, BCMaterials hosted a workshop organized by the MSCA Doctoral Network ECLectic, of which our centre is a partner. The aim of the workshop was to introduce predoctoral researchers and early-stage scientists to the fundamentals of electrochemiluminescence (ECL).
Through a combination of lectures and hands-on sessions, participants explored and applied techniques such as microscopy, examined the relationship between nanomaterials and ECL, and learned about its commercial applications, among other topics.
In the two days prior to the workshop, predoctoral researchers from the ECLectic network took part in one of the training sessions included in the doctoral programme. They received instruction on topics such as scientific publishing, communication, and outreach, and also reviewed the progress of the different work packages within the network.

Track The Twin

NETWORK WORKSHOP

60
ATTENDEES

3
DAYS

From June 30 to July 2, BCMaterials hosted the workshop "Quantum Dot Computations," organized within the framework of the MSCA doctoral network Track the Twin, of which our centre is a partner.
The event brought together internationally renowned experts in the theoretical and computational study of quantum dots, including E. Rabani (UC Berkeley), O. Voznyy (University of Toronto), J. I. Climente (Universitat Jaume I), N. Yazdani (ETH Zurich), C. Delerue (Université de Lille), and I. Infante (BCMaterials).
The presentations covered a wide range of topics, including surface dynamics, electron–phonon coupling, excited-state dynamics, tight-binding models, classical and machine-learning force-field methods, and density functional theory.
Around 60 experts and students participated in the workshop, which concluded with a hands-on session led by the doctoral researchers of the network.

AT
BCMATERIALS

SEMINARS & INVITED TALKS

Invited talk by Maia García Vergniory, from the Donostia International Physics Center (DIPC) and the University of Sheerbroke (Canada)

Raynald Gauvin, from McGill University (Canada), creator of the CASINO software for Monte-Carlo simulations, gave a talk at BCMaterials in July

BCMaterials' program of fortnightly seminars and invited talks aims to provide our scientists and those from our nearest scientific community with diverse and in-depth knowledge of materials science. These events offer valuable perspectives in fields relevant to the research of any materials scientist. Additionally, participating as speakers in the fortnightly seminars allows our junior scientists to develop the skills necessary for presenting their research findings to the public.

BCMaterials - Biofisika Symposium

On June, 19 we hosted the 'Processes and Materials for Life' symposium, organized jointly with Instituto Biofisika. The goal of the symposium was to share the common knowledge of both centers on cutting-edge research with potential applications in healthcare, sustainability and beyond.
The talks covered a wide range of topics that shape the future of life sciences, from responsive polymer brushes to electroactive biomaterials. The program included very interesting presentations by Instituto Biofisika and BCMaterials researchers, as well as keynote speakers from the University of Newcastle and UNSW in Australia, and the North Carolina State University in the USA.
The event also served as a way to establish new connections between both organizing entities and to seed future collaborations.

Ane García, predoctoral researcher, during one of the fortnightly seminars offered by BCMaterials scientists during the year

22 EVENTS

8 FORTNIGHTLY SMINARS

11 INVITED TALKS

3 OTHER EVENTS

OUT

BCMATERIALS

EXTERNAL **DISSEMINATION**

Senentxu Lanceros-Méndez speaker at 'Jornada de inmersión en impresión funcional: Redefiniendo Industrias' Functional Print Cluster (Madrid)

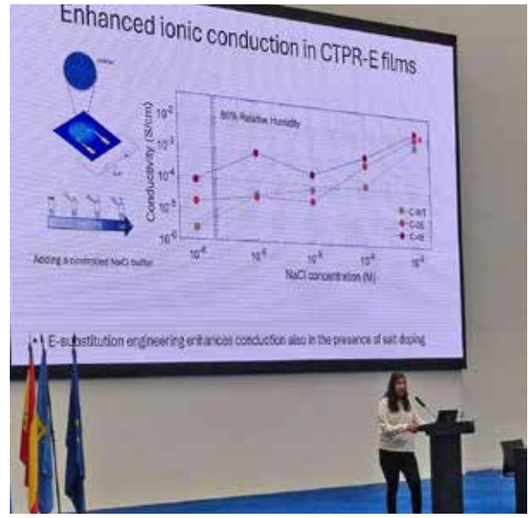
Javier del Campo at the GERSEQ 2025 conference, held at the Unviersity of La Laguna - Tenerife (Spain) in July

