IMB-CNM Instituto de Microelectrónica de Barcelona - Centro Nacional de Microelectrónica

Annual Report

2019

CSIC
Consejo Superior de Investigaciones Científicas
Centro Nacional de Microelectrónica IMB

Contents

Highlights

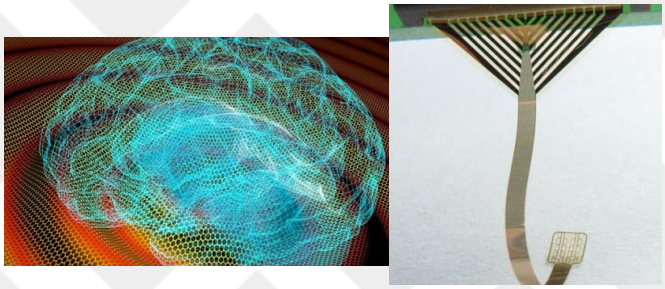
A graphene-based implant overcomes technical limitations to record brain activity at extremely low frequencies

The body of knowledge about the human brain is growing exponentially, but questions big and small remain unanswered. Researchers have been using electrode arrays to record the brain's electrical activity for decades, mapping activity in different brain regions to understand what it looks like when everything is working, and what is happening when it is not. Until now, however, these arrays have only been able to detect activity over a certain frequency threshold. A new technology overcomes this technical limitation, unlocking the wealth of information found below 0.1 Hz, while at the same time paving the way for future brain-computer interfaces.

The results of the study, co-financed by the European Graphene Flagship project and the BrainCom project, were published in the journal Nature Materials (vol. 13 (2019) p. 289).

Developed at the IMB-CNM, the Catalan Institute of Nanoscience and Nanotechnology (ICN2, a center of BIST and CSIC), the CIBER in Bioengineering, Biomaterials and Nanomedicine (CIBER-BBN), and adapted for brain recordings in collaboration with the August Pi i Sunyer Biomedical Research Institute (IDIBAPS), the technology moves away from electrodes and uses an innovative transistor-based architecture that amplifies the brain's signals 'in situ' before transmitting them to a receiver.

Furthermore, the use of graphene to build this new architecture means the resulting implant can support many more recording sites than a standard electrode array, plus is slim and flexible enough to be used over large areas of the cortex without being rejected or interfering with normal brain function. The result is an unprecedented mapping of the kind of low frequency brain activity known to carry crucial information about different events in the brain, such as the onset and progression of epileptic seizures and strokes. Future applications will give new insights into where and how seizures begin and end, enabling new approaches to the diagnosis and treatment of epilepsy.



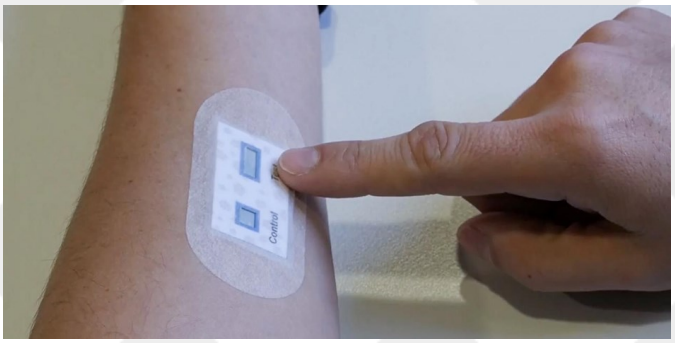
A new skin patch facilitates the diagnosis of cystic fibrosis

A team led by IMB-CNM researchers has developed a new smart device, based on a paper battery 8 cm long by 4 wide, which could be used to facilitate the diagnosis of cystic fibrosis, an inherited pathology of the mucous and sweat glands.

Cystic fibrosis is the rare disease most common in the West and in Spain is suffered by around 2.500 people, according to data from the Spanish Federation of Cystic Fibrosis. It affects areas of the body that produce secretions and causes infections and inflammations in areas of the lung, liver, pancreas and reproductive system. It is usually diagnosed with a sweat test, which, in patients affected by the disease, is saltier than normal.

The new device is a patch for the skin, battery and sensor at the same time, capable of generating power depending on the conductivity of the liquid with which it gets wet. When it comes into contact with a liquid, this species of Band-Aid activates the electrochemical

reaction of the electrodes. If the liquid analyzed is more conductive (saltier), the device generates more power; if it is less conductive (less salty), it generates less. This patch, which does not depend on a external power supply, would be very easy to use and have a very low cost, which would allow the measurement to be performed without external medical instruments, usually expensive, making it accessible to a greater number of hospitals and health centers. Two electrochromic displays are used to show the result.



The work is part of the ERC Consolidator Grant SUPERCELL project, which aims to develop fuel cells and paper batteries to design a new generation of self-powered in-vitro diagnostic devices. These eco-friendly, single-use power sources will allow powering portable disposable diagnostic devices, such as pregnancy tests and glucometers. In all of them the same fluid that is intended to be analyzed is used as fuel. The device won the 2018 Best Prototype Award of the Organic and Printed Electronics Association, and has been patented.

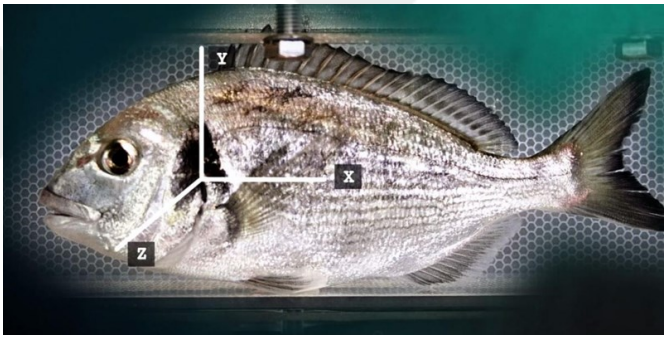
Alert system to improve the production of farmed fish

Researchers from the Instituto de Acuicultura Torre de la Sal (IATS-CSIC), the IMB-CNM and the Universidad de Las Palmas de Gran Canaria have developed an intelligent system "AE-FishBIT" for monitoring the behaviour of breeding fishes. The device makes it possible to know the degree of well-being of farmed fish to improve their production.

The system is innovative and barely invasive due to its size, which allows it to be implanted in the operculum of fish lighter than 100 grams. Placing the device in this bone structure, which covers the gill, is useful to measure simultaneously respiration rate and acceleration rates of fish when they are moving. This gives information about the levels of stress and metabolic status, which directly affects growth, the quality of the final product and the economic performance of production.

Compared to other conventional stress markers, handling the animal is not required in order to collect samples. This minimises the impact of the animal's manipulation on the measured parameters. This system can help aquiculture to optimise production by making it more efficient and sustainable. The module is reusable and low cost, and it can be adapted for monitoring a broad spectrum of farm fishes.

The design and validation of the implant have been carried out within the European initiative AQUAEXCEL2020. Nowadays, more than half of the pisciculture production comes from aquiculture, according to FAO (Food and Agriculture Organisation of the United Nations) figures. In Spain, depending on the species, the aquiculture is approximately 90% of the total production compared to traditional capture.



IMB-CNM receives a Proof of Concept grant from the European Research Council

The Proof of Concepts call (POC-ERC-2019) of the European Research Council (ERC) supports researchers funded in an earlier call, to develop commercial applications of their research. The grants consist on 150.000 € that can be used to establish intellectual property rights, research business opportunities, develop technical validations, etc.

The POWER-PATCH proposal, presented by the researcher of the IMB-CNM Neus Sabaté, has been one of the 54 research projects awarded in this edition, and one of the three Catalan proposals selected. The project intends to carry out a first clinical validation of an economical and simple rapid diagnostic prototype of cystic fibrosis, a genetic disorder that causes serious respiratory problems and significantly reduces life expectancy. Currently the early diagnosis of this ailment is still very inaccessible, but unfortunately essential to guarantee a minimum quality of life to patients who suffer from it.

With the previous support of an ERC Consolidator grant, the IMB-CNM researcher has developed since 2015 electrochemical energy sources capable of generating energy using biologically sourced fluids. In this case it is a paper battery that is activated by adding a fluid and is able to measure conductivity.

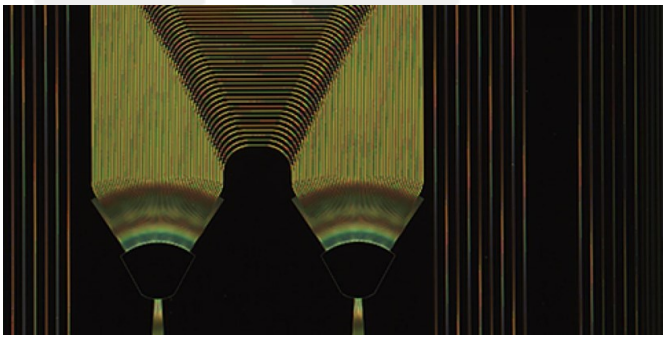
This technology will be the basis of the device that, through the energy power generated by each fluid, will detect different responses. It should be noted that the sweat composition of cystic fibrosis patients is more conductive than that of healthy individuals and therefore the batteries will be able to detect it. The project will be carried out with the collaboration of the medical team led by Dr. Maria Cols, head of the Pediatrics Pneumology Unit of the Sant Joan de Déu Hospital in Barcelona.

