CAMPUS DIAGONAL -BESÒS

Research Newsletter

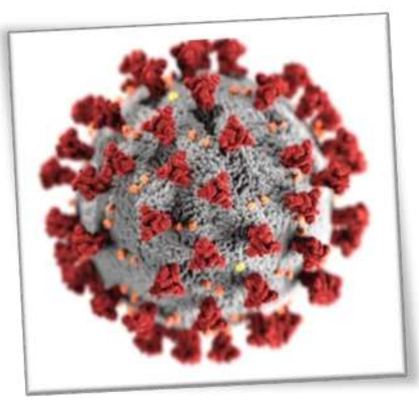
Winter 2020

FOREWORD

Campus Diagonal-Besòs

Fighting Against COVID-19

Undoubtedly, **2020** will be remembered as the year of the pandemic. Countless efforts have been devoted to fight the **SARS-CoV-2** virus, through widespread initiatives. New strategies to confront COVID-19 have been devised by several research groups of the **Campus Diagonal-Besòs (CDB).**



A cutting-edge initiative, led by **IMEM-BRT** (*Innovation in Materials and Molecular Engineering – Biomaterials for Regenerative Therapies*), has been analyzing the inactivation of the SARS-CoV-2 virus through modified nano-particles and activation of heat nanosources[1].

The effect of COVID-19 confinement measures has been assessed by means of a new method developed by **SPECS** (*Synthetic, Perceptive, Emotive and Cognitive Systems Group*), confirming a negative impact on people's mental health and emotional wellbeing[2].

These examples highlight the **multidisciplinary** nature of the research conducted at the CDB. But perhaps more significantly, they prove that CDB's research groups are ready to confront a wide spectrum of technological and scientific challenges that our Society may need to face in coming years.

Welcome to the Campus Diagonal-Besòs, where future's science and technology is being forged.

[1] https://www.upc.edu/en/press-room/news/a-upc-research-group-and-the-company-b-braun-investigate-new-inactivation-strategies-against-sars-cov-2-virus-through-modified-nanoparticles-and-activation-of-heat-nanosources#

[2] http://www.ibecbarcelona.eu/a-new-method-confirms-the-impact-of-covid-19-confinement-measures-on-mental-health-and-wellbeing/

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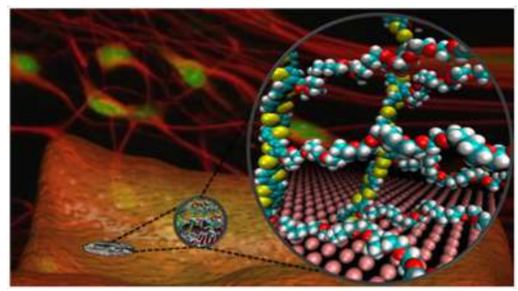


Research Bites

A selection of high-impact articles, among those published by CDB researchers during the **first semester of 2020**, in areas such as *bioengineering, materials science, environmental engineering, chemistry, energy*, and *astrophysics*, is displayed on Pages 2-3. An overview of one of the CDB research groups, **BIOSPIN**, is presented on Page 4. These snapshots show the rich and diverse research landscape that characterize the Campus.

News & Events

Funding opportunities, new research facilities and grants, past and future events, and research awards given to CDB researchers, can be found on Pages 6-7.

Research Highlights

ON THE EFFECT OF AMYLOIDS IN HIPPOCAMPAL DOWNREGULATION

S. Skouras, S., **J. Torner**, P. Andersson, Y. Koush, C. Falcon, C. Minguillon, K. Fauria, **F. Alpiste**, K. Blenow, H. Zetterberg, J.D. Gispert, & J. Molinuevo, **"**Earliest amyloid and tau deposition modulate the influence of limbic networks during closed-loop hippocampal downregulation", ***Brain*** 143, 976 (2020) [*Q1, 4/378 in Neurology (clinical); IF=11.337*]

Hippocampus is a brain structure responsible for processing of long-term memory and emotional responses. Research into hippocampal self-regulation abilities may help determine the clinical significance of hippocampal hyperactivity throughout the pathophysiological continuum of Alzheimer's disease.

