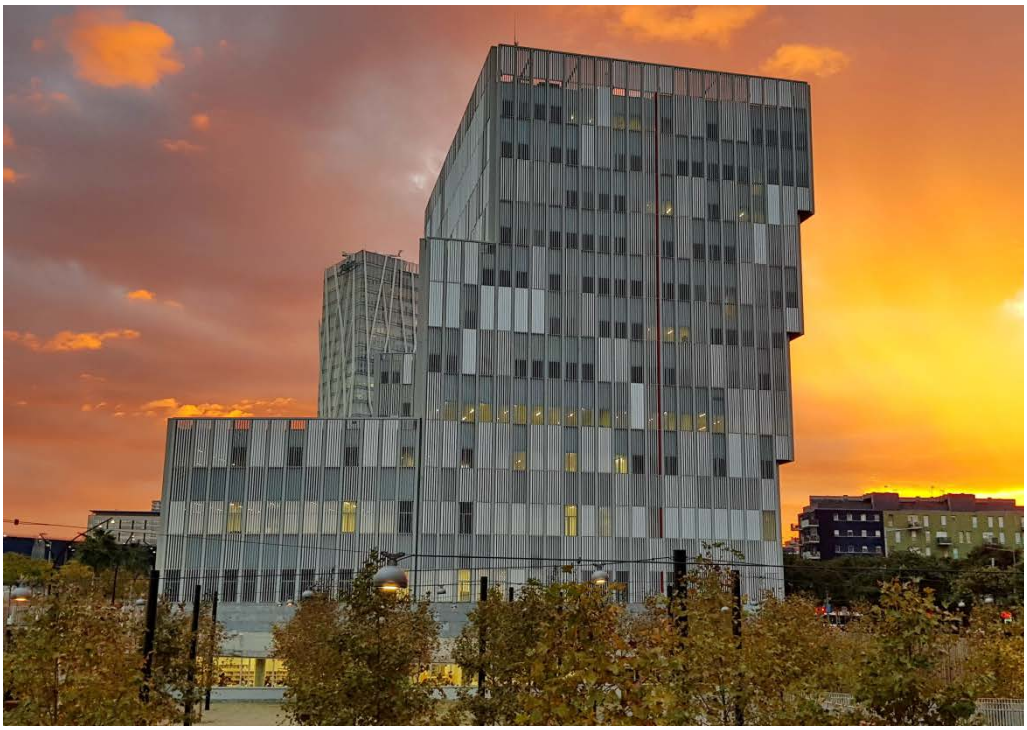


CAMPUS DIAGONAL -BESÒS

Research Newsletter

Fall 2019

FOREWORD

Campus Diagonal-Besòs

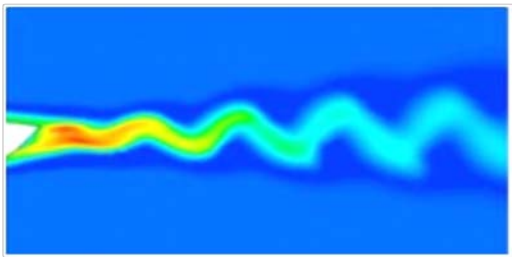
Barcelona's New Research Pole

Since its foundation in 2016, the **Campus Diagonal-Besòs (CDB)** has been aimed at pushing the frontiers of human knowledge. It gathers about **400 faculty and researchers** from more than **40 groups**, contributing to a multifaceted and rich research landscape. In response to a global, constantly evolving world, researchers at CDB have a wide research portfolio, ranging from the exploration of the structure of the universe or the atom, to the biology of the human brain, the development of future fuel cells, or new materials for the regeneration and repair of degraded tissues and organs. Through this multidisciplinary and panchromatic effort, researchers from the **Barcelona East School of Engineering (EEBE)** of the **Universitat Politècnica de Catalunya (UPC)** and from the **Institute for Bioengineering of Catalonia (IBEC)** are undeniably contributing to erect CDB as a new research pole.