IMB-CNM collaborates with the company VLC Photonics

The collaboration has developed silicon photonic chips with applications in biomedicine and telecommunications. The chips and technology developed from the collaboration between the company VLC Photonics, the Polytechnic University of Valencia (UPV) and the IMB-CNM were presented at the Workshop on Si photonics-Cátedra Alter-ETSIT" in Madrid.

The company, created in 2011 as a spin-off of the UPV, designs and manufactures integrated photonic circuits. These circuits work with light signals such as those emitted by lasers. The aim of the company is to miniaturize these systems that, otherwise, are bulky and consume a lot of power. For the development of these chips, the company has collaborated with the IMB-CNM in the establishment of a platform for the fabrication of photonic circuits integrated with silicon nitride technology. This technological platform is part of the processes of the CMOS line, in the Integrated Micro and Nanofabrication Clean Room.

Currently, these microchips are mainly used in the ICT sectors, although they are also applied in other areas such as aerospace, biotechnology and precision instrumentation. Both VLC Photonics and IMB-CNM are members of the European alliance ePIXfab, a group of organizations that promote the science, technology and application of silicon photonics.



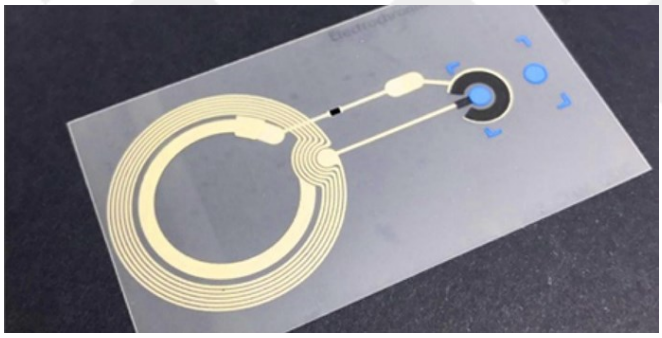
Low cost and reusable wearable sensors

Scientists at IMB-CNM have developed new portable and non-invasive sensors for monitoring biomarkers such as glucose, lactate or alcohol. They are based on wireless electro chromic and electrochemical sensors,

and they can be used to detect metabolites in biological fluids, either human fluids (sweat, urine…) or in fluids derived from food products (e.g., leaking).

Wearable sensors can facilitate the detection and monitoring of biomarkers in a non-invasive way. Nevertheless, their use on biological fluids raises technological challenges related to their production, performance and life cycle. The sensors can be manufactured at large amounts by conventional methods. Therefore, they can be easily implemented on many devices, such as smart patches, food packaging or textile applications. The sensors are actuated by a radiofrequency signal. An electrochromic transducer provides information on the concentration of the target analyte by a change of colour. The colour change can be seen by the naked eye, which indicates whether the target is present or not. For a quantitative result, the device can be complemented with an image analysis system, such as a mobile camera or a photo detector.

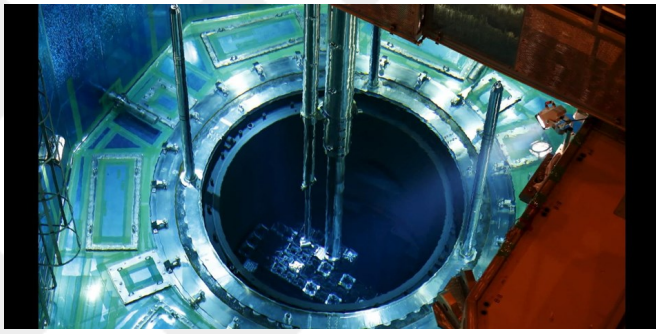
The scientists have tested the system for glucose analysis. It can be applied also for detecting lactate, alcohol or other molecules, in several formats including skin patches, smart labels, food packaging or sensing RFID tags.



Switch device for high power and radioactive environments

Scientists at the IMB-CNM have developed a novel JFET (Junction Field-Effect Transistor) which is very suitable for high-power devices and radioactive environments, where conventional JFET fail. Due to its particular configuration, the device presents very high radiation hardness.

JFET devices are widely used as switches or as a passive protection element. However, none of them is ideal for high radiation applications because they require an inter-level oxide, which fails under expositions to high radiations levels. Furthermore, the use of n-doped substrates in electronics devices to improve their electrical properties increases their vulnerability to the radiation, making them not suitable to operate in high radiation environments. Thus, an issue of modern power electronics is to develop appropriate devices for power distribution circuits and systems control that are capable of operating in high radiation environments.



CSIC scientists at IMB-CNM have developed a JFET device which has a very high radiation hardness. It is suitable for environments such as space, aeronautics, as well as nuclear power plants or radiomedical equipment. It can also be applied in energy applications as switch device in high power systems. Its main advantages are, among others, the high robustness to ionizing and non-ionizing radiation damage; SEE (Single Event Effects) robustness due to its bulk configuration; improved device design, which allows a higher carrier injection into the channels and therefore higher current densities; high active area ratio (~90%); a very high breakdown voltage (> 800 V); and full custom design capability for specific applications.

Gonzalo Murillo, researcher at IMB-CNM, receives a "La Caixa" 2019 research grant

The researcher received a Junior Leader Retaining research grant, in the call for postdoctoral fellowships.

On September 16, the "La Caixa" banking foundation presented the grants for 79 pioneering research projects with a great social impact amounting to 28 mil-

lion euros. The grants were delivered by the president of the foundation, Isidro Fainé; general manager Jaume Giró; Javier Solana, member of the Board of Trustees and the Advisory Council of Experts in Research of the foundation; and Pedro Duque, Minister of Science, Innovation and Universities. The research is included in three of the lines of action in the field of research of the "la Caixa" Banking Foundation: postdoctoral fellowships, to promote research talent; support for research excellence projects in biomedicine and health Health Research, and the CaixaImpulse programme, to transfer the results of biomedical research to society.

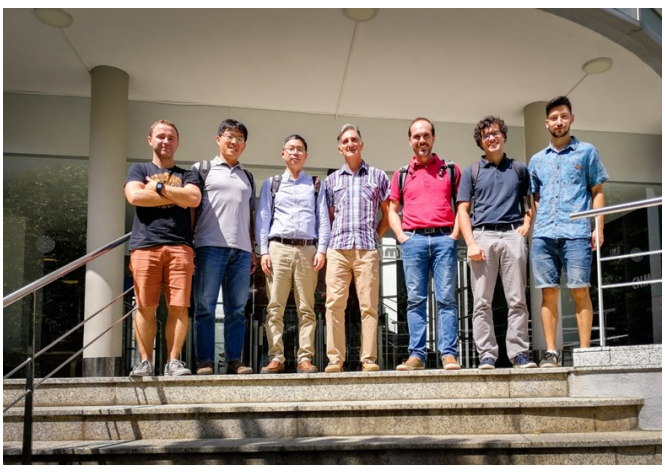
The researcher of the IMB-CNM Gonzalo Murilllo will receive a total of 300.000 € over three years, from the Call Junior Leader Retaining. This is the second edition of this call in which 11 researchers of excellence have been selected from more than 480 applications from different nationalities, with the aim of helping them generate their own research group, carry out their research and thus promote high quality and innovative scientific careers in Spain and Portugal.

The project led by Murillo, “Energy harvesting for extremely-miniaturized autonomous bioelectronic devices applied to minimally-invasive electrical stimulation at cell level” (SPARKDUST), aims to study the application of autonomous microchips, smaller than a cell, in the fields of medicine and nanomedicine. This study comes from its background in energy harvesting and piezoelectric nanomaterials. Our body is mostly regulated by electrical impulses. Nerves, muscles and organs use neural impulses as a language of communication. In fact, disorders such as epilepsy, Alzheimer's, Parkinson's disease, chronic pain and depressions can be treated with electrical stimuli. Despite efforts to miniaturize these implantable devices, known as electroceuticals, patients still have to undergo delicate surgery and carry a device and battery all the time.

This project proposes the development of autonomous micro and nano bioelectronic devices for the future treatment of a wide variety of devastating diseases such as neural and motor disorders. It is based on electrical stimulation of electroactive cells such as muscle cells, osteoblasts and neurons. These small devices produce electrical potential when collecting energy around the cell (cell motility, ultrasounds, magnetic fields, etc.). They are manufactured by integrating intelligent nanomaterials, micro and nano electromechanical systems (MEMS/NEMS) and microelectronics.

Huawei visits IMB-CNM

Liu Fancheng and Kai Xin from Huawei's Central Research Institute Watt Lab meet Luis Fonseca´s Group at IMB-CNM and IREC co-workers in search of advanced thermoelectric technologies.