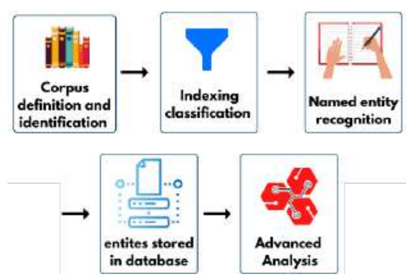
In this study, performed by researchers of the **Multimedia Applications and ICTs Laboratory Group (LAM),** the authors aimed at identifying the effects of amyloids (aggregates of proteins) and on the patterns involved in hippocampal downregulation. 48 cognitively unimpaired participants have been identified from the population-based 'Alzheimer's and Families' study. A real-time functional MRI neurofeedback task was developed with virtual reality and tailored for training downregulation. This interactive, adaptive and gamified neuroimaging procedure may provide important information for clinical prognosis and monitoring of therapeutic efficacy.

USE OF DATA MINING IN MATERIALS SCIENCE

O. Hakimi, M. Krallinger, & **M.P. Ginebra**, "Time to kick-start text mining for biomaterials", ***Nature Reviews Materials*** 5, 553 (2020) [*Q1, 1/1580 in Materials Science; IF=74.699*]

Artificial intelligence presents great possibilities to the advancement of biomaterials design and development, with the use of data mining text technologies to extract information about biomaterials, which is currently dispersed across scientific articles, patents, FDA reports and congress proceedings. These methods of advanced data mining, together with deep learning techniques, could reveal associations not previously considered between materials' attributes and biological responses, and could help with the design and discovery of new biomaterials.

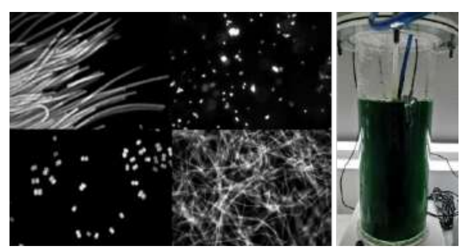
Biomaterials are materials that interact with biological systems and are highly used in modern medicine and surgery. Their design involves tapping into complex processes, such as the interactions between cells and materials and the degradation of materials in the body. The rising volume of published results in the field is contrasted by a low degree of sharing and systematization of data. The study, performed by researchers of the **Biomaterials, Biomechanics and Tissue Engineering** group **(BBT),** explains the specific challenges in the highly multidisciplinary domain of biomaterials, and proposes steps to tackle them and enable the organization and exploitation of accumulated data.



PHBs AS ALTERNATIVES TO PETROLEUM-BASED PLASTICS

E. Rueda, M.J. García-Galán, R. Díez-Montero, J. Vila, M. Grifoll, & J. García, "Polyhydroxybutyrate and glycogen production in photobioreactors inoculated with wastewater borne cyanobacteria monocultures", ***Bioresource Technology*** 295, 122233 (2020) [*Q1, 2/184 in Environmental Engineering; IF=7.539*]

60% of the plastic produced worldwide (4900 million tones) has already been discarded to landfills or natural ecosystems, creating serious pollution problems. How can we keep on using plastics without generating this negative impact? Polyhydroxybutyrate (PHB), a type of bioplastic, is a good alternative to meet this challenge. Since, it is produced by many microorganisms, such as, cyanobacteria (photosynthetic bacteria), it is biocompatible and biodegradable and has similar properties to polypropylene. This study, performed by researchers of the **Environmental Engineering and Microbiology** group **(GEMMA),** evaluates the accumulation of PHB and glycogen in cyanobacteria isolated from photobioreactors fed with wastewater. The isolated cyanobacteria were cultivated using periods with different availability of inorganic carbon. Results of this study provide new strategies to increase the %PHB in cyanobacteria and confirm the possibility of finding an alternative to petroleum-derived plastics.



NEW POLYMER-BASED SURGICAL MESHES

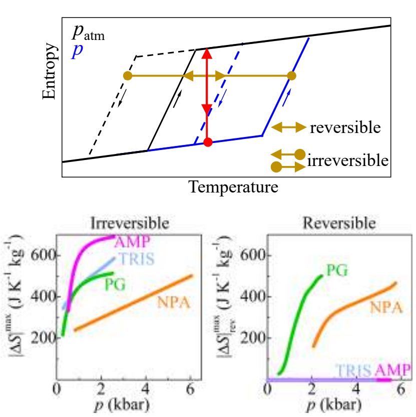
S. Lanzalaco, P. Turon, C. Weis, **C. Mata, E. Planas, C. Alemán, & E. Armelin,** "Toward the New Generation of Surgical Meshes with 4D Response: Soft, Dynamic, and Adaptable", ***Advanced Functional Materials*** 30, 2004145 (2020) [*Q1, 12/961 in Chemistry; IF=16.836*]

