

Annual Report | 2020

SUMMARY

About ICMAB

INSTITUT DE CIÈNCIA DE MATERIALS DE BARCELONA
ICMAB-CSIC



We are a public and multidisciplinary research institute dedicated to cutting-edge research in functional advanced nanomaterials, pursuing excellence in the generation and transfer of knowledge, and in the development of scientific and technical tools and methodologies for the synthesis, preparation and characterization of new materials in the fields of energy, electronics and nanomedicine.

Funded in 1986, the ICMAB is a center of the Spanish National Research Council (CSIC), and since 2016 a Severo Ochoa Center of Excellence. It brings together more than 390 people and 16 research groups distributed in 9 research units and 5 research lines on materials science research.

*“Certainly 2020 has been a challenging year for the whole world and ICMABers have also been deeply concerned by the strong uncertainty we have faced. While Covid-19 has been a lesson in humility, it has also had as a positive upheaval the demonstration of the value of science. **Our second Severo Ochoa is an opportunity for us to tackle global scientific challenges in energy, electronics and health with renewed enthusiasm.**”*

Xavier Obradors, ICMAB Director

Almost **400** ICMAB Members, **122** PhD Researchers, **62** Senior Researchers, **60** Undergraduate Students and **50** Postdoctoral Researchers

Thank you to the contributors who participated in this publication
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Cover Image: Artur Martínez

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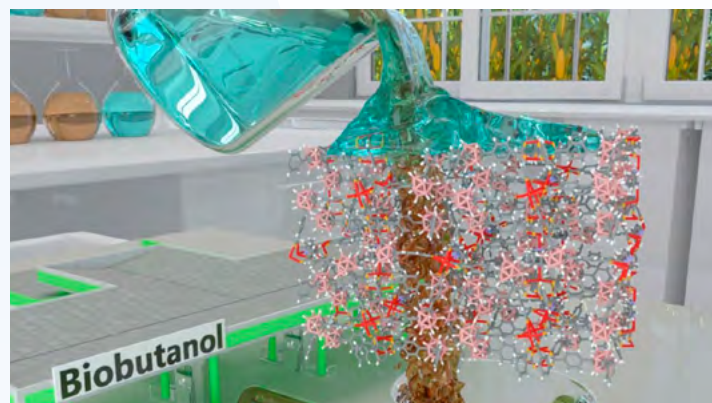


@ICMABCSIC

A walk through 2020

The ICMAB donates 33.200 gloves for medical uses

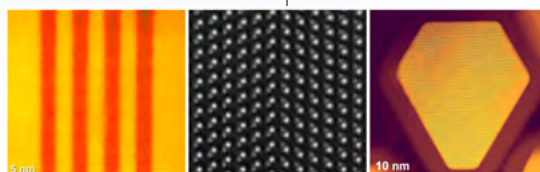
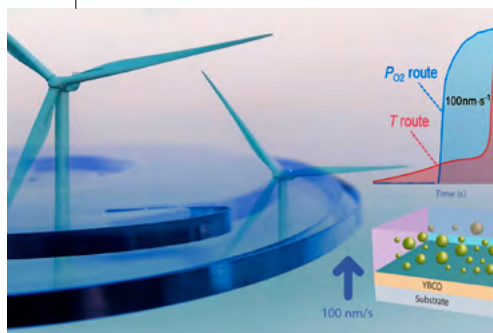
#ICMAB11F: Celebrating the International Day of Women and Girls in Science at the ICMAB



Towards green energies: new materials for biobutanol separation

20 JAN 05 FEB 06 MAR 22 MAR 09 APR 27 APR 21 MAY 19 JUN

Breakthrough in the ultrafast growth of superconducting films with high performances



Barcelona equips itself with a European first-class collaborative microscopy platform through the joint action of nine research institutions and the support of ERDF

Four ICMAB groups join XRE4S, a network for energy technology transference

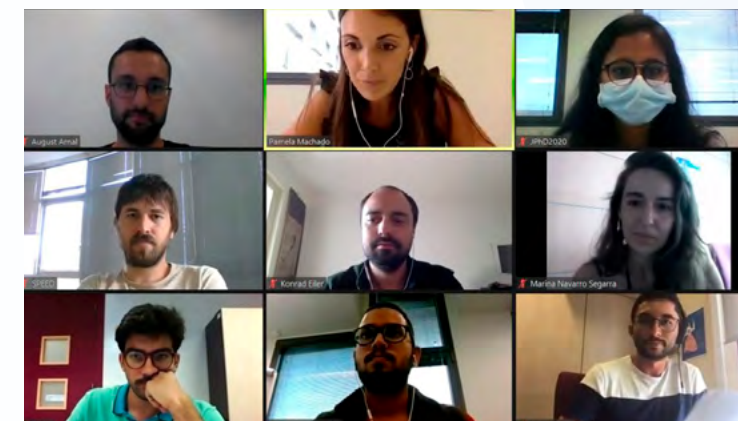
"Photonic mirror" the winning photo of our FOTICMAB 2020 contest



Workshop ALBA-ICMAB: a successful meeting to create more synergies between the two institutions



ICMAB is awarded with the "Severo Ochoa" Center of Excellence Award for the second time in a row

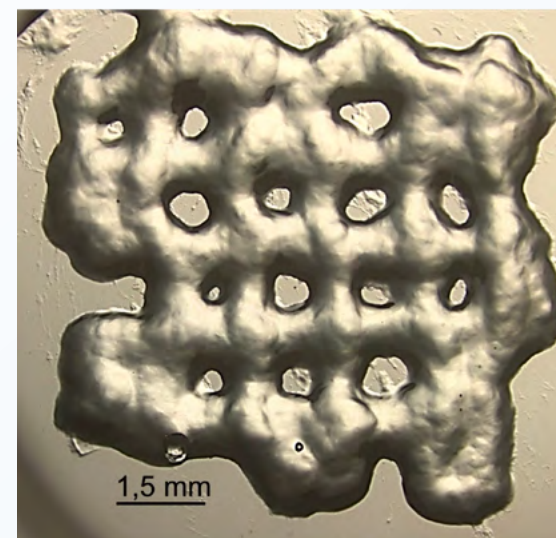


The JPhD2020 closes this edition having achieved the highest participation ever!