This Newsletter is aimed at reporting progress on scientific research at the CDB. Aside from a selection of top research papers, it includes an overview of one *Research Group* and an in-depth analysis of a *hot* research topic by an specialist. .

Welcome to the CDB, where future's science and technology is being forged.

IN THIS ISSUE

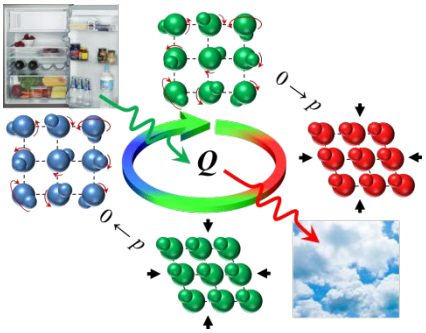


Research Highlights

COLOSSAL BAROCALORIC EFFECTS IN PLASTIC CRYSTALS FOR SOLID-STATE COOLING

P. Lloveras, A. Aznar, M. Barrio, Ph. Negrier, C. Popescu, A. Planes, L. Mañosa, E. Stern-Taulats, A. Avramenko, N. D. Mathur, X. Moya & **J.-Ll. Tamarit,** ***Nature Communications*** 10, 1803 (2019)

Pressure-driven liquid-vapor transition permits the exchange of latent heat using external work and is the basis for current cooling devices. However, the fluids used pose serious environmental problems due to their huge greenhouse potential. Alternatives based on solid-state, first-order phase transitions have been proposed but the magnitude of the latent heat associated with such transitions is usually much smaller compared to evaporation. Recently, researchers of the **Group of Characterization of Materials (GCM)** have shown that the pressure-driven caloric response (i.e. barocaloric effect) at phase transitions in plastic crystals is comparable to that in fluids due to the emergence of molecular orientational disorder.

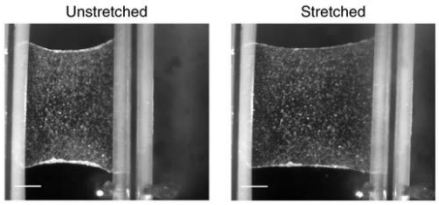


They also identified the reversible range where barocaloric effects can be implemented in a device working upon cyclic application and removal of pressure. The study should inspire the development of future environmentally-friendly solid-state barocaloric cooling devices.

STRESS RELAXATION IN EPITHELIAL MONOLAYERS IS CONTROLLED BY THE ACTOMYOSIN CORTEX

N. Khalilgharibi, J. Fouchard, **N. Asadipour,** R. Barrientos, M. Duda, A. Bonfanti, A. Yonis, A. Harris, **P. Mosaffa,** Y. Fujita, A. Kabla, Y. Mao, B. Baum, **J.J. Muñoz,** M. Miodownik & G. Charras, ***Nature Physics*** 10, 1803 (2019)

Epithelial monolayers are one-cell-thick tissue sheets that line most of the body surfaces, separating internal and external environments. They must withstand extrinsic mechanical stresses applied at high strain rates. However, little is known about how monolayers relax their stresses during imposed deformations.



Researchers of the group on **Numerical Methods for Applied Sciences and Engineering (LACÀN)** have participated in a study that showed that, by subjecting suspended epithelial monolayers to stretch, they dissipate stresses on a minute timescale and that relaxation can be described by a power law with an exponential cut-off at timescales larger than about 10 s.

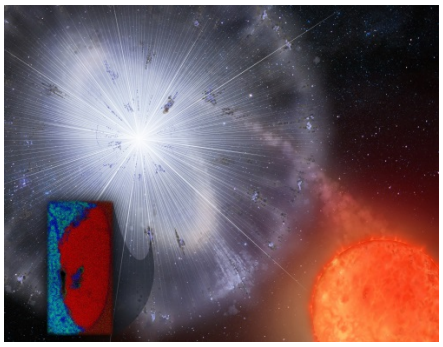
This process involves an increase in monolayer length, pointing to active remodeling of cellular biopolymers at the molecular scale during relaxation. Strikingly, monolayers consisting of tens of thousands of cells relax stress with similar dynamics to single rounded cells.