Dynamic devices designed on the 4D-concept represent an evolution that completely alter how we create and produce materials by adding the dimension of transformation over time into the creation process. Smart polymer-based materials that can change their shape and/or function under controlled stimuli can be obtained through this emerging technology. In this work, conducted by researchers of the **Innovation in Materials and Molecular Engineering – Biomaterials for Regenerative Therapies group (IMEM-BRT)**, in collaboration with **Centre d'Estudis del Risc Tecnològic (CERTEC),** and B Braun Surgical, a biomedical device able to self-unfold under temperature and humidity stimuli, has been developed. The study reports the 4D movement of a flat and inanimate surgical mesh, employed for hernia repair. A commercial mesh composed by isotactic polypropylene (iPP) has been modified by coating with a thermosensitive poly (*N*-isopropylacrylamide) (PNIPAAm) hydrogel. The thermo dependent motion of the hydrogel chains is responsible for the smart behavior of the mesh that simultaneously works as an *actuator*, able to self-unfold after implantation in human body, and as a *sensor* that can detect any local temperature increase due to post-surgery inflammatory processes. The study found that the response to the application of the stimulus (temperature), on macroscopic and microscopic scales, is strongly connected with the gel expansion/contraction and with its morphology.

BALOCALORIC EFFECTS IN PLASTIC CRYSTALS

A. Aznar, P. Lloveras, M. Barrio, Ph. Negrier, A. Planes, L. Manosa, N. D. Mathur, X. Moya, & **J.Ll. Tamarit,** "Reversible and non-reversible colossal barocaloric effects in plastic crystals", ***Journal of Materials Chemistry A*** 8, 639 (2020) [*Q1, 15/858 in Energy; IF=11.301*]

Solid-state phase transitions driven by external fields promise an environmentally-friendly alternative to current cooling methods that use fluids with huge greenhouse potential.

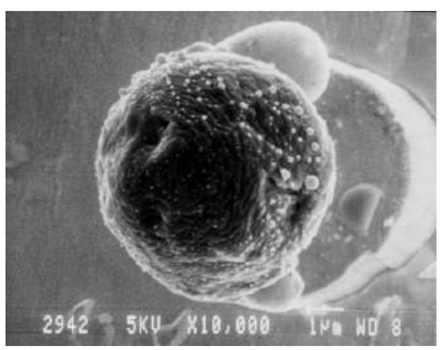


Recently, plastic crystals were identified as best solid-state agents due to their colossal transition latent heat that can be controlled by pressure, which maximizes the heat exchanged. However, a large transition hysteresis imposes a severe increase in the pressure needed to drive the transition forth and back, i.e., to drive reversible caloric effects, which is required for the implementation in a cyclic machine.

In this study, performed at the **Group of Characterization of Materials (GCM)**, the reversible barocaloric response was analyzed in a series of plastic crystals that were previously proposed as outstanding compounds for cooling applications. It was found that, while half of them are indeed optimal candidates, the other half cannot be used in practical machines due to too large transition hysteresis.

NUCLEAR EXPERIMENTS TO UNDERSTAND ELEMENT PRODUCTION IN STARS

A. Kennington, G. Lotay, D. Doherty, D. Seweryniak, C. Andreoiu, K, Auranen, M. Carpenter, W. Catford, C. Deibel, K. Hadyńska-Klek, S. Hallam, D. Hoff, T. Huang, R. Janssens, S. Jazrawi, **J. José**, F. Kondev, T. Lauritsen, J. Li, A. Rogers, J. Saiz, G. Savard, S. Stolze, G. Wilson, & S. Zhu, "In search of presolar nova grains: gamma-ray spectros-copy of ^{34}Ar and its relevance for the astrophysical ^{33}Cl(p,γ) reaction", ***Physical Review Letters*** 124, 252702 (2020) [*Q1, 38/1514 in Physics and Astronomy; IF=8.385*]



Presolar grains are isotopically-anomalous components in the homogeneous material that forms the Solar System. Discovered in meteorites, they predate the birth of the Sun itself, and therefore were already present in the Solar nebula before the first solids began to condense. These grains hold an impressive survival record, considering that they escaped destruction from a suite of processes in the neighborhood of their stellar cradles, in the surrounding interstellar medium, along the collapsing cloud that gave birth to the Solar System, during the formation and breakup of their meteoritic parent bodies, the atmospheric entry, and their isolation in terrestrial labs. Encapsu-lated in those grains, there is pristine information on the different processes operating in their parent stars.

Recently, it has been suggested that sulfur isotopic abundances may hold the key in the unambiguous identification of grains originated in nova explosions. In this regard, the ^{33}Cl(p, gamma)^{34}Ar reaction is expected to play a decisive role.