26 JUN 15 JUL 31 AUG 18 SEP 22 OCT 17 NOV 01 DEC

The ICMAB participates in the EU's most ambitious battery research project: BIG-MAP

New 3D printed hydrogels for T-cell growth to be used in cancer immunotherapy



Announcement of a public-private investment fund for the promotion of knowledge transfer

First meeting of the CSIC Equality Committees at ICM-Institut de Ciències del Mar

Participate in the Matheroes Virtual Escape to help them achieve the SDGs



Research Lines

RL1

Sustainable energy conversion and storage systems

Mission: Contribute to the global energy challenge by advancing the next materials generation for efficient clean-energy conversion and storage.

RL2

Superconducting materials for emerging technologies

Mission: Promote and develop superconducting materials as a solution for key emerging technologies of our society

RL3

Oxides for new generation electronics

Mission: R&D related to fundamental physics of oxide-based materials and their application to help finding solutions to Global Challenges towards efficient, energy friendly data storage and advanced computing.

RL5

Bioactive materials for therapy and diagnosis

Mission: Contribute to the current nanomedicine challenges providing platforms that integrate therapeutic and/or diagnostic capabilities.

RL4

Tuneable and low cost molecular electronics

Mission: Development of novel electronic platforms based on molecular materials for the fabrication of (bio) chemical and physical sensors with high impact on our societal well-being and contributing to technological advances.

Our R&D activities are strongly backed up by state-of-the-art scientific instrumentation and specialised technical staff available in our scientific services. We are ready and able to deploy R&D activities at the forefront of international knowledge.



Severo Ochoa Project

Severo Ochoa 2020-2023

2020 has been the first year of our second recently awarded Severo Ochoa “Center of Excellence” Project, after our first Severo Ochoa period (2016-2019).

The project “Advanced Functional Materials for a Better Future” (FUNFUTURE) will enable

us to continue in the forefront of materials research in Spain and in the world. With our ambitious programme, we tackle three of the main social grand challenges of the 21st Century, which are our three main application areas:

**CLEAN AND
SECURE
ENERGY**

**SUSTAINABLE
AND LOW
COST
ELECTRONICS**

**SMART
NANOMEDICINE**

**Training activities
for our researchers
and staff for a
non-stop learning
career**

**Enhance
communication
and outreach
activities to put
ICMAB on the
map**

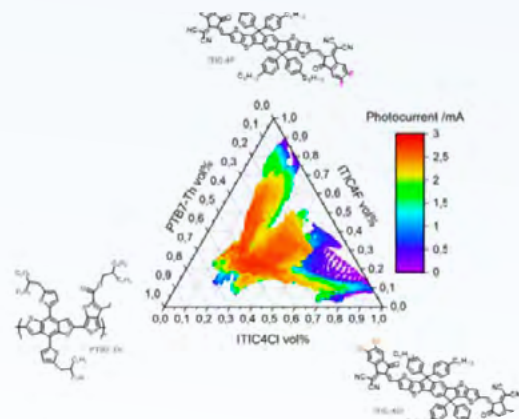
**Invigorate
technology
and knowledge
transfer of our
innovations to the
market**

**Improve attraction
and recruiting of
talented scientists
and research support
staff to keep building
up an amazing team**

Strategic Priority Actions



Scientific Highlights



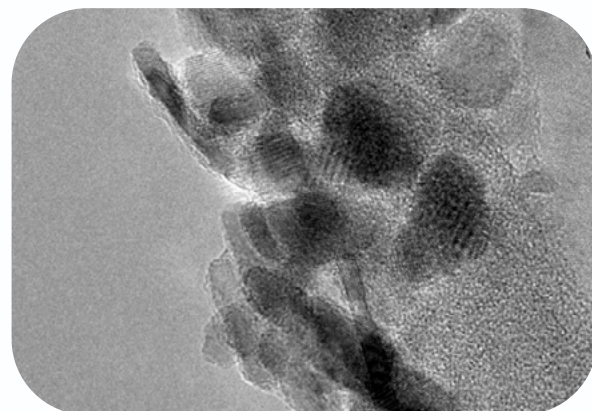
High throughput screening of organic solar cells

Mariano Campoy-Quiles, Nanopto Group



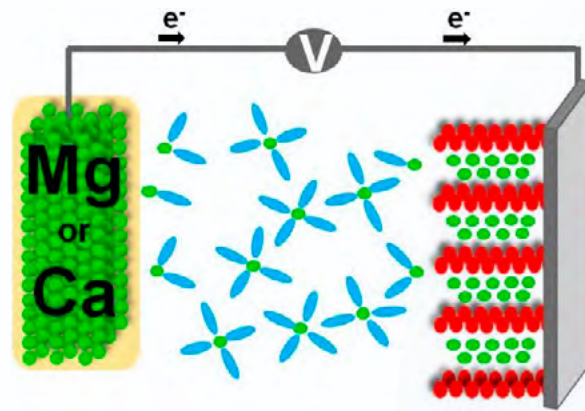
Novel photonic architectures by nanoimprinting unconventional materials

Agustín Mihi, Nanopto Group



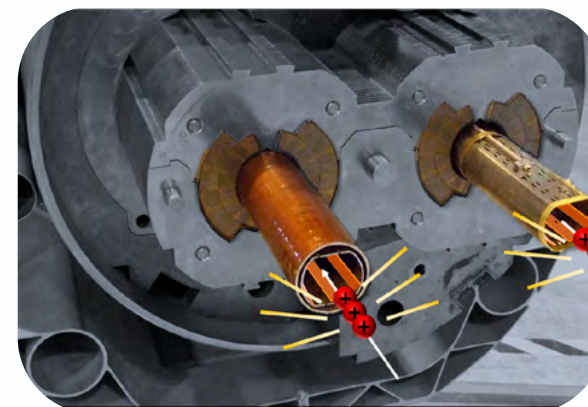
Laser fabrication of supercapacitor electrodes containing low dimensional materials

Ángel Pérez, Laser Processing Group



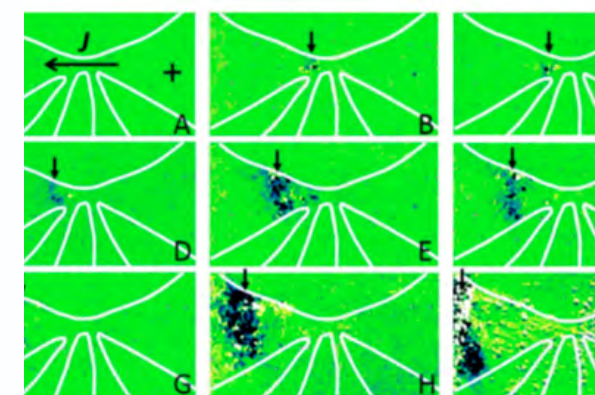
Electrolyte and solid electrolyte interphase for Ca Metal Anode Based Batteries