In contrast, cell–cell junctional complexes and intermediate filaments do not relax tissue stress, but form stable connections between cells, allowing monolayers to behave as single cells.

LABORATORY EVIDENCE FOR CO-CONDENSED O- AND C-RICH METEORITIC DUST FROM NOVA OUTBURSTS

P. Haenecour, J.Y. Howe, T.J. Zega, S. Amari, K. Lodders, **J. José,** K. Kaji, T. Sunaoshi & A. Muto, ***Nature Astronomy*** 3, 626 (2019)

A micron-sized spherule has been isolated from a rocky, non-metallic primitive meteorite found in Antarctica. It likely originated in the material expelled during a classical nova explosion, wandered throughout the interstellar medium, and survived cosmic-ray impacts and high-energy radiation, until it became trapped in the cloud of gas and dust that about 4600 million years ago became our Solar System.

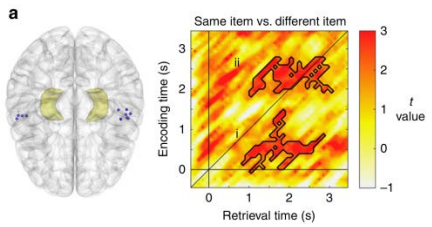


It represents the only meteoritic *stardust* grain composed of both graphite and silicates found to date. Its discovery challenges current ideas about how dying stars sow the universe with raw materials, from which planets, and ultimately, the precursor molecules of life, would form. A researcher from the **Astronomy & Astrophysics Group (GAA)** has participated in this study.

COORDINATED REPRESENTATIONAL REINSTATEMENT IN THE HUMAN HIPPOCAMPUS AND LATERAL TEMPORAL CORTEX DURING EPISODIC MEMORY RETRIEVAL

D. Pacheco Estefan, M. Sánchez-Fibla, **A. Duff**, A. Principe, R. Rocamora, H. Zhang, N. Axmacher & **P.F.M.J. Verschure**, ***Nature Communications*** 3, 626 (2019)

Researchers of the **Synthetic, Perceptive, Emotive and Cognitive Systems group (SPECS) at IBEC** have recorded, for the first time in humans, the brain activity of two key areas linked to memory: the hippocampus and the neocortex. The study involved a group of epilepsy patients who performed spatial memory tests. The study revealed that when a person is remembering an incident, it's the hippocampus that initiates a certain engram and, 500 milliseconds later, the neocortex adds to this activity.

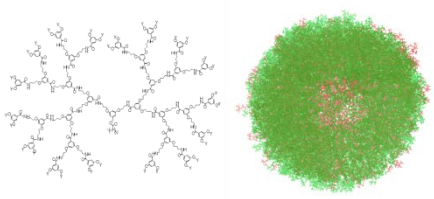


These results represent a breakthrough in the understanding of the cerebral mechanism underlying episodic memory. Potential future applications of the results of this study range from treatment for those who have suffered traumatic episodes, to the optimization of learning.

SOLVENT-SWELLING INDUCES MAIN-CHAIN SCISSION IN CONGESTED DENDRONIZED POLYMERS, THE LARGEST COVALENT MACROMOLECULES WITH PRECISE MOLECULAR STRUCTURE

D. Messmer, **O. Bertran**, R. Kissner, **C. Alemán** and A. D. Schlüter, ***Chemical Science*** 10, 6125 (2019)

Researchers of the group of **Innovation in Materials and Molecular Engineering/ Biomaterials for Regenerative Therapies (IMEM-BRT)** have participated in a study of main-chain scission processes on highly congested macromolecules. The cylindrical persistent shape of dendronized polymers, which are the largest macromolecules with precise molecular structure, is created by using covalent bonds and steric congestion, which results in significant strain on the polymer backbone when the dendritic generation (g) is high enough. This work proves that scissions occur in the main chain of these macromolecules by exposure to solvents.