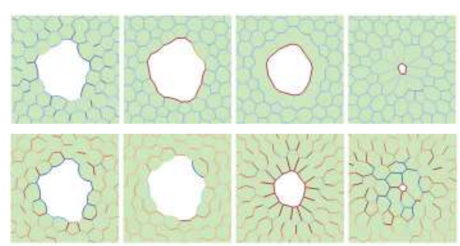
This work, with participation of researchers of the **Astronomy & Astrophysics Group (GAA)**, presents a detailed nuclear physics, γ-ray spectroscopy study of ^{34}Ar. Excitation energies have been measured with high precision and spin-parity assignments for resonant states have been made for the first time, reducing the uncertainty affecting the ^{33}Cl(p, gamma) reaction.

MODELING THE HEALING PROCESS IN WOUNDS

P. Mosaffa, R.J. Tetley, **A. Rodríguez-Ferran**, Y. Mao, & **J.J. Muñoz**, "Junctional and cytoplasmic contributions in wound healing", ***Journal of the Royal Society Interface*** 17, 20200264 (2020) [*Q1, 168/4843 in Engineering; IF=3.748*]

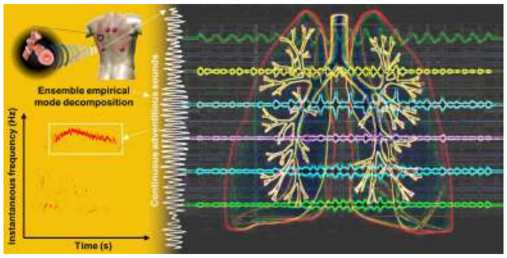
The healing process in wounds aims at preserving tissue functionality: providing a confinement and protection against external agents. Strikingly, while in embryonic and larval tissues there is no scar left after wound closure, in adults cells leaves a clear imprint of cellular debris. This has motivated experimental research and simulation of wound closure.

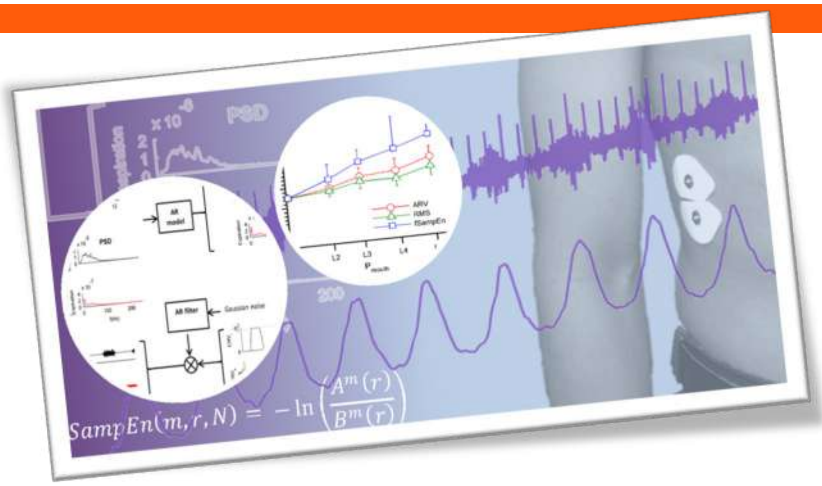
In this study, performed by researchers of the **Numerical Methods for Applied Sciences and Engineering** group **(LACÀN),** a vertex model is proposed and carefully calibrated in order to mimic the observed viscoelastic recoil of the wound gap after laser ablation. The model is then employed to test the relative contributions of cell junctions, bulk (cytoplasmic) forces, and cell-cell intercalation.



Interestingly, it is found that junctional mechanics is more effective in closure, and that while the intercalation process poses no difference in the mechanical energy evolution of the tissue, it is able to speed up the process. These results highlight the benefit of tissue fluidization for reducing wound exposure in vivo situations.

RESEARCH GROUPS





RESEARCH GROUPS @ CDB

Biomedical Signal Processing and Interpretation (BIOSPIN)