IMB-CNM leads a project to develop chip platforms for neural cell control

The objective of the LAB4CELL project ("Lab-on-chip systems based on microelectronic and photonic technology for cell culture control and neural behavior") is to study the behavior of neural cells against drugs and electrostimulation processes. The project is led by the IMB-CNM and involves three national research institutions. On 3 October, the initial meeting of the project took place at the IMB-CNM facilities.

The project aims to develop several Lab-On-a-Chip (LOC) platforms for the control of culture cells and more specifically neural cells. The LOC will contain electrochemical and photonic sensors, developed using silicon and new silk-based technology, fluid control elements based on polymeric technology and electronics for neuron electrostimulation. Sensors will measure biochemical parameters such as pH, CO2, dissolved O2, glucose and lactate to study the behavior of neural cells against drugs and electrostimulation processes. The LAB4CELL Project is funded by the Ministry of Science, Innovation and Universities, within the 2018 call of R+D+I projects oriented to Societal Challenges.

The project involves the team of the Chemical Transducers Group (GTQ) of IMB-CNM led by Dr. Cecilia Jiménez and Dr. Xavier Muñoz, together with a team from the Department of Electronic Engineering of the University of Seville, led by Professor José Manuel Quero, and with the collaboration of the Murcian Institute of Agricultural and Food Research and Development (IMIDA) with researcher Dr. Salvador Aznar.

Attendance of IMB-CNM to the EPoSS Annual Forum

Researchers of IMB-CNM attended the EPoSS Annual Forum 2019, held in San Sebastian on 16-17 October 2019. This forum brings together all researchers and companies addressing all demands related to the automated and sustainable production of and by Smart Integrated Systems. The IMB-CNM researchers Carles Cane, Lluís Fonseca, Stella Vallejos and Cecilia Jimenez attended the forum.

The Institute, which is member of the EPoSS initiative, was present on the official agenda with some presentations. Carles Cané, presented the project “Smart Systems for Sensing and Network Inspection in Utilities (SENIX)” focused on Utilities 4.0 and founded by ACCIO, the Agency for Business Competitiveness of Catalonia. On the other hand, Cecilia Jimenez presented the project “Wecare” devoted to multisensing wearable technology for sweat biomonitoring” funded by Swiss National Science Foundation.

Under the title “MiSSIon Smart Systems”, the EPoSS Annual Forum 2019 addressed all demands related to the automated and sustainable production of and by Smart Integrated Systems. EPoSS (European Technology Platform on Smart Systems Integration) is an industry-driven policy initiative defining R&D and innovation needs as well as policy requirements related to Smart Systems Integration (SSI) and integrated Micro- and Nanosystems. EPoSS brings together European private and public stakeholders in order to create an enduring basis for structuring initiatives, for coordinating and

bundling efforts, for setting-up sustainable structures of a European Research Area on Smart Systems Integration. EPoSS embraces all key players, public and private, in the entire value chain.

The Clean Room of IMB-CNM becomes a member of the European network EuroNanoLab

The MicroNanoFabs network, where the Clean Room for Micro and Nano fabrication (SBCNM) of IMB-CNM is integrated, has now become a member of the European network EuroNanoLab, an initiative to establish a large-scale distributed nanofabrication research infrastructure.

MicroNanoFabs is a Clean Room Network for Micro and Nano Manufacturing. It is one of the Spanish Scientific and Technical Facilities (ICTS). An ICTS is a unique facility whose importance and strategic character on research and/or technological development justifies its availability to the entire R&D community and society as a whole. The mission of the MicroNanoFabs Network is to support Spanish and European research groups and industries in their research in the fields of Micro-Nano Manufacturing and Photonics, which have been considered Key Enabling Technologies (KET´s) by the European Commission for their key contribution to the development of innovative products for our daily life.

A researcher from IMB-CNM wins the 10th "Generation of Ideas" Program of UAB Research Park.

Cellupack, in which a researcher from IMB-CNM participates, has been chosen the most innovative project of the "Generation of Ideas" Program on Smart Food of the UAB Research Park. The project proposes to use a material derived from cellulose as a substitute for plastic to make different single-use containers. This material is biodegradable, soluble and has a minimal ecological footprint.

In view of European regulations that in 2021 will ban single-use plastic products, Cellupack intends to develop a substitute material that is biodegradable, water-soluble and edible, which has no taste or smell. This material allows large-scale manufacturing, is very versatile and can be used to build different types of single-use packaging. It also promotes the circular economy through its dissolution and subsequent regeneration and reuse, with a minimum energy consumption.

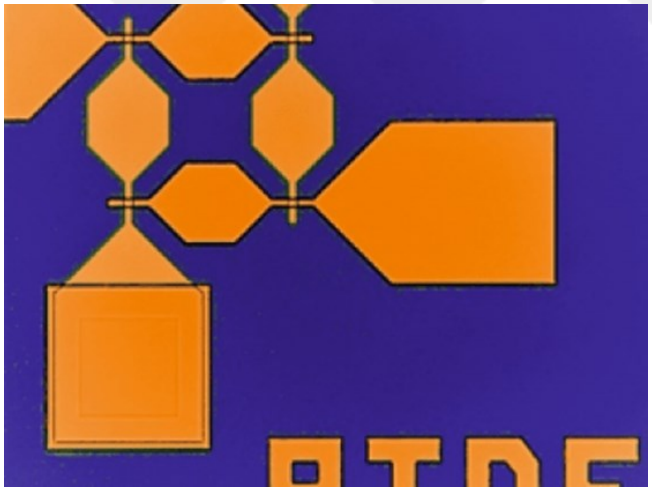
For the prototyping of the new products, they will have available the new network of innovation laboratories of the Campus, the UAB Open Labs. The Cellupack team is made by the researcher of the IMB-CNM Michele Dei, the nanotechnology engineer and PhD candidate at ICMAB, Camilla Dore, and the food technologist Elena Jacas.

Research

The research activities of IMB-CNM are dedicated to Micro/Nano Integrated Systems: miniaturized electronic systems which include sensing and/or actuating capabilities in addition to electronic information processing, power management and external interfaces.
The core of the IMB-CNM research can be included into the "More than Moore" and the "Heterogeneous integration" internationally established technology domains, although some of the activities can be integrated into the "Beyond CMOS" and "More Moore" areas.

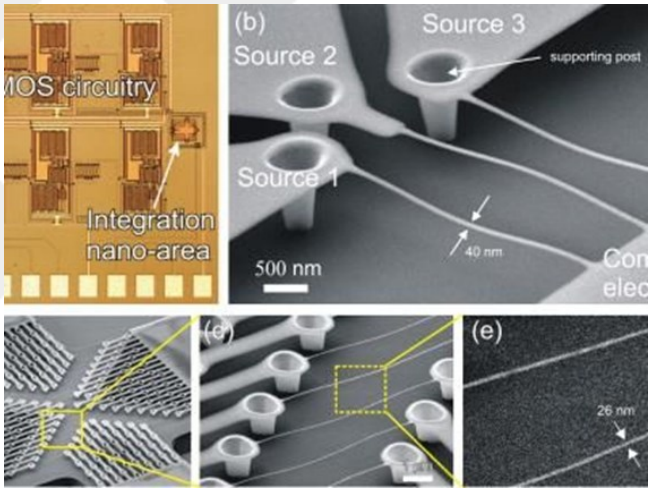
Advanced Thin Dielectric Films Group (ATDF)

The aim of the group is the investigation of the properties of thin dielectric films for silicon-based micro / nanoelectronic applications. Within this general framework, the group is currently working in the field of memristor devices based on the resistive switching-phenomenon in high-k dielectrics deposited by Atomic Layer Deposition. Research activities cover from the development of memristor fabrication technologies, the electrical characterization of resistive switching devices and their study as electronic synapses for neuromorphic applications.



Nanofabricacion and Nanomechanical Systems Group (NANONEMS)

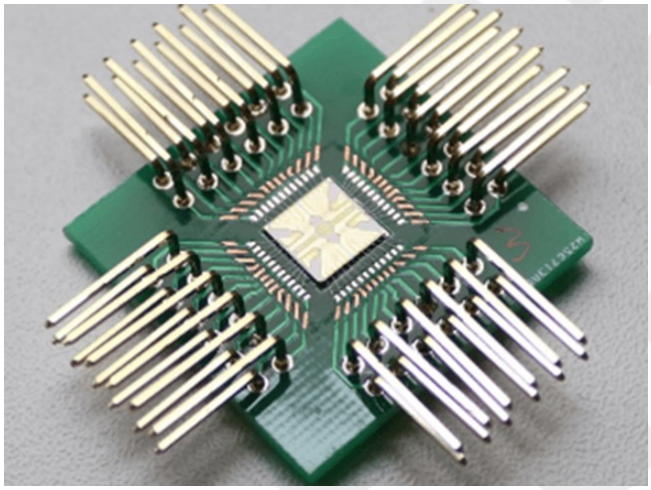
The group explores the electronic and electromechanical properties of nanostructures that can provide new or improved features to nanodevices and nanosystems. It also performs research and development of advanced nanofabrication methods, preferably those that can be applied to devices used in miniaturized integrated systems. These activities cover two of the Key Enabling technologies (KETS): nanotechnology and micro-nanoelectronics.