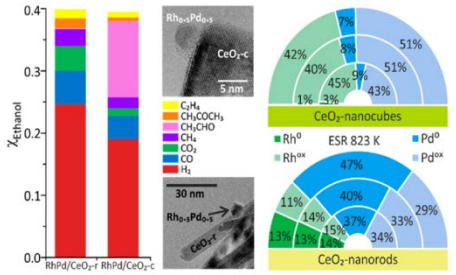


Main chain swelling-induced scissions occur readily for the dendronized polymers with g= 5, regardless of whether the polymer is charged or is neutral. Thus, solvent molecules penetrate, reach the backbone and cause substantial local strain on individual C–C bonds, which undergo homolysis. In contrast, dendronized polymers with g < 5 resemble classical polymers and are accessible to the strongly interacting polar solvent molecules, whereas those with g > 5 are essentially closed off to solvent due to their more closely colloidal character.

DYNAMIC REORGANIZATION OF BIMETALLIC NANOPARTICLES UNDER REACTION DEPENDING ON THE SUPPORT NANOSHAPE: THE CASE OF RhPd OVER CERIA NANOCUBES AND NANORODS UNDER ETHANOL STEAM REFORMING

L. Soler, A. Casanovas, J. Ryan, I. Angurell, C. Escudero, V. Pérez-Dieste and **J. Llorca**, ***ACS Catalysis*** 9, 3641 (2019)

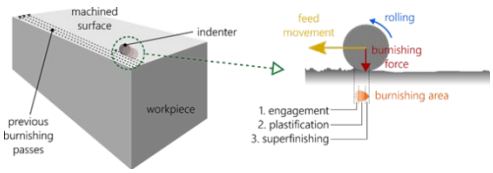
Bimetallic catalysts exhibit high performance compared to that of their monometallic counterparts in a wide range of catalytic reactions. Both geometric and electronic phenomena yield unique properties that cannot be reproduced by other means. Bimetallic nanoparticles reorganize dynamically under reaction conditions, usually forming complex core-shell distributions of metals and oxidation states. This reorganization is even more complex in the presence of a reducible support. In this study, researchers from the group of **Nanoengineering of Materials Applied to Energy (NEMEN)** have shown through X-ray photoelectron spectroscopy that the shape of the support also plays a crucial role in the reorganization of bimetallic nanoparticles, which has important consequences for catalytic performance. The study monitored the surface composition and oxidation states of preformed $Rh_{0.5}Pd_{0.5}$ model nanoparticles of 4 nm in size supported over CeO_2 nanocubes and CeO_2 nanorods during the catalytic steam reforming of ethanol (ESR) at 823K. Over $Rh_{0.5}Pd_{0.5}/CeO_2$-nanocubes, both Rh and Pd become strongly oxidized and ethanol mainly dehydrogenates into acetaldehyde and H_2. In contrast, over $Rh_{0.5}Pd_{0.5}/CeO_2$-nanorods, there is an enrichment of Pd toward the surface, both Rh and Pd undergo significant reduction, and ethanol is reformed efficiently.



COMPREHENSIVE ANALYSIS OF SURFACE INTEGRITY MODIFICATION OF BALL-END MILLED Ti-6Al-4V SURFACES THROUGH VIBRATION-ASSISTED BALL BURNISHING

R. Jerez-Mesa, J.A. **Travieso-Rodríguez**, Y. Landon, G. Dessein, **J. Lluma-Fuentes, J.** and V. Wagner, ***J. Materials Processing Technology*** 267, 230 (2019)

An experimental study carried out by researchers of the **Manufacturing Technology Research Group (TECNOFAB)** on the mechanical effects on Ti-6Al-4V surfaces treated with an ultrasonic vibration-assisted ball burnishing process. Its aim was to define the process parameters to achieve the best surface integrity on the target workpiece, as well as to identify the effects caused by the introduction of vibrations as a means of assistance. A comprehensive analysis of the effects was performed, by considering in depth three different facets of surface integrity, namely topology, residual stress and hardness.



Hence, the extensive result data sets presented in this study, which deliver an exhaustive description of the process effects. The main conclusion is that the optimal parameters to perform the process are different with regard to the optimization objective.