BIOSPIN *(Biomedical Signal Processing and Interpretation)* is a *Generalitat de Catalunya's Consolidated Research Group* (2017 SGR 1770) of the Institute for Bioengineering of Catalonia (IBEC) and UPC, and it is a group of the *Centro de Investigación Biomédica en Red de Bioingeniería, Biomateriales y Nanomedicina*. It was founded by Raimon Jané in 2007. The group consists of 12 members and it is located at the CDB campus. BIOSPIN is formed by Raimon Jané, José Antonio Fiz, Beatriz Giraldo, Jordi Solà Soler, Abel Torres, Manuel Lozano-Garcia, Dolores Blanco-Almazán, Clare Davidson, Luis Estrada-Petrocelli, Daniel Romero, Yolanda Castillo-Escario and Ignasi Ferrer-Lluis. The group's research addresses the design and development of advanced signal processing techniques and the interpretation of multimodal biomedical signals to improve non-invasive monitoring, diagnosis, disease prevention and pathology treatment. The research is conducted with a strong collaboration of national and international hospitals, research centres and companies. Novel physiological biomarkers and mHealth devices are proposed for patients with Obstructive Sleep Apnea (OSA), Chronic Obstructive Pulmonary Disease (COPD), Asthma, Chronic Heart Failure and for Neurorehabilitation. The BIOSPIN lab at CDB, and joint labs at the hospitals, allow staff and PhD and Master students to conduct research in this field.

BIOSPIN's RECENT RESEARCH HIGHLIGHT

M. Lozano-García, L. Estrada-Petrocelli, A. Torres, G.F. Rafferty, J. Moxham, C.J. Jolley and **R. Jané**, *Noninvasive Assessment of Neuromechanical Coupling and Mechanical Efficiency of Parasternal Intercostal Muscle during Inspiratory Threshold Loading*, **Sensors** 21, 1781 (2021)

BIOSPIN's RESEARCH FAST FACTS

Source: https://ibecbarcelona.eu/biomedsignal
https://futur.upc.edu/BIOSPIN

RESEARCH OUTPUTS

- 93 research papers in indexed journals
- 435 contributions to Conference Proceedings
- 33 research and text books
- 20 PhD theses
- 2 patents

FUNDING & AWARDS

- 33 R+D+I international & national competitive projects
- 10 awards and special grants

At present time, BIOSPIN's research lines at the Campus Diagonal-Besòs are, mainly, the following:

- Multimodal physiological biomarkers for non-invasive monitoring and home healthcare of COPD patients with comorbidities
- Novel mHealth tools for unobtrusive sensing and management improving of Obstructive Sleep Apnea patients at home
- Smart health ecosystem for personalized medicine and Healthcare in Respiratory diseases and Sleep disorders
- mHealth system for respiratory sound analysis to improve drug delivery and assessment in respiratory diseases
- Early identification of patients with COVID-19 at home, using acoustic cough analysis with smartphones. Diagnostic Role of the Cough Profile in COVID-19 Patients
- A novel non-invasive respiratory pattern monitoring tool in patients with severe COVID-19 pneumonia
- Biomedical signal interpretation to study motor function, neuromuscular disorders and novel personalized neurorehabilitation therapies in patients with spinal cord injury or stroke

FOR MORE INFORMATION

Prof. Raimon Jané, rjane@ibecbarcelona.eu

WHAT/WHICH/HOW

WHAT are Photonic Crystals?

By Prof. Muriel Botey (DONLL, Dept. Physics, EEBE-CDB)

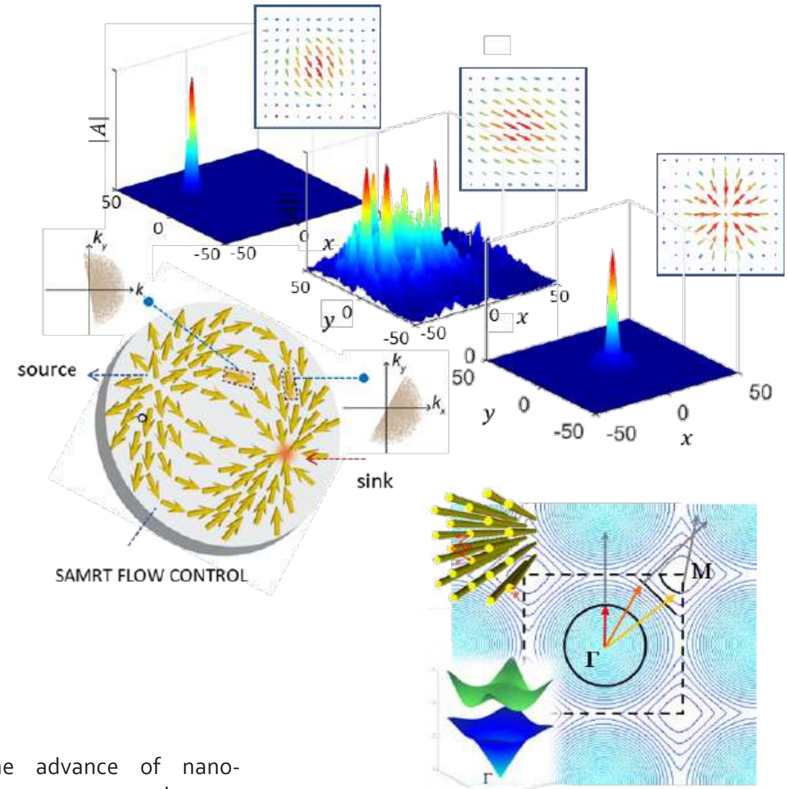
The advent of artificial structured materials on micro- and nanometer scales has become a fruitful playground to uncover novel physical phenomena due to their ability to tailor the propagation and generation of light even in exotic or counterintuitive ways.