64
ORAL PRESENTATIONS

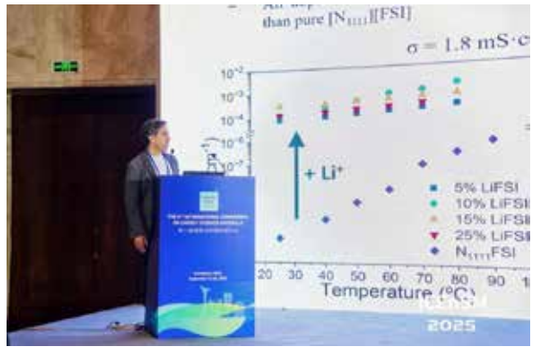
32
INVITED TALKS

40
POSTER PRESENTATIONS

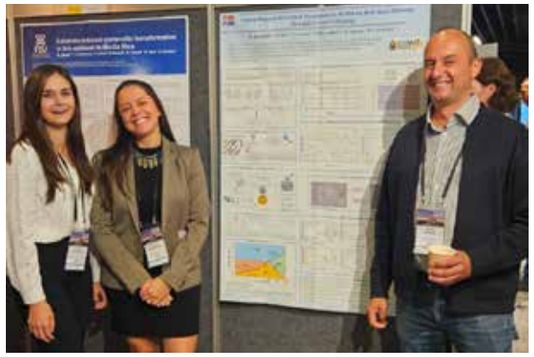
Javier Vicente, post-doctoral researcher presented a poster at the 'Jornada conjunta ciencia-industria espacial'. Agencia Espacial Española (Bilbao)

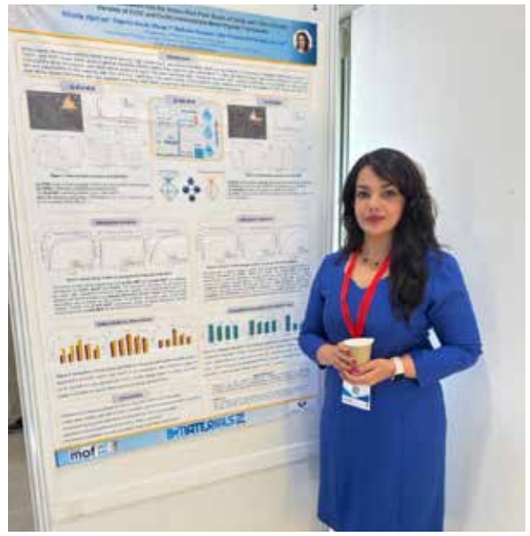


Oral presentation by our post-doctoral researcher Lisa Almonte during the GEFES 2025 Conference in Oviedo (Spain)



Manuel Salado, Ikerbasque Research Fellow, at the International Conference on Energy Storage Materials (ICEnSM) in China, and Niloufar Abdirad, pre-doctoral researcher, at the EuroMOF 2025 conference, held in Greece.





BCMaterials researchers Daniel Salazar and Mariana Ríos, with visiting student Milena Kowalska at the ICOMAT event in Prague (Czech Republic)

SCIENCE FOR SOCIETY

In addition to the dissemination work focused in the science sphere, there is a huge work we do to address the general public through different outreach initatives carried out by BCMaterials or organized by third parties in which we take part. This is our resposibility to make our research understandable by society. We need that people see that the work we do has a possitive impact in their daily lives. At the same time, we want to encourage the younger generations to devote to science and technology, because everyone's efforts will be necessary to address the challenges our planet is facing for the present and the near future.

SCIENCE
FOR SOCIETY

MATERIALS FOR SOCIETY
A SCIENTIFIC, CULTURAL & SOCIAL INITIATIVE BY BCMATERIALS

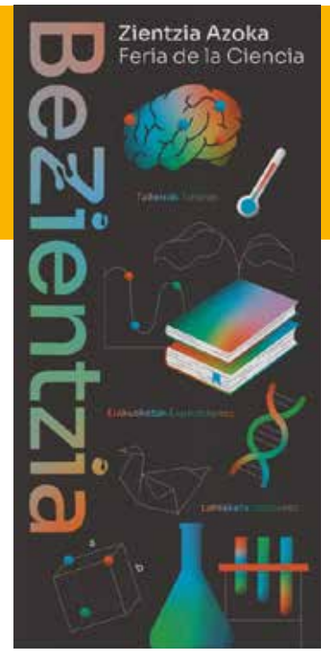
NEW
EVENT

BCMaterials expanded its Materials for Society initiative with new chapters in 2025. This scientific, cultural and social endeavour aims to explore the relationships between science and the many dimensions of society, including thought, politics, art, ways of life and technology.