RESEARCH GROUPS

EPIC in a nutshell

EPIC (*Energy Processing and Integrated Circuits*) is a *Generalitat de Catalunya's Consolidated Research Group* (2017 SGR 1464). It was founded by Alberto Poveda-López and Luis Martínez-Salamero in 1983. The group consists of 10 members and it's arranged into two units: one located at the EEBE-CDB and the other at Campus Nord. The EEBE unit is formed by Ramon Bargalló, Francisco Casellas, Àngel Cuadras, Herminio Martínez, Juan Morón, Robert Piqué, Guillermo Velasco, and Joan Puig. The Campus Nord unit integrates Eduard Alarcón and Francesc Guinjoan. The EEBE unit has a research lab (E3PACS) at CDB, which benefited from a 450-k€ aid fund package from EU and the *Generalitat de Catalunya*. The lab allows faculty and students to conduct research in different areas, such as power converters, power electronic systems prototyping, low-power energy harvesting, energy management systems, photovoltaic & renewable energy systems, electrical machine design, sensors & magnetics, process automation & SCADA...

EPIC'S RECENT RESEARCH HIGHLIGHT

P. Asef, **R. Bargalló**, R. and A. Lapthorn, *Optimal Pole Number for Magnetic Noise Reduction in Variable-Speed Permanent Magnet Synchronous Machines with Fractional-Slot Concentrated Windings*, **IEEE Transac. Transportation Electrification** 5, 126 (2019)

EPIC'S RESEARCH FAST FACTS

Source: https://futur.upc.edu/EPIC

RESEARCH OUTPUTS

- 238 research papers in indexed journals
- 899 contributions to Conference Proceedings
- 43 research and text books
- 38 PhD theses
- 8 patents

FUNDING & AWARDS

- 92 R+D+I international & national competitive projects
- 23 awards and special grants

FOR MORE INFORMATION

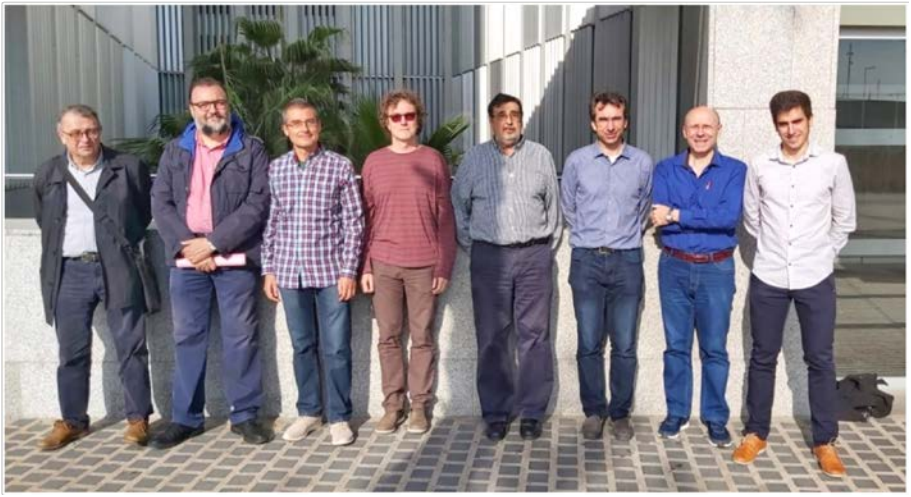
Prof. Robert Piqué, robert.pique@upc.edu

RESEARCH GROUPS @ CDB

Energy Processing & Integrated Circuits (EPIC)

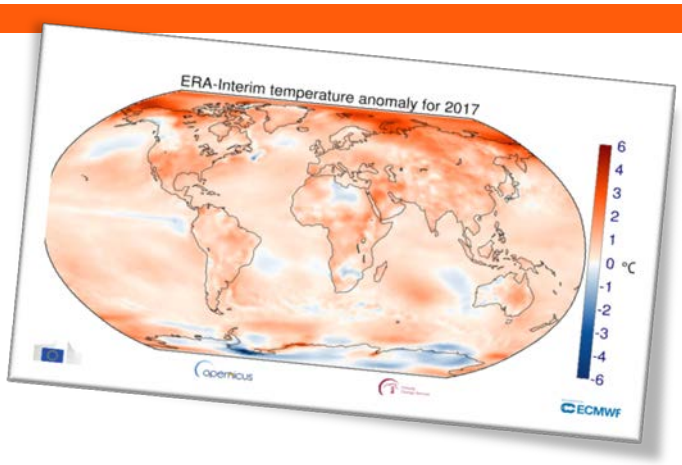
At present time, EPIC's research lines at the EEBE are, mainly, the following:

- Power electronics research with development of new static converter topologies, and power components
- Energetic systems modelling, with emphasis on renewable energy system and electrical energy microgrids, and control via energetic macroscopic representation and inversion-based control
- Systems based on energy harvesting (EH) and wireless power transfer (WPT)
- Real-time control of energy systems: HIL (hardware-in-the loop, including signal and power paths) and PIL (processor-in-the loop) techniques
- Design of building-integrated DC urban microgrids and its static converters with power-flow real-time control
- Development of high performance electric machines through multi-physics modelling
- Characterization of batteries by impedance spectroscopy. Study of their aging through entropy measurements



WHAT/WHICH/HOW

WHAT is Global Warming? Facts & Clues



By Prof. Marta Alarcón (AEROBIOTAS, Dept. Physics, EEBE-CDB)

Undoubtedly, Earth's climate is, and has always been, changing. But unlike past periods, today's changes are so dramatically fast that they are observable on a human timescale. This has never occurred before. Are those changes natural or man-induced? The contribution of natural phenomena (i.e., solar variability, volcanoes) compared to anthropogenic factors is actually very small. All in all, the sun's contribution to global warming was estimated to about 10% in the last century, while almost nothing in the last 25 years. Current indicators can only be explained by an increase in the concentration of greenhouse atmospheric gases. The most significant evidences of change are the increase in the average temperature, the accelerated ice melting (e.g., Greenland and Antarctic ice sheets, Arctic sea ice, mountain glaciers), and the rapid rise in sea level.

The strong, positive feedbacks underlying the climate system accelerate warming and can lead to abrupt changes. Models and past climate changes indicate that a number of potential relevant elements could cross a threshold of sudden change. These elements, that significantly affect human welfare, can be grouped into three major factors, namely the melting of large masses of ice, changes in atmospheric and oceanic circulation, and loss of large communities of flora and fauna.

Some expected consequences with deep impact on society and ecosystems are related with water availability, and an increase in extreme events (e.g., heat waves, heavy precipitation, droughts, and wildfires).

What should/can we do? Obviously, the human natural response to the prospect of an event of great impact is to try to avoid it. However, the strong inertia of the climate reduces our chances of intervention and limits its effectiveness. The only feasible option is to try to keep the system away from certain threshold values (getting dangerously close to a threshold would probably mean that it is already too late to avoid them). In terms of average temperature, two degrees is some sort of a threshold value. Nevertheless, there is a very high risk that climate warming may lead to temperatures beyond this value by 2100 unless global emissions start to decline rapidly.

.

AWARDS, GRANTS & EVENTS

Awards

Prof. M. Pau Ginebra (BBT) has been awarded with an *ICREA Academia* distinction and the *Klaas de Groot Award* of the European Society of Biomaterials.

New Postdoctoral Fellows

Dr. Esther Comellas (LaCàN)

New Research Grants

Energy Management in Collaborative Urban Microgrids, MICINN, PGC2018-098946-B-I00 (2019-2021). PI: Herminio Martínez (EPIC)

Ultrasonic assisted machining for the functional improvement of components of the transport sector, MICINN, RTI2018-101653-B-I00 (2019-2021). PI: Antonio Travieso (TECNOFAB)

Mechanochemical preparation of catalysts for energy applications: Methane activation and hydrogen generation, MICINN, RTI2018-093996-B-C31 (2019-2021). PI: Jordi Llorca (NEMEN)

Solar Hydrogen generation using photo-catalytic doped titania inverse opals, MICINN, RTI2018-095498-J-I00 (2019-2022). PI: Lluís Soler (NEMEN)