Two papers published in 1987, in the same volume of *Physical Review Letters* (Joannopoulos et al.; Hayran et al.), predicted that a periodic modulation of the retrieve index on the wavelength scale could either inhibit spontaneous emission or localize light. Both effects arise from the modification of the dispersion relation of photons forming frequency transmission bands, similarly as a periodic potential in a semiconductor crystal; hence the name of **Photonic Crystals** (PhC).

Yet photons are bosons. The periodic architecture of the wings of a butterfly reflect the frequencies within their stop band, providing structural coloring. A defect in a PhC represents a completely shielded trap, routing and bending light.

Managing the modulus and direction of group velocity leads to slow light, and, in at least 2D structures, can shape monochromatic beams or focalize them with a flat lens due to negative diffraction.

Moreover, with the advance of nano-fabrication techniques, structured non-Hermitian photonic materials, among which the pioneering PhCs, have become an ideal platform not only to observe concepts predicted in other fields, such as quantum mechanics, but to uncover novel exotic physical phenomena such as breaking spatial symmetry and causality. Effects that can be universal to other kind of waves beyond photonics.



FURTHER READING ON PHOTONIC CRYSTALS

W. W. Ahmed, R. Herrero, **M. Botey**, Y. Wu, K. Staliunas, "Restricted Hilbert transform for non-Hermitian management of fields", *Physical Review Applied* 14, 044010 (2020)

SCIENCESCAPES

A new research initiative is taking shape at the CDB: **Sciencescapes**, a series of short videos, aimed at introducing current advances and challenges in science and technology at a reasonably basic level. Each video will be presented by a CDB researcher. In the pilot video, focused on *artificial intelligence*, **Prof. Raúl Benítez** (ANCORA) addresses the question: **Are scientists going to be replaced by computers?**

https://www.youtube.com/watch?v=RrR-ExyxKNY&list=PLgpOonZ3aDwxlNDzlWUSWEBB_6ywn5Nl9

The series is coordinated by Prof. Jordi José (GAA).

NEW RESEARCH FALICITIES

An Innovative Testing System for Assessment of Mechanical Response of Advanced Materials at Different Length Scales