MicroEnergy Sources and Sensor Integration Group (MESSI)

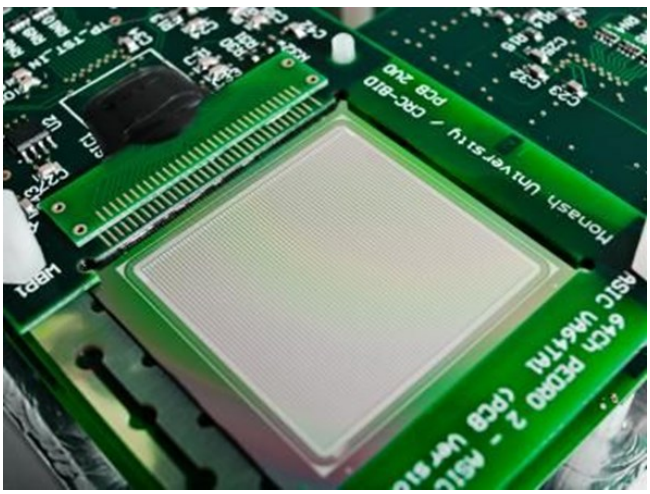
The aim of the group is to contribute with new microenergy and smart sensing devices to important long-term challenges such as “Healthier Citizens” and “Net Zero Human Impact”. Within this general framework, different lines of research are addressed: In the microenergy field, we cover harvesting (thermoelectricity) and generation/storage (micro-fuel cells / biodegradable batteries) activities. In the sensing field, we focus

on systems that allow identifying gases or biomarkers. The microintegration feasibility of both sensors and energy sources to achieve autonomous systems is another interest of the group, using standard silicon technologies and rapid prototyping and additive manufacturing.



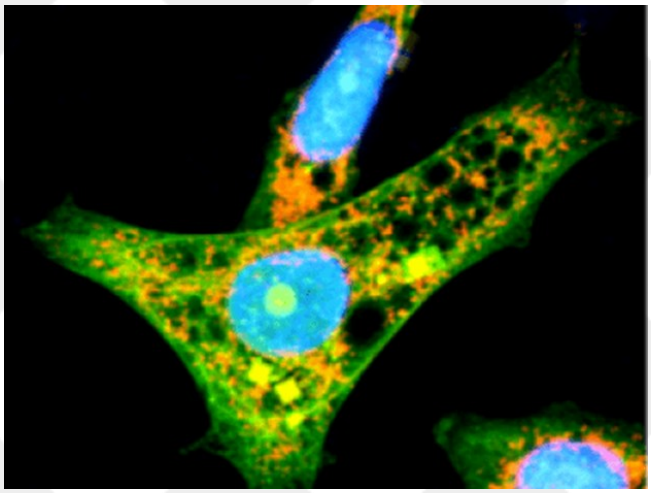
Radiation Detectors Group(RDG)

The aim of the RDG is to contribute to the research and development of advanced technologies and applications of radiation detectors. The R&D activity of the group rest on the expertise of its members in layout design, simulation, fabrication and characterization of semiconductor radiation sensors; microelectronics devices; interconnections; implementation of complete systems and study of the radiation effects on components and systems. The fields of application of the RDG activity are: particle physics, nuclear physics, medical imaging and dosimetry, synchrotron and nuclear fusion facilities, space applications, instrumentation for civil security and societal challenges.



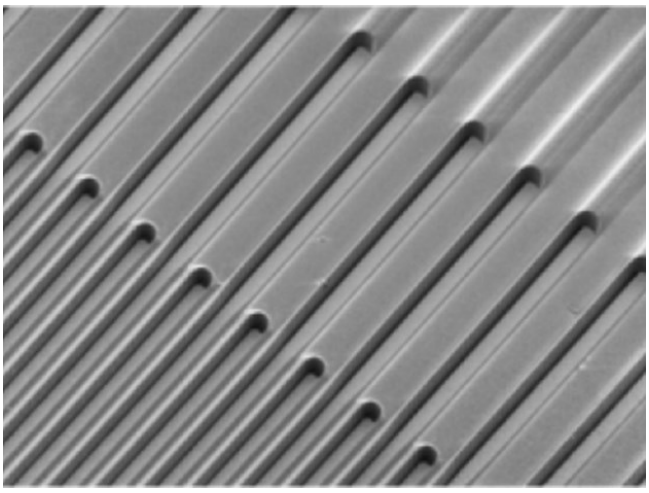
Micro and Nanotools Group (MNTL)

“Contributing to lay the foundations of micro- and nanosystems of the future". The research line of the group is focused on the development of new Micro- and NanoTools to explore new applications or functionalities for MEMS and NEMS.



BioMEMs Group

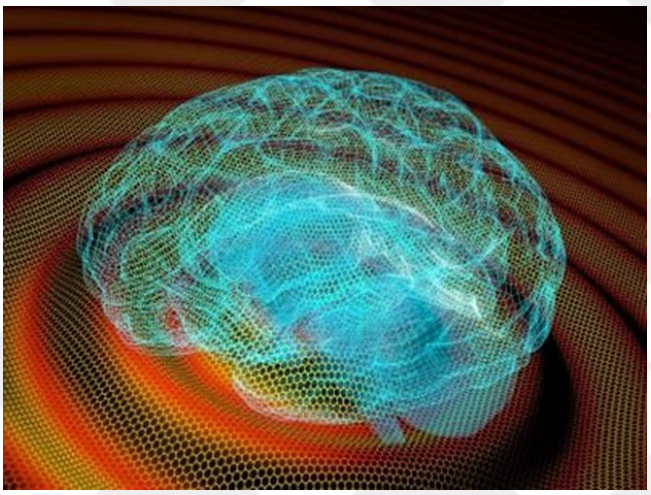
The main activity of the group addresses the design and development of novel micro and nanosensors and complex and compact miniaturized systems for biological and biomedical applications.



Research

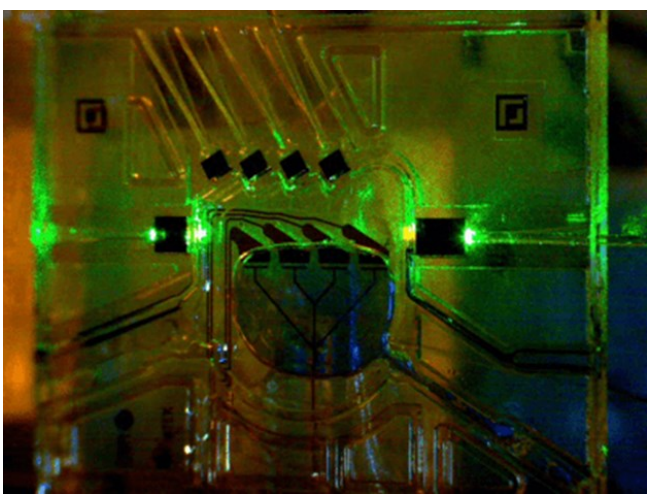
Biomedical Applications Group (GAB)

The Biomedical Applications Group (GAB) mission is to provide clinicians with advanced tools, based on micro and nano-technologies, to tackle the medical challenges of the future.



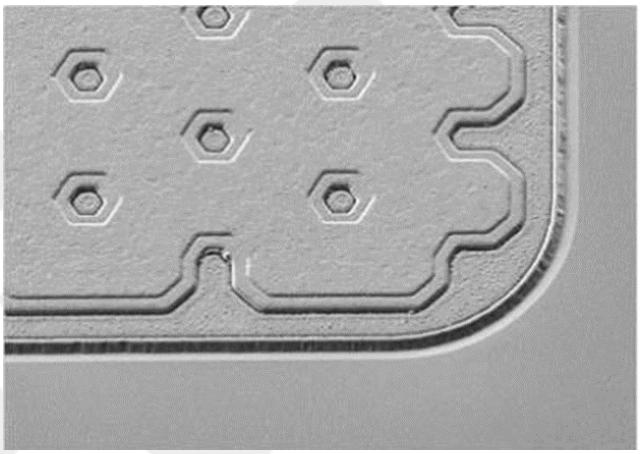
Chemical Transducers Group (GTQ)

The group activities are focused on applied research on the development of application-specific analytical systems (ASAS): Ad-hoc analytical tools for the measurement of chemical parameters in (biological) liquid fluids. We aim at offering market solutions to analytical needs in the environment, health and food fields and contributing to some of the sustainable development goals set by the UN to address the social, environmental and economic challenges of our time.