Alexandre Ponrouch, Solid State Chemistry Group



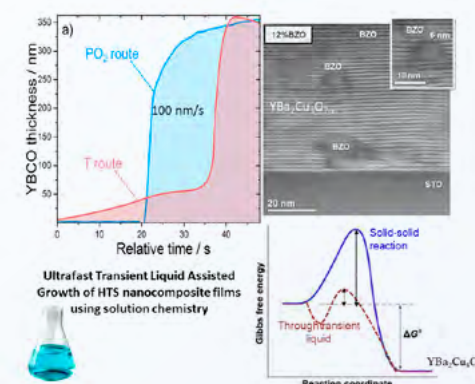
High temperature superconductors for high-energy physics

Joffre Gutiérrez, SUMAN Group



Functional superconductor and ferromagnetic oxides for energy efficient electronic devices

Anna Palau, SUMAN Group



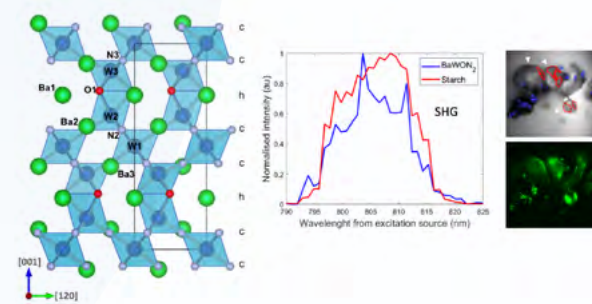
Ultrafast TLAG of high current density superconducting films and coated conductors

Teresa Puig, SUMAN Group



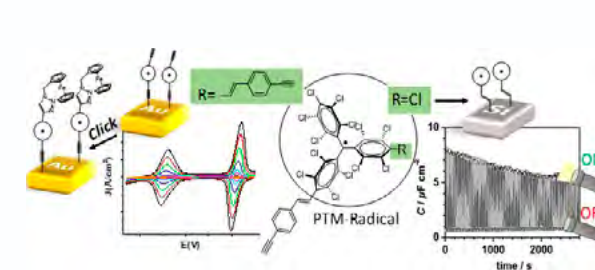
Flexible antiferromagnetic FeRh tapes as memory elements

Ignasi Fina, MULFOX Group



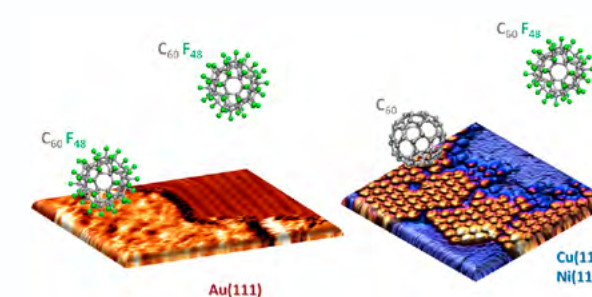
Design of new polar oxynitride perovskites

Amparo Fuertes, Solid State Chemistry Group



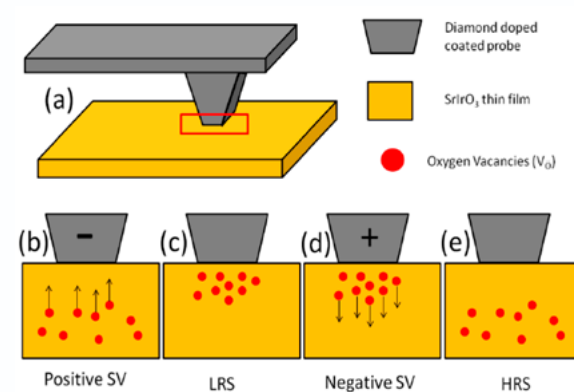
Exploiting the versatile alkyne based chemistry for expanding the applications of a stable triphenylmethyl organic radical on surfaces

Núria Crivillers, Nanomol Group



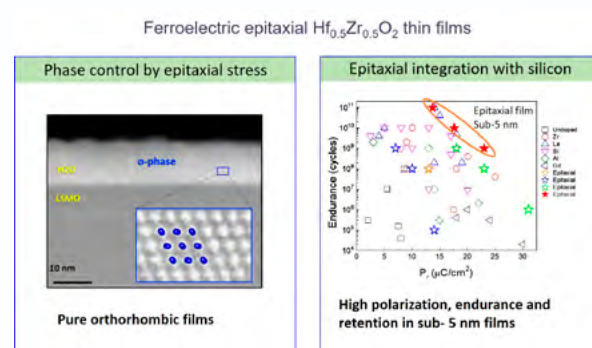
Metal's type specificity on the de-fluorination of $C_{60}F_{48}$ dopants used in organic devices

Carmen Ocal, SURFACES Group



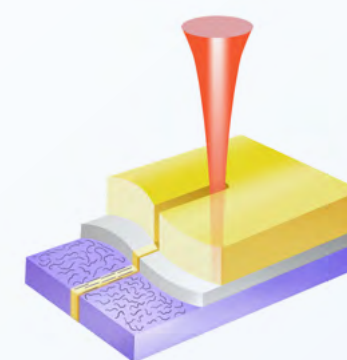
Resistive switching in strontium iridate thin films

Alberto Pomar, ACNM Group



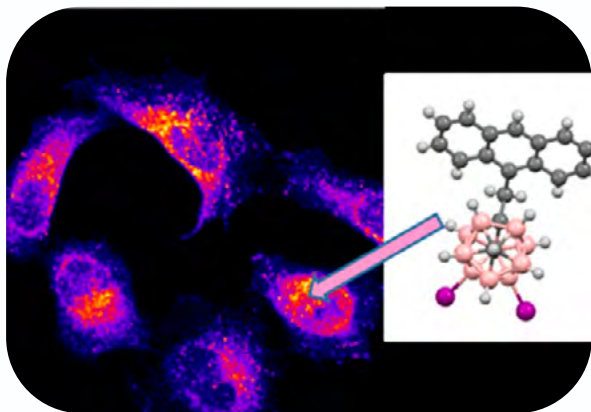
Ferroelectric epitaxial $Hf_{0.5}Zr_{0.5}O_2$ thin films