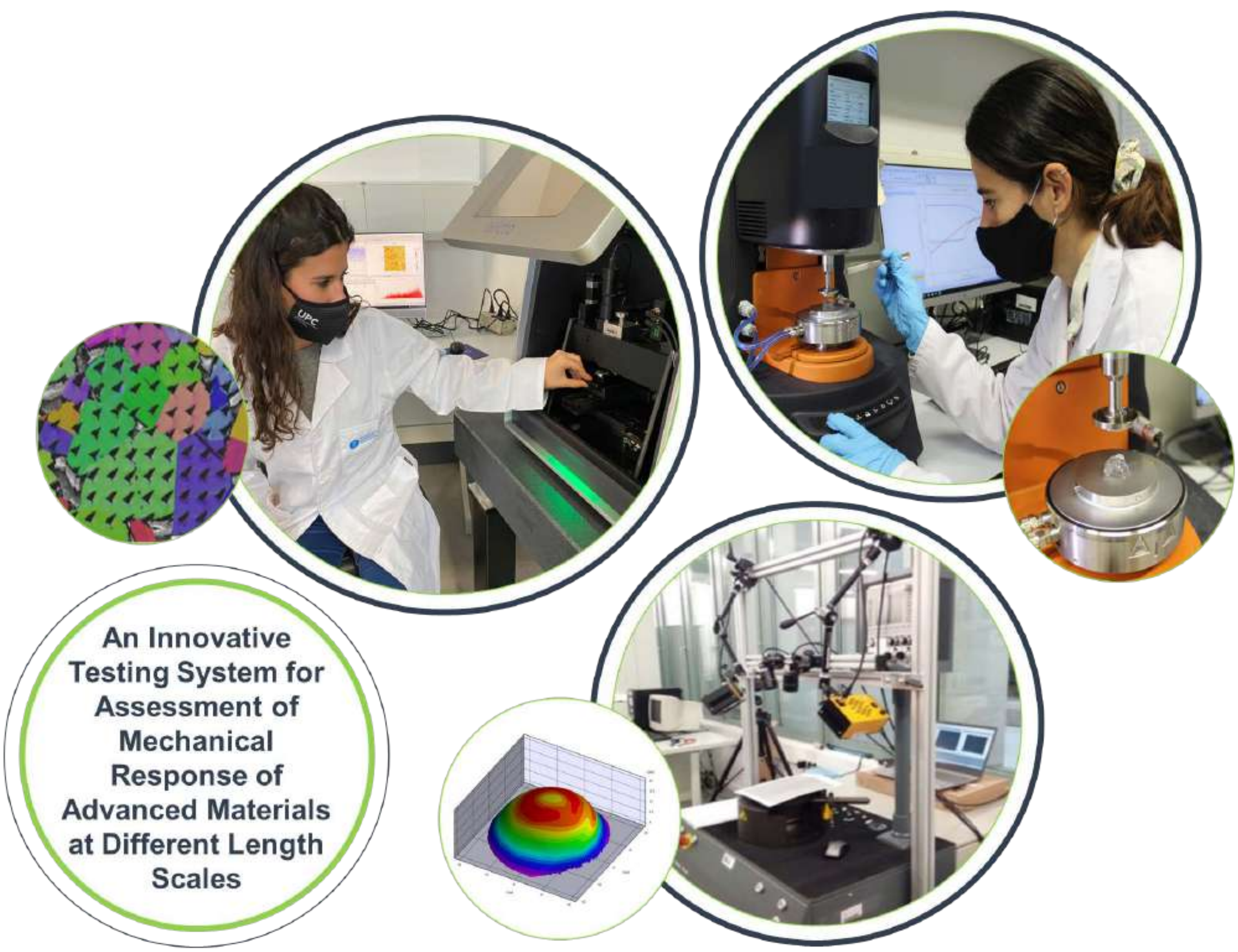
The success in the development of new materials with unique performances depends, in a great extent, on the precise and reliable characterization of their properties at the nano-, micro- and macro-scales. In this regard, the most promising approaches are those based on the optimization of microstructural design, in particular in heterogeneous and / or multiphase materials, with the aim of discovering or identifying new functionalities, and / or improving existing ones, which allow opening fields of non-existent or just emerging application today.

Within this context, an innovative testing system has been set out as a new research facility at the Campus Diagonal-Besòs. It consists of three modules that seek to cover requirements for evaluating the elastic, viscoelastic and plastic behavior of different advanced materials in a wide range of length scales.

The three modules refer to a nanoindenter with high data acquisition capacity, a deformation measurement equipment using DIC (digital image correlation), and a modular rheometer. The facility is the result of a joint action among three research groups of the Materials Science and Engineering Department, based at the EEBE: **CIEFMA**, **PROCOMAME** and **BBT**, and financially supported (50%) by Spain's Science, Innovation and University Ministry, within State Subprogram for Research Infrastructures and Scientific-Technical Equipment, under grant EQC2018-004902-P.

This integral service unit will allow to complement interdisciplinary with transversal approaches to optimize the microstructural design of metals, ceramics, polymers, composites, (bio) -inks, coatings and hydrogels. Such a knowledge will have a direct impact on the promotion of the lines of research of the abovementioned groups, as well as those developed by other UPC and external groups, which have also expressed interest in using the requested mechanical characterization system.

Furthermore, this acquisition is directly related to three key cross-cutting technologies considered in the "Research and Innovation Strategy for the Smart Specialization of Catalonia (RIS3CAT)": advanced materials, nanotechnology and advanced manufacturing. Its implementation is expected to have a relevant effect in applications within leading economic sectors such as industrial systems, design industry, chemistry, energy and resources, health- and life-sciences industries, as well as in emerging technologies such as additive manufacturing (3D), industry 4.0 or smart materials design.