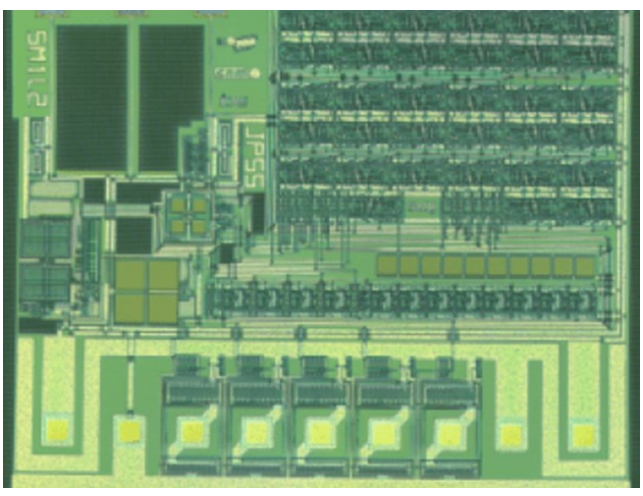
Power Devices and Systems Group (PDS)

The Power Devices and Systems Group focuses on the design, fabrication, characterization and integration of power semiconductor devices, optimized for developing reliable and energy efficient converters and electronic systems, operating even in harsh environments (high temperature, radioactive environments, etc.).



Integrated Circuits and Systems Group (ICAS)

The essence of this group has been always the design of application specific integrated circuits (ASICs). Currently, ICAS R&D is focused on ultra low-power analog, mixed and RF integrated circuits, organic/printed microelectronics, short range RF communications with remote power systems, digital integrated circuits in nano-electronics and multi-technological HDL-AMS modeling. The group also supports electronic system design for the ICAS itself as well as for other R&D groups of IMB.



Facilities

Micro and Nanofabrication Clean Room

The Micro and Nanofabrication Clean Room (SBCNM) is a Singular Scientific and Technological Infrastructure (ICTS) dedicated to the development and application of innovative technologies in the field of Microelectronics together with other emerging Micro/ Nanotechnologies.

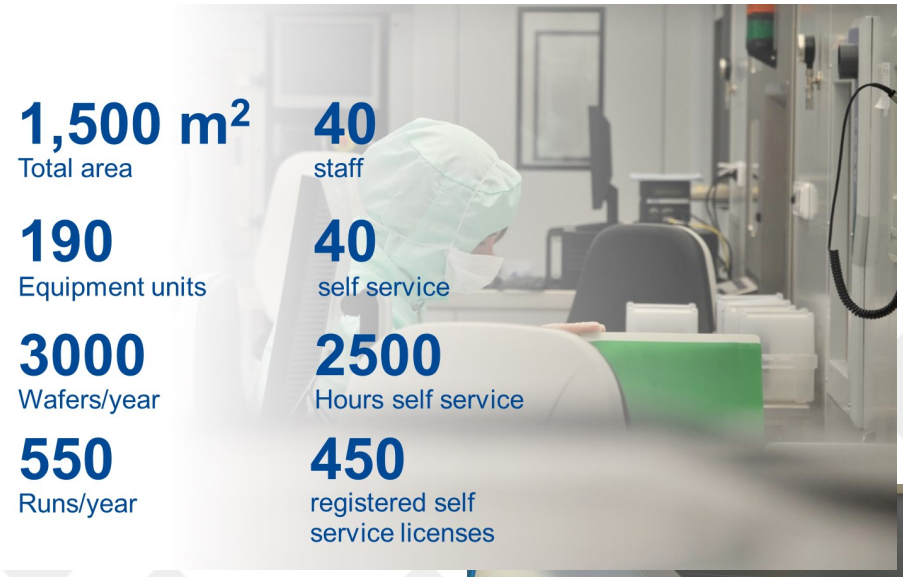
SBCNM is an open access facility that aims at helping national and international research groups to carry out R&D activities thanks to the availability of a set of complete micro and nanotechnologies and processes housed in a highly specialised Clean Room environment devoted to R&D&i of excellence, and driven by an expert team. Such support ranges from technology awareness to the development of basic demonstrators, or small series of prototypes.

Since 2014, the ICTS-SBCNM it is one of the three nodes of the MICRONANOFABS ICTS Network, the Large Scale Facility supported by the Spanish Ministry of Science and Innovation (MICINN), together with the Clean-Room from ISOM-UPM and the one from NTC-UPV.

MICRO nano FABS

Red Española de Salas Blancas de Micro y Nano Fabricación

Facilities



Within the MICRONANOFABS structure, the CSIC's Clean -Room at IMB-CNM offers its know-how on:

- Fabrication of devices and electronic circuits.
- Physical and electrical characterisation of electronic components, MEMS/NEMS, sensors, actuators, Lab-on-Chip, integrated circuits and smart systems.
- Packaging of electronic components.
- Training activities on micro and nanoelectronics.
- Dissemination and outreach on micro and nanoelectronics.

The IMB-CNM Integrated Clean Room includes equipment for micro and nanofabrication processes mainly based on silicon technologies for wafers of 100 mm and 150 mm, but can also operate with substrates of different materials and sizes on demand. Its structure allows flexible operation, which makes it especially suitable for R+D+i.

In addition to the ICTS facilities, IMB-CNM has a number of research laboratories dedicated to specific fields:

- Advanced Packaging Laboratory
- Biosensors Laboratory
- Characterisation of Microsystems Laboratory
- Chemical Transducers Laboratory
- Design & CAD Service
- Electronic Systems Laboratory
- General Chemistry Laboratory
- Integrated Circuits and Systems Testing
- Integrated Optics Laboratory
- Micro/nano systems Laboratory
- Packaging Service
- Power Devices Laboratory
- Printed Electronics Laboratory
- Prototyping Laboratory
- Radiation Detectors Laboratory
- Reverse Engineering Laboratory
- SAM/SEM Laboratory
- Thermal Characterisation
- Wafer Electrical Characterisation Service

Publications

IMB-CNM has published a total of 99 scientific papers in 2019 in journals included in the Science Citation Index. The complete list of publications in scientific journals is available at the IMB-CNM website. The specific page can be accessed through this QR code:

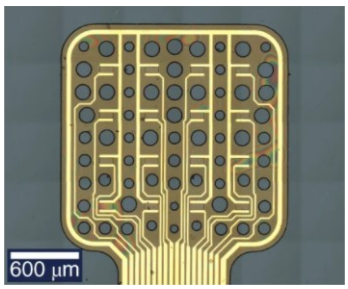
Some publication highlights:

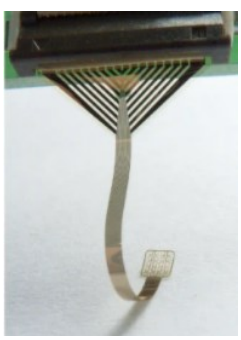
High-resolution mapping of infraslow cortical brain activity enabled by graphene microtransistors.

Masvidal-Codina, E.; **Illa, X.**; Dasilva, M.; Calia, A.B.; Dragojevic, T.; Vidal-Rosass, E.E.; **Prats-Alfonso, E.**; Martinez-Aguilar, J.; De la Cruz, J. M.; Garcia-Cortadella, R.; **Godignon, P.**; **Rius, G.**; Camassa, A.; Del Corro, E.; Bousquet, J.; Hebert, C.; Durduran, T.; **Villa, R.**; Sanchez-Vives, M.V.; Garrido, J.A.; **Guimera-Brunet, A.**

Nature Materials, vol. 13 (2019) pp. 280-288.
Impact factor: 38.663.

https://doi.org/10.1038/s41563-018-0249-4



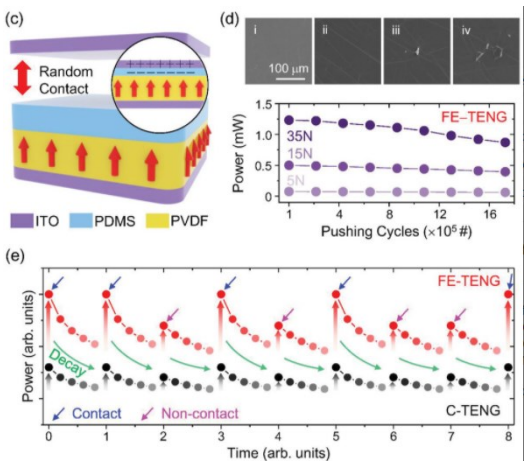


Ferroelectric-polymer-enabled contactless electric power generation in triboelectric nanogenerators.

H.S. Kim, D.Y. Kim, J.-E. Kim, J.H. Kim, D.S. Kong, **G. Murillo**, G.-H. Lee, J.Y. Park, J.H. Jung.