Florencio Sánchez, MULFOX Group



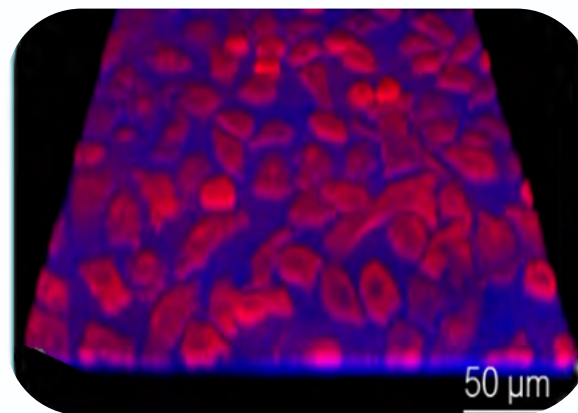
Micro-engineering of organic semiconductors: A 'molecular gate' approach

Aleksandr Perevedentsev, Nanopto Group



Boron clusters and carbon nanomaterials for bioimaging and cancer therapy

Rosario Núñez, LMI group, and Gerard Tobias, Solid State Chemistry Group



Bacterial nanocellulose to treat corneal pathologies

Anna Laromaine, NN group

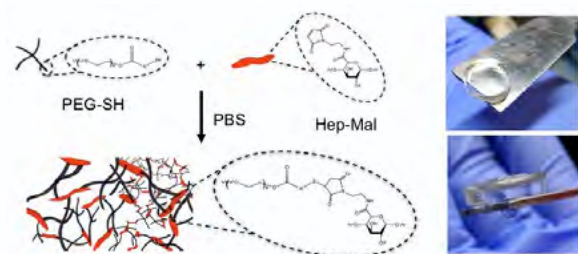


Fig.5 Schematic synthesis of PEG-Hep hydrogels and pictures of the resulting hydrogels.

Towards biomimetic lymph nodes for cancer immunotherapy

Judith Guasch, Nanomol Group



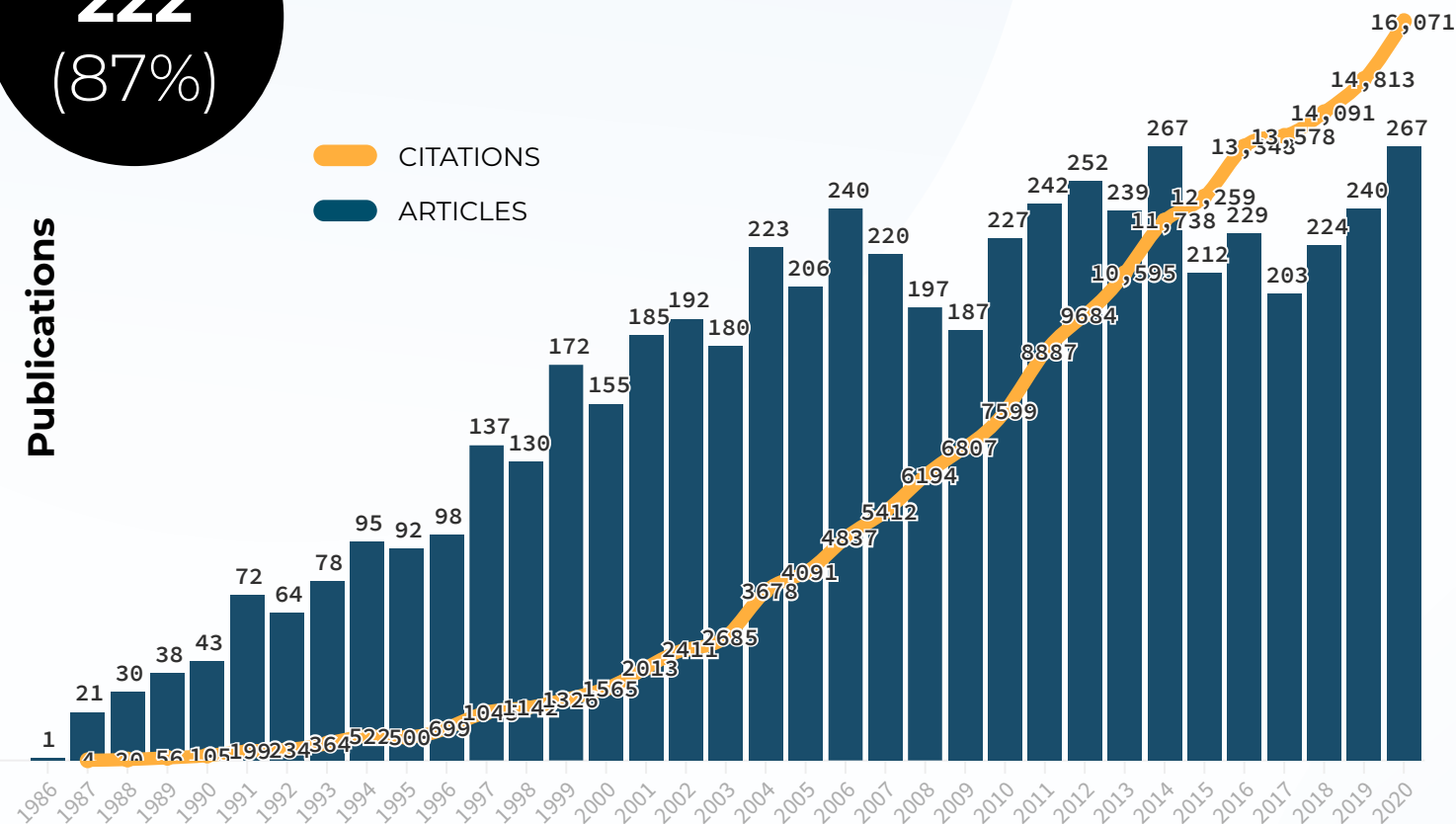
Facts & Figures

Q1

222
(87%)