AWARDS, GRANTS, & EVENTS

PhD Theses Defended

Karen A. García (Advisor: José A. Benito/Gemma Herranz, PROCOMAME), "Procesado y caracterización de propiedades mecánicas de acero TWIP mediante técnicas pulvimetalúrgicas" (Mar/2020)

Ana Somoza (Advisor: Antonio Espuña/Moisès Graells, CEPIMA), "Decision support strategies for the efficient implementation of circular economy principles in process systems" (Mar/2020)

Ivan Masmitjà (Advisor: Jacopo Aguzzi/Spartacus Gomáriz, SARTI), "Acoustic underwater target tracking methods using autonomous vehicles" (Jan/2020)

New Research Grants

Computational study to guide the development of new SARS-CoV-2 detection hyper-spectral platforms, PRACE (2020), PI: C. Alemán (IMEM-BRT)

REVALPET'UP. Revalorización de residuos de PET opaco en materiales de alto valor añadido, Interreg VA Poctefa, EU (2020-2022), PI: M. Maspoch (ePLASCOM)

Estudi per avaluar la resistència al foc d'un mòdul structural en un edifice format per diverses plantes de contenidors marítims habilitats com a allotjaments, Ajuntament de Barcelona, C-11679 (2020), PI: E. Planas (CERTEC)

Open fire plume simulation comparison exercise, USDA Forest Service, 20-JV-11261987-006 (2020), PI: E. Pastor (CERTEC)

Closing gaps in measurements and understanding: plume characteristics, live fuel moisture dynamics, and process-based modeling, SERDP-Dept. Defense USA, RC20_C3_1025 (2020-2025), PI: E. Planas (CERTEC)

Hematopatología computacional: soluciones de aprendizaje profundo para el diagnóstico de enfermedades hematológicas a partir de imágenes de células de sangre periférica, MICINN, PID2019-104087RB-I00 (2020-2023), PI: J. Rodellar (CoDAlab)

Desarrollo de un sistema de monitorización estructural basado en un microinterrogador y redes neuronales, MICINN, PID2019-105293RB-C21 (2020-2023), PI: L. E. Mujica (CoDAlab)

Implementació industrial del brunyit per a l'acabament de superfícies de motlles d'injecció, AGAUR, IU68-016743 (2020), PI: J. A. Travieso/J. Llumà (TECNOFAB)

Agrupacions en tecnologies emergents per a la realització de projectes de valorització i transferència de resultats de la recerca, AGAUR, IU16-011591 (2020), PI: J. A. Travieso/J. Llumà (TECNOFAB)

Bio-TUNE: Fine tune of cellular behavior: multifunctional materials for medical implants, Marie Curie Actions – EU, H2020-MSCA-RISE-2019 Bio-TUNE 872869 (2020-2023), PI: C. Mas-Moruno (BBT)

AddLife. Additive Manufacturing for the Life Sciences, Vinnova (Gov. Sweden), 2019-00029 (2020-2021), PI: M.P. Ginebra (BBT)

ENABLE. New enabling technologies for the development of high performance osteoinductive and antimicrobial bone grafts, MICINN, PID2019-103892RB-I00 (2020-2023), PI: M.P. Ginebra/C. Canal (BBT)

Integridad estructural a diferentes escalas dimensionales de nuevos materiales compuestos cerámica-metal procesados mediante rutas de fabricación aditivas, MICINN, PID2019-106631GB-C4 (2020-2023), PI: L. Llanes/A. Mateo (CIEFMA)

Estudio de soluciones de bajo coste para la rehabilitación energética exprés en hogares vulnerables – campaña experimental en el barrio del Raval, CCD-UPC, 2020-D005 (2020-2021), PI: A. Guardo (CDIF)

DEEPDREAM. A Data-drivEn computational mEthod for PersonalizeD healthcare in chronic REspiratory diseases through big-dAta analytics and dynamical Modelling, Marie Curie Actions – EU, Gr. 846636 (2020-2022), PI: D. Romero (BIOSPIN)

REHYB. *Rehabilitation based on Hybrid neuroprosthesis*, EU, Gr. 871767 (2020-2023), PI: A. Mura (SPECS)

Events Hosted at CDB

3DDAY EEBE, Feb. 2020, Organized by TECNOFAB, Dept. Mechanical Engineering (UPC), and Associació d'estudiants FabLab EEBEst

Bio-TUNE RISE Kick off Meeting & Symposium, Feb. 2020, Organized by BBT

ChETEC. Chemical Elements as Tracers of the Evolution of the Cosmos, Feb. 2020, Organized by GAA

New Postdoctoral Fellows

Maria del Mar Pérez Madrigal (IMEM-BRT, Beatriz Galindo fellow)

Enrica Uggetti (GEMMA, Ramón y Cajal fellow)

Rubén Díez Montero (GEMMA, Juan de la Cierva fellow)

Awards

Prof. Jordi Llorca (NEMEN) has been awarded with an *ICREA Academia* distinction

CAMPUS DIAGONAL-BESOS
Research Newsletter

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