Advanced Functional Materials, vol. 29 (2019) 1905816.
Impact factor: 16.836.

https://doi.org/10.1002/adfm.201905816



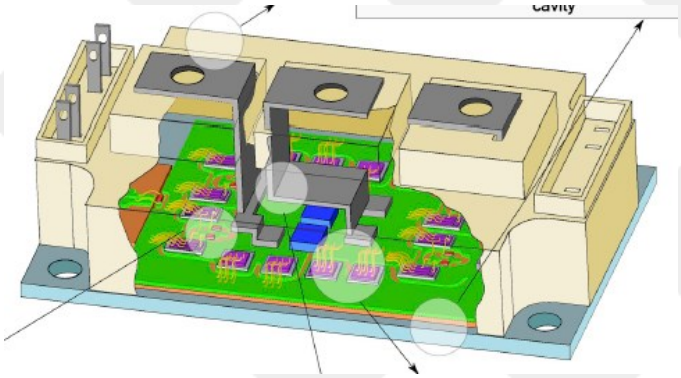
Publications

Matallana, A.; Ibarra, E.; Lopez, I.; Andreu, J.; Garate, J. I.; **Jorda, X.**; **Rebollo, J.**

Power module electronics in HEV/EV applications: New trends in wide-bandgap semiconductor technologies and design aspects.

Renewable & Sustainable Energy Reviews, vol. 113 (2019), 109264 (33 pp.).
Impact factor: 12.110.

https://doi.org/10.1016/j.rser.2019.109264

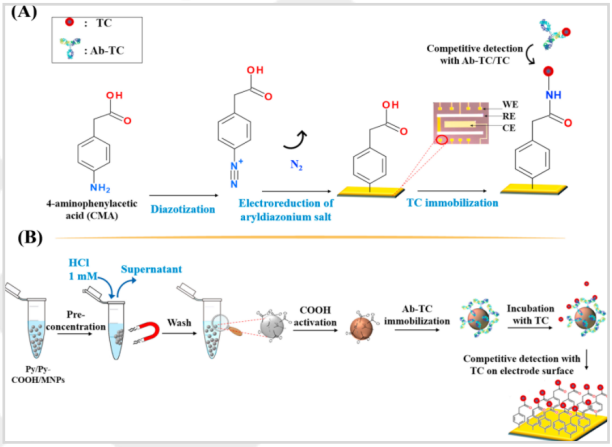


El Hassani, N. E.; Baraket, A.; Boudjaoui, S.; Neto, E. T. T.; **Bausells, J.**; El Bari, N.; Bouchikhi, B.; Elaissari, A.; Errachid, A.; Zine, N.

Development and application of a novel electrochemical immunosensor for tetracycline screening in honey using a fully integrated electrochemical BioMEMS.

Biosensors & Bioelectronics, vol. 130 (2019) pp. 330-337.
Impact factor: 10.257.

https://doi.org/10.1016/j.bios.2018.09.052.

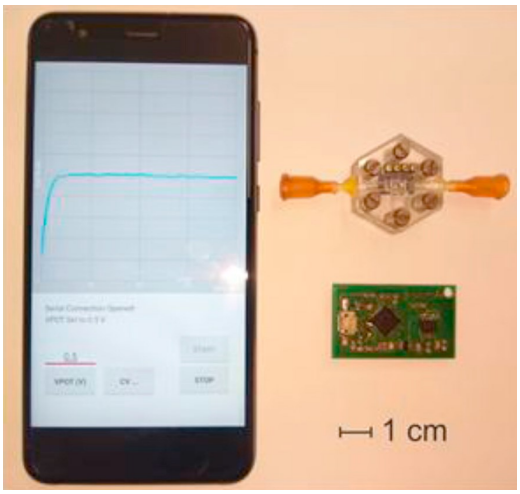


Marquez, A.; Aymerich, J.; Dei, M.; Rodriguez-Rodriguez, R.; Vazquez-Carrera, M.; Pizarro-Delgado, J.; Gimenez-Gomez, P.; **Merlos, A.**; **Teres, L.**; **Serra-Graelles, F.**; **Jimenez-Jorquera, C.**; **Dominguez, C.**; **Munoz-Berbel, X.**

Reconfigurable multiplexed point of care system for monitoring type 1 diabetes patients.

Biosensors & Bioelectronics, vol. 136 (2019) pp. 38-46.
Impact factor: 10.257.

https://doi.org/10.1016/j.bios.2019.04.015



Ph.D. Thesis

Aller Pellitero, Miguel

Design and development of a self-powered electrochromic biosensor.

F.J. Del Campo (dir.).

Universitat Autònoma de Barcelona, Ph.D. in Electrochemistry. Science and Technology, 2019.

Cabello Fusarés, Maria

MOS interface improvement based on boron treatments for high channel mobility SiC MOSFET .

P. Godignon, J. Montserrat (dirs.).

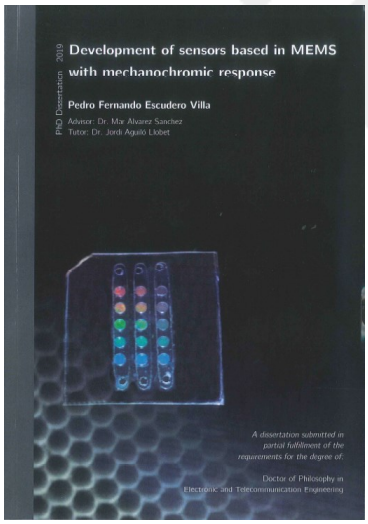
Universitat Politècnica de Catalunya, Ph.D. in Electronic Engineering, 2019.

Carulla Areste, Maria del Mar

Thin LGAD timing detectors for the ATLAS experiment.

G. Pellegrini, D. Flores (dirs.).

Universitat Autònoma de Barcelona, Ph.D. in Physics, 2019.

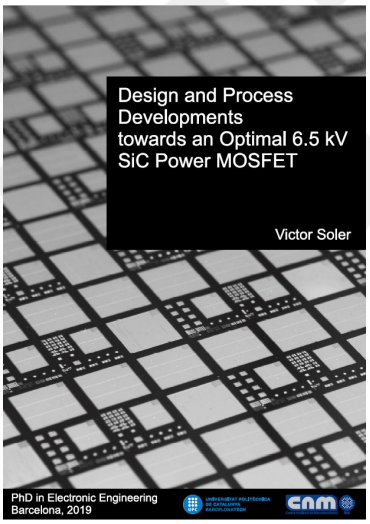


Escudero Villa, Pedro Fernando

Development of sensors based in MEMS with mechanochromic response.

M. Alvarez (dir.).

Universitat Autònoma de Barcelona, Ph.D. in Electronic and Telecommunication Engineering, 2019.

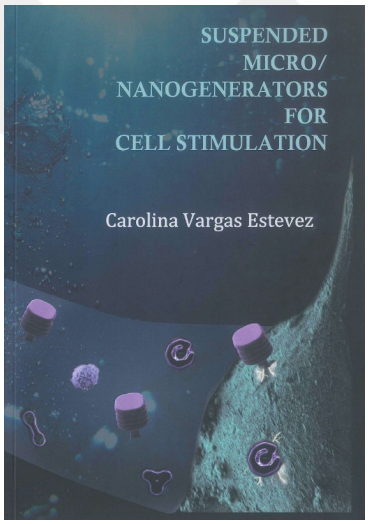


Soler Rosales, Victor José

Design and process developments towards an optimal 6.5 kV SiC power MOSFET.

P. Godignon, J. Rebollo (dirs.).

Universitat Politècnica de Catalunya, Ph.D. in Electronic Engineering, 2019.



Vargas Estevez, Carolina

Suspended micro/nanogenerators for cell stimulation.

J. Esteve, G. Murillo (dirs.).

Universitat de Barcelona, Ph.D. in Nanosciences, 2019.

Technology Transfer

Micro and nano electronics, photonics and smart systems have been identified as a fundamental part of the Key Enabling Technologies, which are the basis for the development and the improvement of the innovation capability of the European industry. These technologies have a high economic potential and the capability to contribute to solve the current societal challenges.

The mission of IMB-CNM is, in addition to improve the knowledge in the micro and nano electronics fields, to contribute to the implementation of solutions based in these technologies in industrial products. It has therefore a strong focus on technology transfer activities, which mainly include the creation of spin-off companies and the development of patents.

Researchers of IMB-CNM have collaborated in the recent years to create Spin-Offs for the valorisation of ideas and products partially or fully developed within the research groups of the institute:

Alibava Systems (www.alibavasystems.com)

Compact System for Radiation Sensor Characterisation. The Alibava system is conceived to measure ionising radiation with semiconductor detectors, providing high sensitivity to low signals, high position resolution and high speed.

A4CELL (Arrays for Cell Nanodevices) (www.a4cell.com)

A4CELL develops New technology named SPAchip (Suspended Planar-Array Chips) offering a perfect way to monitorize single cell alive. SPAchips are intracellular silicom microchips for monitoring extraordinarily small volumes as a single cell.

BLB (Barcelona Liver Bioservices) (liver.barcelona)

Design and development of pre-clinical studies in the field of liver diseases and hepatotoxicity. The system allows human liver cells to be kept in culture for long periods of time and in better conditions than conventional culture methods, much as if they were in the liver. This allows in vitro studies of drug efficacy and toxicity in a microenvironment very similar to that of the human liver.