CITATIONS
ARTICLES

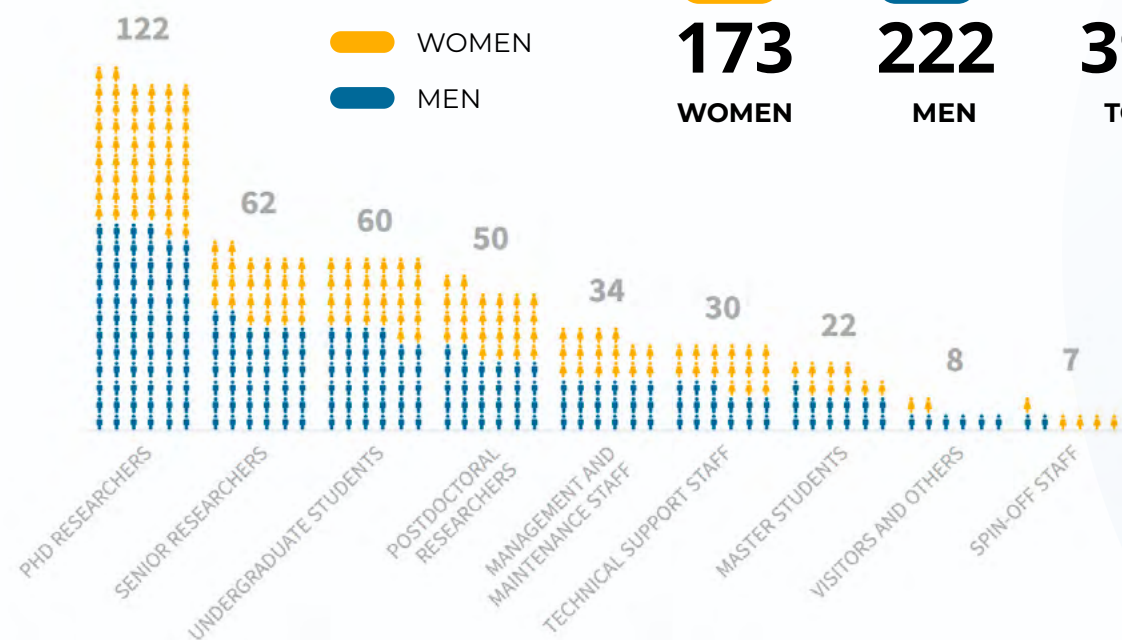
Publications



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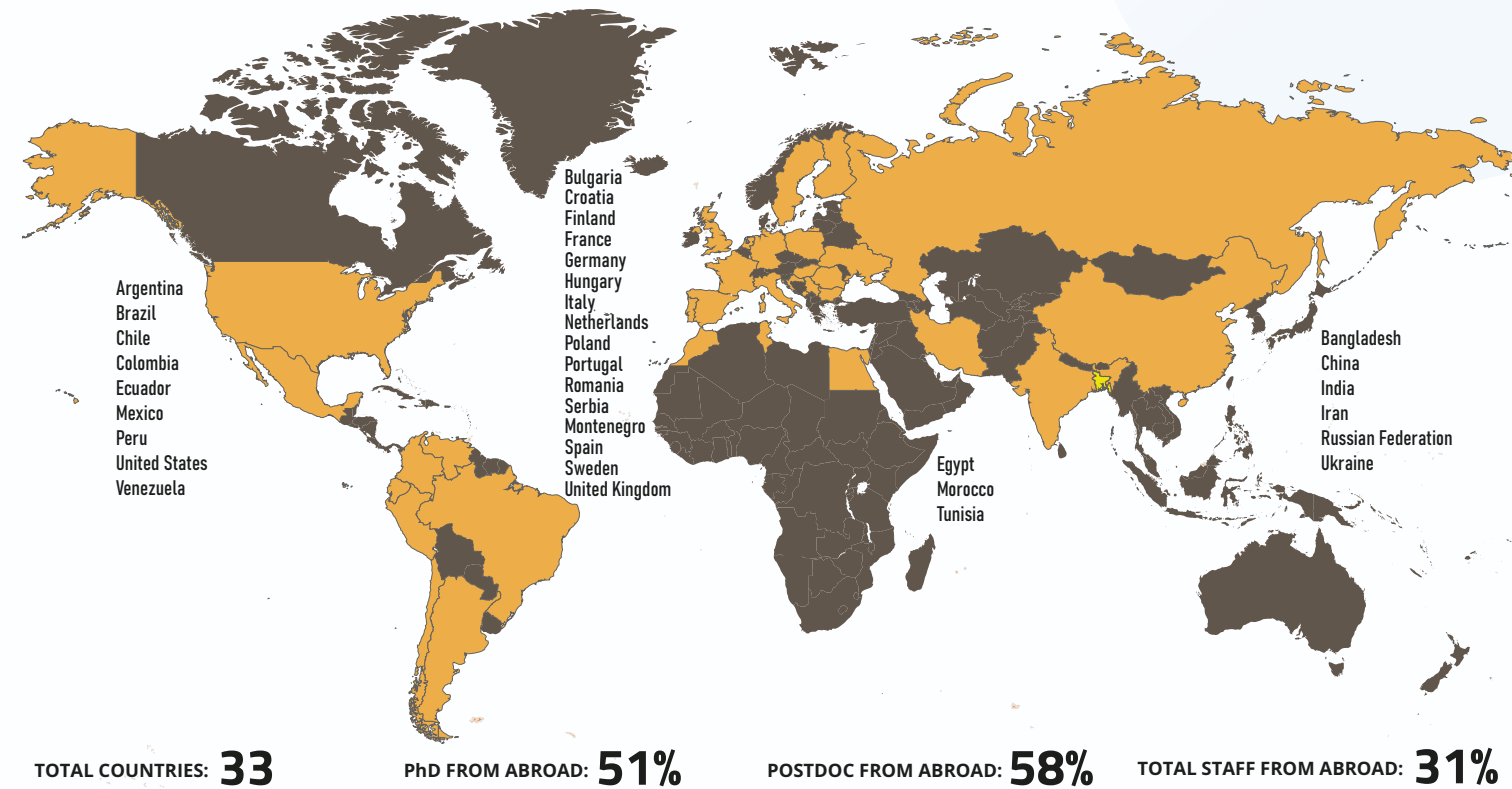
173 **222** **395**
WOMEN MEN TOTAL