Electronic Biopsy of In-Vivo Lung Tissue Based on Electrical Impedance Spectroscopy, MICINN, RTI2018-098116-B-C21 (2019-2021). PI: Ramon Bragós (IEB)

Advanced CMOS-MEMS Integration for New Generation Millimeter-Scale Systems, MICINN, RTI2018-099766-B-100 (2019-2021), PIs: Jordi Cosp & Jordi Madrenas (ISSET)

Development of New Additive Manufac-turing Processes for Metallic Components, MICINN, RTI2018-097885-B-C31 (2019-2021), PI: José María Cabrera & Jessica Calvo (PROCOMAME)

Microalgae for sustainable production of bioproducts and reclaimed water, MICINN, RTI2018-099495-B-C21 (2019-2021), PI: Ivet Ferrer & Joan García (GEMMA)

Potential and validation of sustainable natural and advanced technologies for water and waste-water treatment, monitoring and safe water reuse in India, EU-H2020-SC5-2018-1, 821410 (2019-2023), PI: María Jesús García Galán (GEMMA)

Wildland-Urban Interface Virtual Essays Workbench, EU-ECHO/2018/826522 (2019-2021), PI: Elsa Pastor (CERTEC)

PhD Theses Defended

Pedram Asef (Advisor: Ramon Bargalló, EPIC), "Multi-Level-Objective design optimization of permanent magnet synchronous wind generator and solar photovoltaic system for an urban environment application" (Jan/2019)

Irene Cano (Advisors: Elisabet Engel/Miguel Angel Mateos, IMEM-BRT), "Cell derived-Extracellular Matrix Scaffolds with Polylactic Acid Microcarriers for Tissue Engineering and Cell Therapy" (Apr/2019)

Jordi Triguero (Advisors: Carlos E. Alemán/David Zanuy, IMEM-BRT), "Study of conductive polymers, biomolecules and their hybrids through computational approaches" (Mar/2019)

Anna Puiggalí (Advisors: Luis Javier del Valle/Carlos E. Alemán, IMEM-BRT, PSEP), "Biointerfaces based on the combination of synthetic polymers and biomolecules" (Mar/2019)

Sergio Morales (Advisors: Joaquim Minguella/Joan Ramon Gomà, TECNOFAB), "Contribución al desarrollo de una metodología de diseño para la fabricación con tecnologías aditivas de piezas con alta variabilidad de demanda" (Apr/2019)

Aurora Alcaraz (Advisors: Adriana Farran/César A. Valderrama, R2EM), "Enhancing the thermal efficiency of a salinity gradient solar pond. Implementation of the study in the design, construction, salinity gradient establishment, operation and energy transfer at industrial scale" (Feb/2019)

Jorge E. Velasco (Advisors: Daniel Crespo/Eloi Pineda, GCM), "Estudio de la inhomogeneidad elástica en vidrios metalicos en la mesoescala" (Jun/2019)

Francesca Audino (Advisors: Montserrat Pérez/Moisès Graells, CEPIMA), "Advanced oxidation process models for optimisation and decision making support in water management" (Jun/2019)

Canan Dombayci (Advisor: Antonio Espuña, CEPIMA), "Conceptual modelling for integrated decision-making in process systems" (May/2019)

Sergio Medina (Advisor: Antonio Espuña, CEPIMA), "A contribution to support Decision Making in Energy/Water Supply Chain Optimisation" (Feb/2019)

Asim Rashid (Advisors: Juan José Mesas/Luis Sainz, QSE), "Harmonic load flow formulation and numerical resolution" (Jan/2019)

CAMPUS DIAGONAL-BESOS
Research Newsletter

Edited by:
Sots-Direcció de Recerca, EEBE
sd.recerca.eebe@upc.edu

Universitat Politècnica de Catalunya (UPC)
Av. Eduard Maristany, 16
08019 Barcelona

UNIVERSITAT POLITÈCNICA DE CATALUNYA
BARCELONATECH
Campus Diagonal-Besòs