On June 18, we enjoyed a highly engaging talk and discussion with one of the Basque region's leading experts in Deep Tech and high-impact science and technology projects: Jorge García del Arco.

In his talk, titled "Deep Tech: Science to Change the World," García del Arco offered an inspiring overview of his professional journey. He highlighted his commitment to cutting-edge technologies, including quantum technologies, as well as his work on projects aimed at addressing the major global challenges of the Fourth Industrial Revolution.

The talk also provided an opportunity to reflect on what truly makes a project innovative, how to identify sources of funding, and how to lead and inspire the people behind projects with social impact.



Our center added in 2025 a new activity to its outreach events portfolio, with the 'BeZientzia' science fair, which took place in Bilbao in October. The event brought together nearly 200 sixth-grade students from schools across Bizkaia. BCMaterials was one of the four organizing institutions, alongside Achucarro – Basque Center for Neuroscience, BC3 – Basque Center for Climate Change, and BCAM – Basque Center for Applied Mathematics, all of them BERC centers in the Bizkaia region.

'BeZientzia' offeres hands-on workshops that turned the students into scientists for a day. Participants explored scientific approaches to mathematics, calculated their carbon footprints, and learned to identify Bizkaia's ecosystems. They also studied food genetics and, in the case of BCMaterials, discovered how new materials can help clean and add value to water resources.

BCMaterials collaborates with the University of the Basque Country in its efforts to promote science outreach in a variety of settings, with science fairs being among the most prominent. Each year, we take part in the European Researchers' Night, held on the last weekend of September, and Zientzia Astea (Science Week), which takes place in early November. Both events are hosted in Bilbao.

These initiatives provide research centres such as ours with an excellent platform to bring materials science closer to audiences of all ages. The aim is to show how materials science works, highlight its applications in everyday life, and showcase its enormous potential for the future.

At the European Researchers' Night, for example, BCMaterials presented experiments related to water purification, the development of stable and safe batteries, and new materials with applications in the health sector.

As for Zientzia Astea, it is worth highlighting the strong involvement of BCMaterials researchers in the event. More than 20 members of our research team took part in the science stand located at Bizkaia Aretoa. There, they demonstrated the ability of nanomaterials to decontaminate water through photocatalysis, showed how batteries and electrical capacitors can be produced using paper, and presented several other engaging experiments.

SCIENCE
FOR SOCIETY

The Week of Women and Girls in Science, centred around the International Day celebrated on February 11, is one of the major annual highlights of BCMaterials' science outreach activities.
As part of the Emakumeak Zientzian (Women in Science) initiative, the centre organised school visits to its facilities on February 11 and 12. More than 130 students from five high schools in Bizkaia toured our laboratories alongside female scientists from the centre. The aim was to showcase their daily work and inspire scientific vocations, particularly among female students.

BCMaterials also contributed to other activities within the programme through events such as the talk 'Emakume Zientzialariak. Atzo eta Gaur' (Women Scientists: Yesterday and Today), in which researcher Maibelín Rosales participated, and the 'Eskolara Itzulera' (Back to School) initiative, a series of visits by female scientists to schools that included the participation of several of our researchers.
In addition to taking part in the programme's activities, BCMaterials was also a member of the Emakumeak Zientzian coordination group for the second consecutive year, the body responsible for shaping each new edition of the initiative.

MEET THE **BCMATERIALS**
WOMEN IN SCIENCE
ON OUR YOUTUBE CHANNEL

MEMBER OF A COLLECTIVE OF MORE THAN 30 ENTITIES COMMITTED TO GENDER EQUALITY IN SCIENCE

BCMaterials has been part of the Emakumeak Zientzian collective since 2023, when it also joined the coordination team. In the 2025 edition, specifically, it combined general coordination tasks with serving on the communications committee.

Maibelín Rosales, MSCA post-doctoral researcher participated at the 'Emakume Zientzilariak. Atzo eta Gaur' ('Women in Science. Yesterday and Today') presentantions in Bilbao

BCMaterials Outreach and Communication Manager, Daniel Bacigalupe, during the opening event of the Emakumeak Zientzian 2025 edition, held in Bilbao

SCIENCE **FOR SOCIETY**

NEW EVENT

3 DAYS

16 SPEAKERS

350 ATTENDEES

(Left) BCMaterials researcher Vera Macedo, gave one of the talks, along with Cristian Mendes on environmetally friendlier batteries

BCMaterials' commitment to science outreach includes organizing events such as the Pint of Science festival in Bilbao. This annual international festival brings science to bars in hundreds of cities across Europe, the Americas, Asia, and Africa.