People

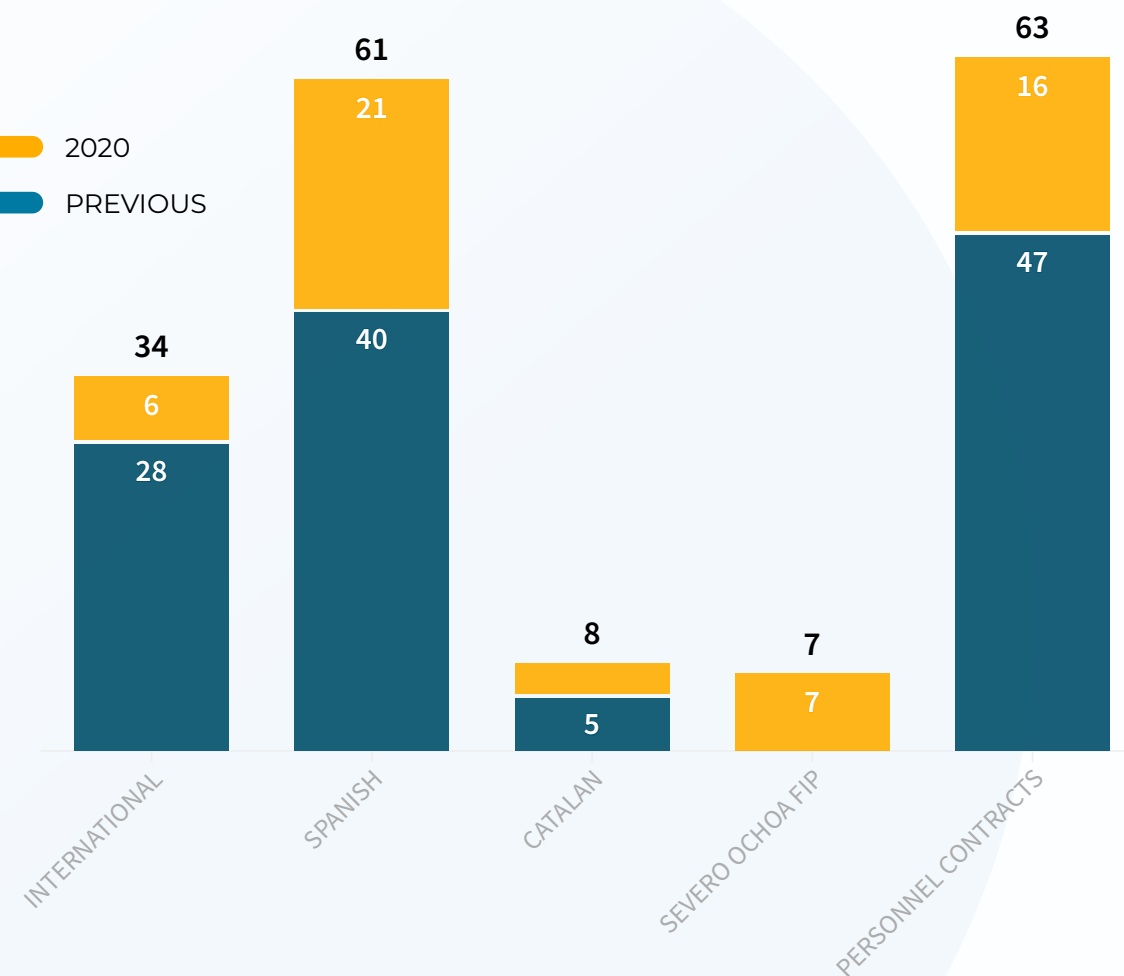


267 ARTICLES
254 ARTICLES WITH IF
7.28 IF AVERAGE
3 HIGHLY CITED PAPERS
156 h-INDEX
32.11 AVERAGE CITATIONS PER ITEM

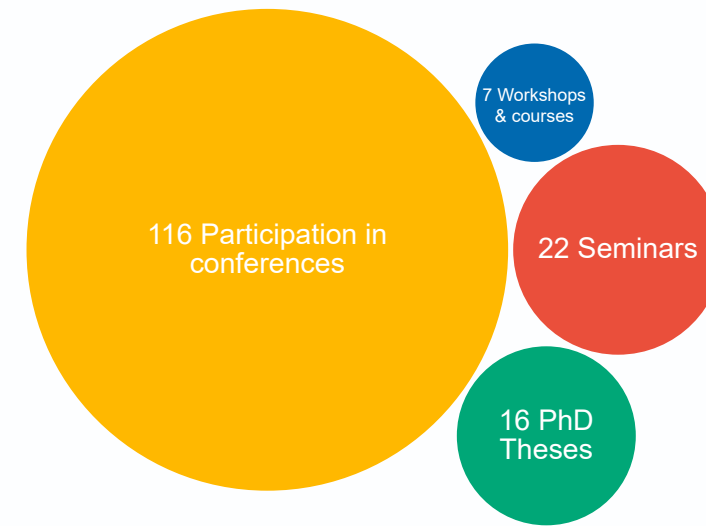