CALY Technologies (caly-technologies.com)

CALY Technologies' SiC products offer unrivaled protection and superior performance than silicon devices in Transportation & EV applications. Its protection products are used in battery packs and power converters to limit the inrush or short-circuit current.

EnergIoT Devices (www.energiot.com)

EnergIoT develops microgenerators to harvest ambient energy for smart wireless sensors, making possible a self-powered Internet of Things (IoT). EnergIoT can also create customized monitoring solutions to enable predictive maintenance for applications in other utility services such as water and gas distribution.

FUELIUM (www.fuelium.tech)

Spin-off from CSIC established in 2015 to commercialize the research activity on fuell cells. It offers paper batteries capable of powering a variety of single-use devices, such as portable diagnostic, and being discarded without recycling. Fundación Repsol Entrepreneurs Fund Award (2016).

FutureSiSens (www.futuresisens.com)

Spin-off company from IMB-CNM and the Autonomous University of Barcelona (UAB) established in 2016 that designs, develops and manufactures thermoelectric micro-sensors that are capable of detecting very small flows and flow variations autonomously. Fundación Repsol Entrepreneurs Fund Award (2016).

Smalle Technologies (smalletec.com)

Energy Harvesting Company. Has developed an electromagnetic harvester device for scavenging ambient mechanical energy with slow, variable and randomness nature. It has applications in sailboats, oceanographic and navigation buoys. Fundación Repsol Entrepreneurs Fund Award (2013).

Outreach

IMB-CNM has a sustained activity in outreach events aiming at promoting the social awareness of the benefits of science and technology, and the public support to them. A program of visits from high-school students is aimed at encouraging young people to follow science and technology careers. IMB participates in the annual Science and Technology Week which is organized at the Spanish and Catalan levels, and regularly presents the results of its research activities in the public media.

IMB-CNM participated in YoMo, a festival to promote technologies among young people

IMB-CNM participated in the 2019 edition of the "Youth Mobile Festival Barcelona" (YoMo), which is a satellite event of the GSMA Mobile World Congress.

YoMo is targeted to young people aged 10 to 16, and aims to inspire young people and help them get to know the professional careers of the STEAM (Science, Technology, Engineering, Arts and Mathematics) sector. At the interactive stand of IMB-CNM visitors could explore the basic components of mobile phones: chips.

The visitors could also discover clean rooms, dress with clean room clothes and photograph with a clean room background.

The 2019 edition of YoMo Barcelona included educational exhibitions, live performances, interactive workshops, conferences and a broad agenda of practical activities. It had a total attendance of 29670, of which 22739 were young people and 4115 educators.

IMB-CNM researchers participated in the “Pint of Science” 2019

“Pint of Science” is an international event of scientific outreach in which researchers present their work in bars and pubs for the general public. It was held in May. In 2019, 784 scientists gave 384 talks in 73 cities of 24 countries.

The IMB-CNM talks were given by Xavier Perpiñà (“People have the power", a history on power electronics), and Gemma Rius ("Km0 Micro and Nano chips”).

Day on women and science

In June IMB-CNM organized a Day on women and science, in which the documentary 'El enigma Agustina' was premiered in Catalonia. The documentary served to illustrate the problem of the gender gap in science, the central theme of the day organized by IMB-CNM.

The director of 'El enigma Agustina', Manuel González, and its main character, Natalia Ruiz, presented the documentary. It is an outreach project of the Institute of Astrophysics of Andalusia (IAA) of CSIC on the enigmatic figure of Agustina Ruiz Dupont, one of the brightest Spanish female scientists, who was literally erased from history. The documentary addresses the struggle of women to enter the scientific career and claims some of the female figures in the history of science and the arts. It was a perfect prelude for a debate about the difficulties faced by women who want to be a scientist.

IMB-CNM participated in the European Researchers' Night

September 27 was the European Researchers' Night. It is an event held throughout Europe to promote public awareness of the importance of research, in which science professionals bring their work closer to citizens through public events and workshops. More than 371 European cities have joined this initiative, promoted since 2005 by the Marie Skłodowska-Curie Actions (MSCA) programme of the EU. The previous edition of 2018 involved more than 21,850 science professionals with more than one and a half million attendees.

The IMB-CNM researcher Gemma Rius participated in the micro-talks organized by Vil·la Urània (Barcelona), as the speaker of a session entitled "The cars of the future are not, in fact, robots?". A second activity was the Nanotalks cycle, held at CosmoCaixa (Barcelona), within the "Young Research Night". Here Eli Prats, researcher at IMB-CNM, moderated the cycle "The nanotechnological revolution". The night ended with a workshop organized by IMB-CNM, on "Working without particles to manufacture micro and nanodevices. We enter a white room". Fifty people were able to discover the Clean Room of IMB-CNM and know how to work without particles for the fabrication of microdevices. The participants, mostly boys and girls, were able to dress in clean-room clothing.

Science and Technology Week

In November, the 24th Science Week in Catalonia / Science and Technology Week in CSIC was held, which included a whole series of scientific dissemination activities such as open days, exhibitions, talks, games, scientific workshops, etc. IMB-CNM joined it with different activities, with the aim of bringing microelectronics research closer to society.

Throughout the week, the center organized open days to allow free and guided entry to the Institute's "Zenón Navarro" Microelectronics Museum Space and to the Integrated Clean Room of Micro and Nanofabrication. Researchers went to a primary school to give a talk to more than 70 children from 6th grade. Also, the center organized two round tables on science and gender, "Women, are we in STEM?" and "Science, research and gender" in Sant Cugat del Vallès, supported by the Gender Perspective Group of the Catalan Association for Scientific Communication (ACCC).

Outreach

Inspiraciencia

IMB-CNM participated in the organization of Inspiraciencia 2019, a contest on science-based stories, organized by CSIC.

The Museum is dedicated to Zenon Navarro Garriga (1947-2007), physicist, who in the early 1980s built the UAB clean room that was used by CNM during its initial years. He later managed the construction and installation of the IMB-CNM clean room and during many years he was the photolithography process manager.

Microelectronics Museum Area

The “Zenon Navarro” Microelectronics Museum area was created to make micro and nanoelectronics technology and applications known to the general public. The museum displays equipment used for the design, fabrication and measurement of electronic devices. It describes what the silicon chips are and how they are made, by using static displays, multimedia material and device prototypes.

Student visits

Guided visits to the IMB-CNM and the museum area are organized for student groups, from high schools or universities. More than 300 students visit the institute annually.

Partnerships

The scientific and technological challenges of today's society are complex and interdisciplinary, and cannot be addressed by a single institution. Cooperative innovation is therefore a key issue, and for this reason IMB-CNM has specific partnerships and collaborations with industry, universities and research centres.

IMB-CNM is a member of the **Barcelona Nanotechnology Cluster-Bellaterra (BNC-b)**. BNC-b is a scientific and industrially oriented virtual entity, grouping the capabilities and expertise in nanoscience and nanotechnology of a number of research centres and companies located in the Research Park of Universitat Autònoma de Barcelona (UAB) at Bellaterra. It includes more than 500 researchers.

http://www.bnc-b.net/

D+T Microelectrónica A.I.E. is an Association of Economic Interest which provides access for industry (especially SMEs) to the micro and nanotechnologies of IMB-CNM. It is located in the IMB-CNM building, and its mission is to facilitate the inclusion of microelectronic technologies in industrial products, by designing, developing and manufacturing chips and microsystems tailored to specific needs.

http://www.dtm.es

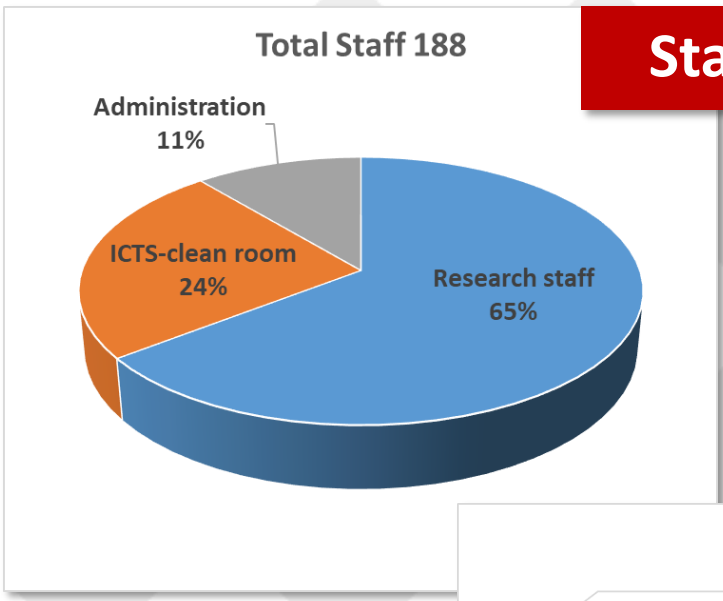
The **UAB Research Park** is a non-profit private foundation, created in 2007 by three research institutions, the Autonomous University of Barcelona (UAB), the Spanish Research Council (CSIC) and the Agrofood Research and Technology Institute of Catalonia (IRTA), as a basic tool to promote the transfer of knowledge and technology between the academic community and the industry. It gathers the research capabilities located at the UAB campus, and it currently includes more than 30 research centres and institutes with more than 4000 researchers.