Our centre served as the main local coordinator, with the support of scientists from CIC bioGUNE, IIS BioBizkaia, and the University of the Basque Country.

In the 2025 edition, three centrally located bars in the city hosted the talks. The presentations covered a wide range of topics, including neuroscience, applications of artificial intelligence, climate change research, and many others.

BCMaterials also contributed speakers, including our researchers Vera Macedo and Cristian Mendes. Their talk focused on solid-state batteries as a safer and more sustainable alternative to current lithium-ion batteries.

Another new addition to BCMaterials' outreach activities in 2025 was its inclusion in the STEAM Sare Catalogue. Coordinated by Innobasque–Basque Innovation Agency, this catalogue compiles activities organized by research and technology centres, universities, and companies across the Basque Country aimed at promoting STEAM skills among primary and secondary school students.

Our centre offered the workshop "Materials Science: Turn Your Mobile Phone into a Portable Laboratory," which explores colorimetry as a method to determine the concentration of a substance in a solution for applications in fields such as food analysis, healthcare, and industry.

The first session took place in November with second-year high school students from Saturnino de la Peña Institute in Sestao.

Using their mobile phones and a simple photo application capable of extracting RGB values from images, the students measured the iron concentration in white wine. They then plotted their measurements on a graph and compared their results with those obtained using a professional spectrophotometer. At the end of the practical session, the students also visited our laboratories.

This first workshop will be followed by several additional sessions throughout the first half of 2026.

SCIENCE **FOR SOCIETY**

zientzia azoka elhuyar

innobasque
Berrikuntzaren Euskal Agentzia
Agencia Vasca de la Innovación

The ZIENTZIA AZOKA (Science Fair), organised annually by Elhuyar Fundazioa, is one of the major STEAM education events held in the Basque Country.

BCMaterials collaborates with the event by evaluating the scientific and technological projects presented by secondary school students, which are exhibited in June in the centre of Bilbao.

Our post-doctoral researcher Paola Zimermann Crocomo, took part in two events in November of the 'STEAM Orientation Sessions' organized by Innobasque - Agencia Vasca de la Innovación.
The aim of this initiative is to give 4th-year ESO students (10th grade) the opportunity to speak directly with people working in science, technology, and industry in the Basque Country.

Through 15-minute meetings, Paola was able to share her experience as a scientist, what her daily work is like, her academic background, and why she chose science as a profession, among other topics.

SCHOOL **VISITS**

Our centre runs a regular programme of school visits aimed at primary and secondary school students, mainly from Bizkaia. The goal of these visits is to bring materials science closer to younger audiences and to show how it contributes to addressing many of today's societal challenges. Nearly 200 students took part in the visits organized by BCMaterials in 2025.

NEWS

El Correo
Juan Pablo Esquivel
September 2025

Interempresas
BiWIN2 Project
November 2025

SINC- Ciencia en Español
e-Prot Project
November 2025

Daily 27
Article by Vera Macedo and Cristian Mendes
June 2025

WWW

STEM Lab Bizkaia Podcast
Maibelín Rosales
June 2025

La Mecánica del Caracol Radio Euskadi
Daniel Salazar
November 2025

Radio Euskadi
Biontier and ECLedctic projects
April 2025

SCIENCE **FOR SOCIETY**

OUR MEDIA

www.bcmaterials.net

87312
PAGE VIEWS

1159
FILES DOWNLOADED

Metrics	Total 2024	Total 2025
Sessions	31381	34733
Users	18706	20012
Pages per session	2.7	2.6

Country	Visits 2025	Pages/ Session
Spain	16098	2.1
India	1467	2.6
United States	805	3.6
Portugal	633	2.5
Germany	477	2.6
China	396	3.0
France	389	3.1

SOCIAL MEDIA

FOLLOWERS

Social Network	2024	2025	Variation
X / Twitter	1,260	1,282	+1.2%
Facebook	220	241	+9.5%
Linkedin	2,319	3,024	+30.4%
Youtube*	4000	5400	+35%
Bluesky	0	53	-

* Total video views

BCMATERIALS
BASQUE CENTER FOR MATERIALS, APPLICATIONS & NANOSTRUCTURES
ehu group

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