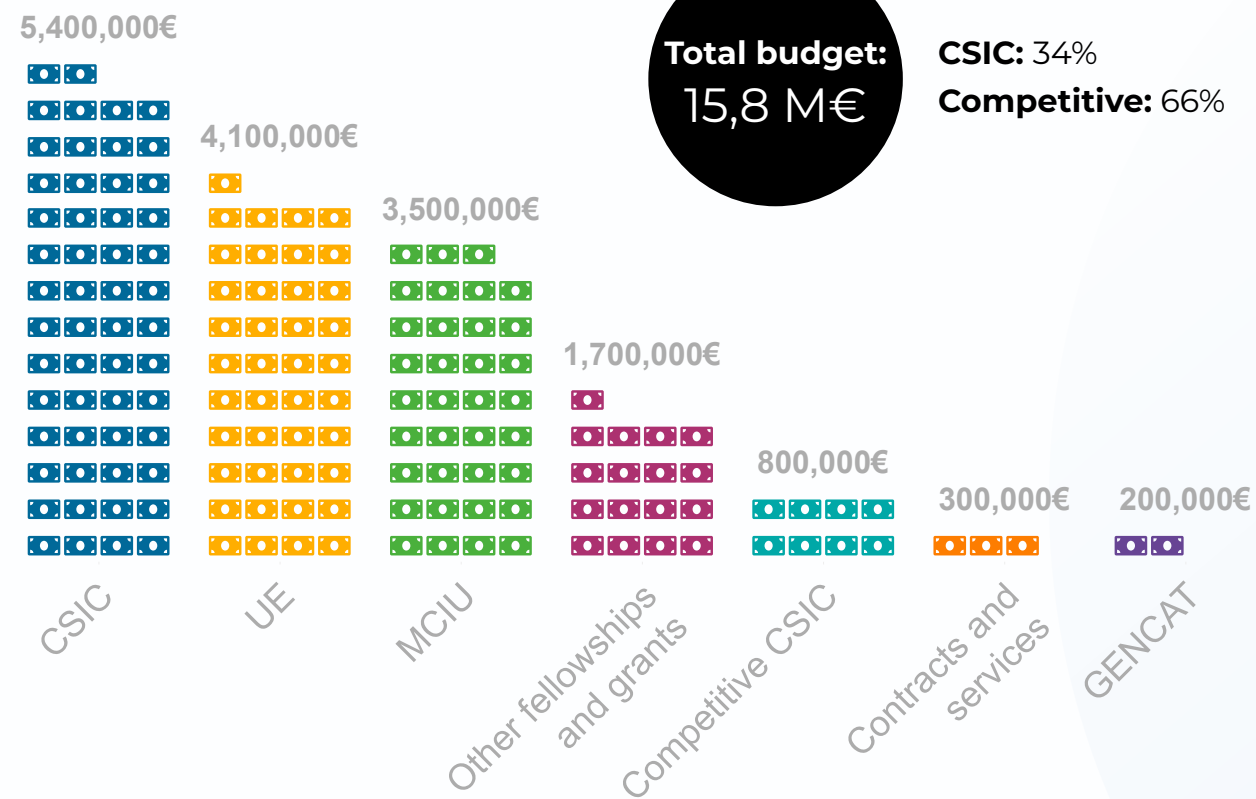
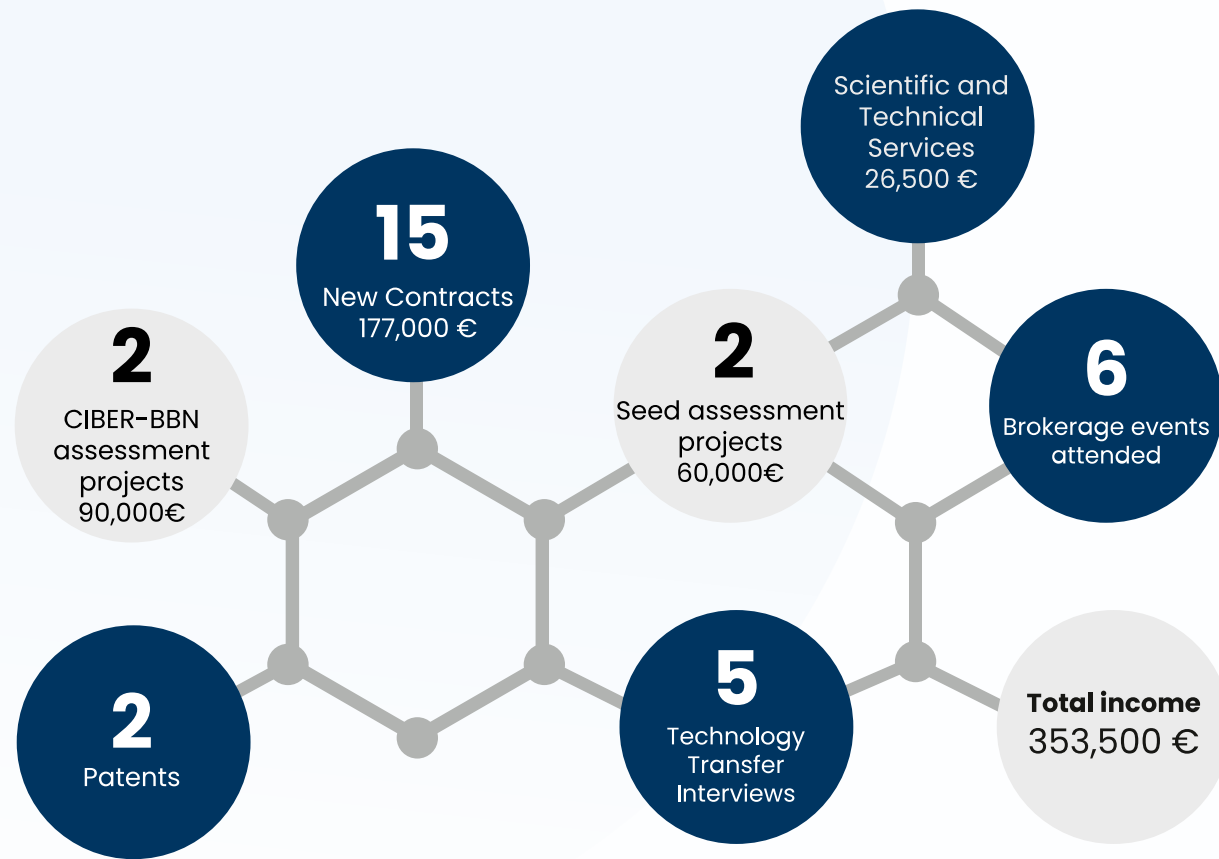
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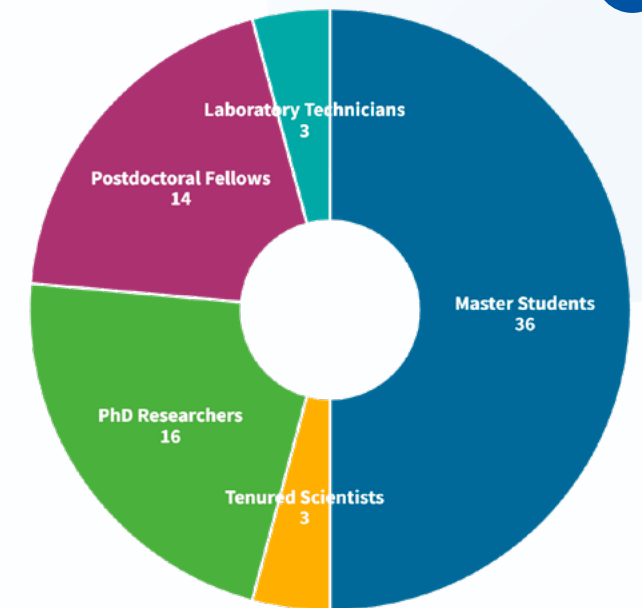
2020
PREVIOUS