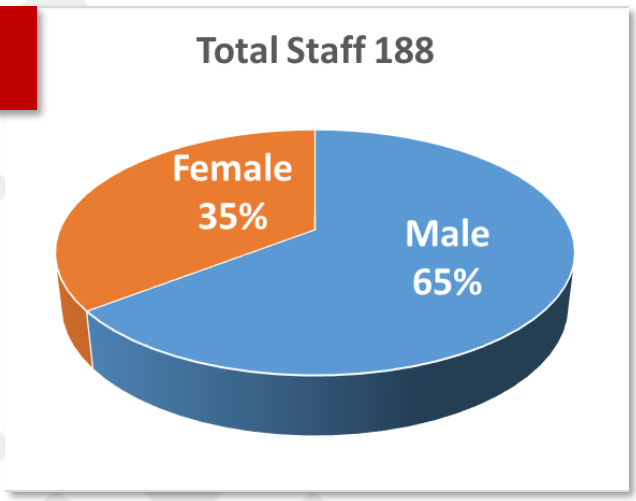
https://www.uab.cat/parc-recerca/

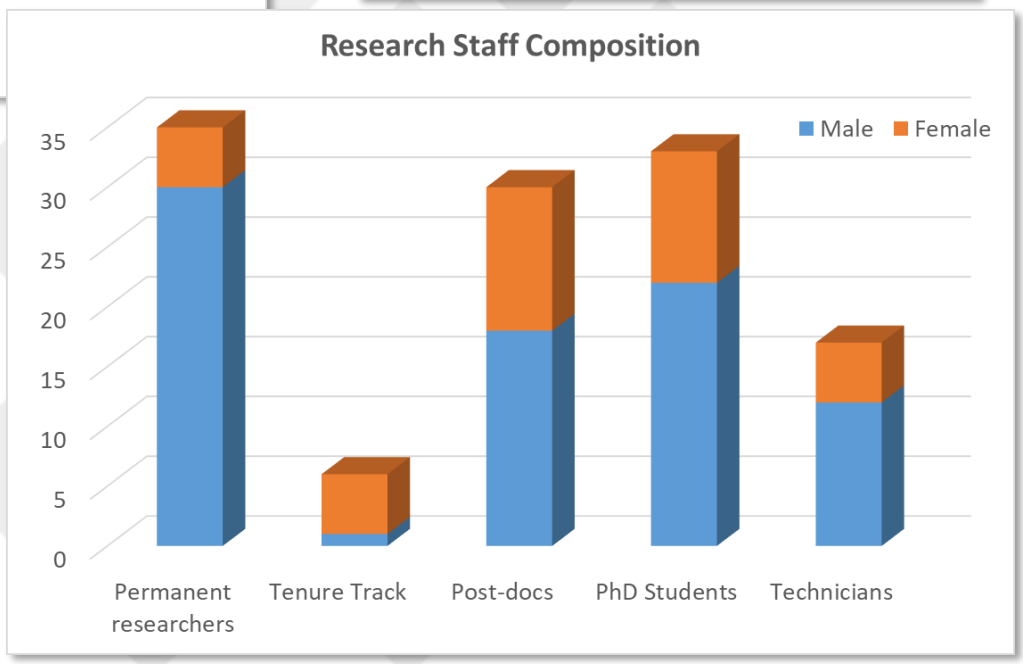
In addition, IMB-CNM is member of more than 20 national and international clusters, technological platforms, industrial associations and research networks.

Key Figures

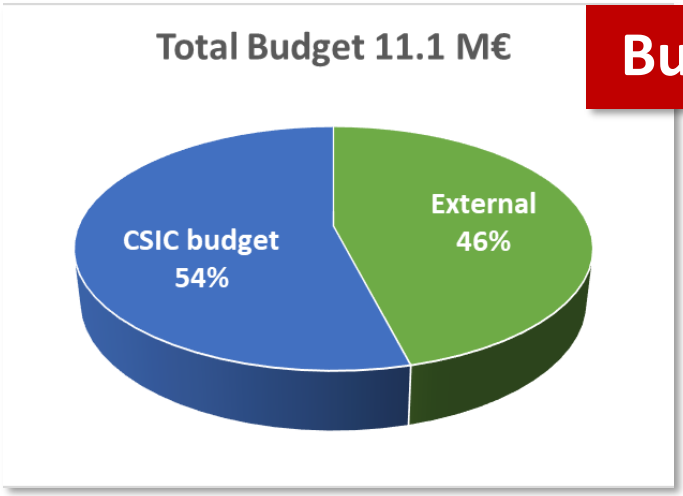
Staff

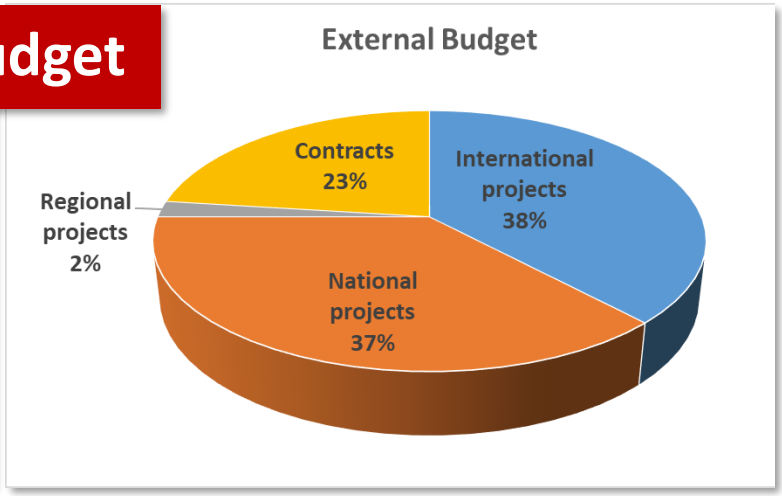






Budget

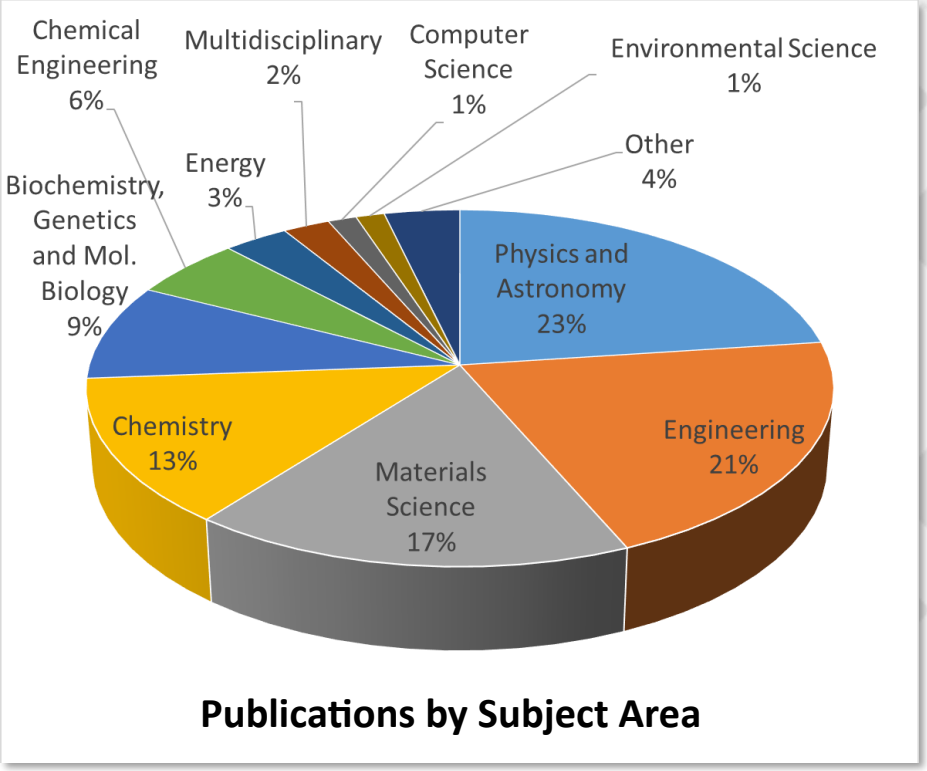




Publications

Journal papers	99
Conference publications	25
Book chapter	1
TOTAL	**125**

Open Access 45
Q1-SJR 88 (94%)
D1-SJR 54 (58%)



Publications by Subject Area

Technology Transfer

Registered patents	3
Licensed patents	4
Active Spin-offs	7

www.imb-cnm.csic.es

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