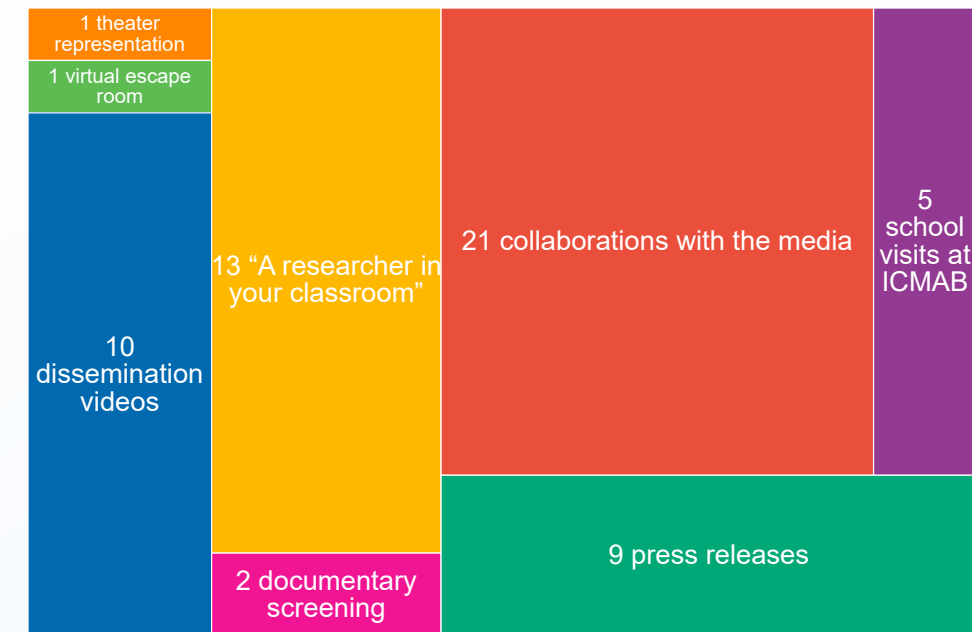
Ongoing Projects



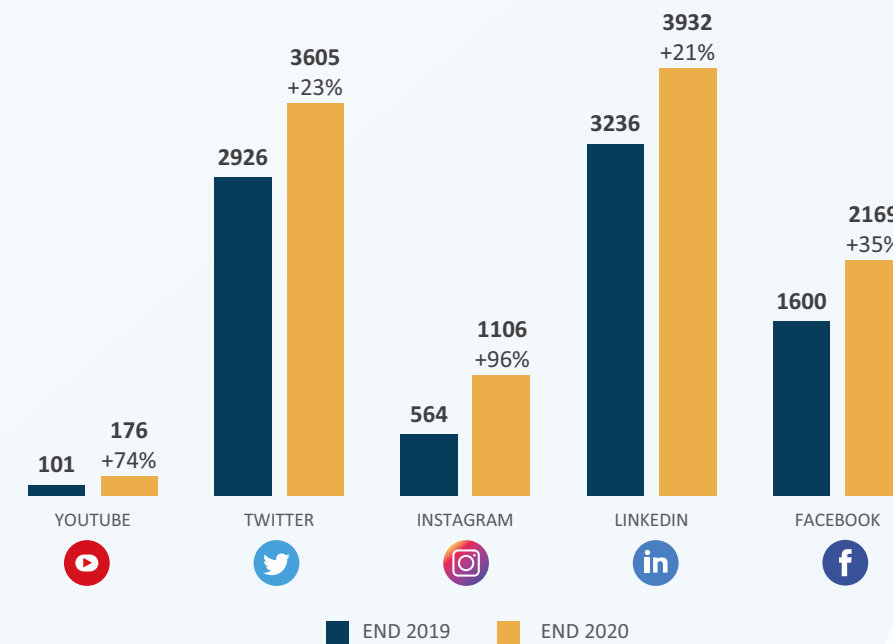
Training



Competitive recruitment



Communication & Outreach



Followers

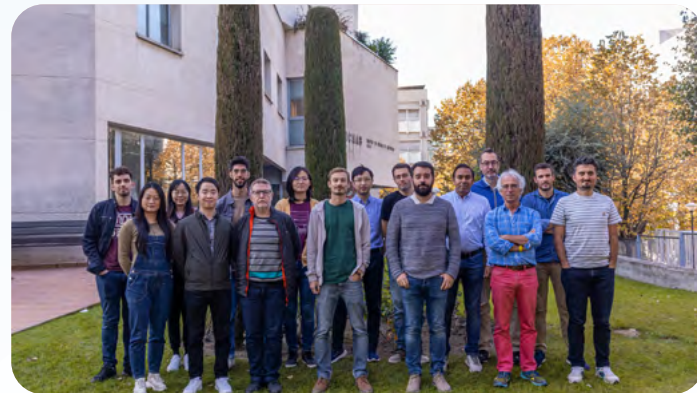
Research Groups

MAGNETIC MATERIALS AND FUNCTIONAL OXIDES



Advanced Characterization and Nanostructuring of Materials (ACNM)

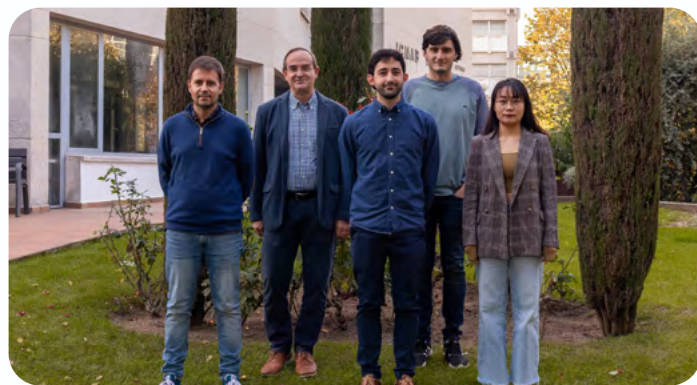
Research of the group has concentrated on the study of spin dependent transport properties in ferromagnetic oxide/normal metal heterostructures. Generation of pure spin currents, by spin pumping, and detection of inverse spin Hall effect voltage signals, separated from spurious spin rectification effects have been accomplished. Spin Hall magnetoresistance has also been used to study interfacial magnetic properties.



Laboratory of Multifunctional Thin Films and Complex Structures (MULFOX)

The group has made an enormous progress on the growth and characterization of epitaxial ferroelectric (Hf, Zr)O₂ films, high polarization and reliability has been achieved in sub-5 nm films, and the disclosure of switchable electroresistance down to few nanometers. Photoresponsive polar materials have evolved into a major axis of research and photoresponsive 2DEGs, that mimic synaptic spike-timing dependent plasticity, have been discovered. New developments encompass flexible antiferromagnets.

ADVANCED STRUCTURAL AND FUNCTIONAL CHARACTERIZATION



Crystallography of Magnetic and Electronic Oxides and Surfaces (CMEOS)

Chiral and noncollinear magnetic orders provide excellent opportunities for the electric control of magnetism thanks to the coupling between electron spin and its orbital motion. Symmetry motivated approaches anticipate the identification on new improper magnetoelectric multiferroics and allow to tackle coupled transitions in frustrated oxides.



Crystallography & X-Ray Diffraction

The group has contributed in the areas of intermolecular interactions (halogen bond in cocrystals, hydrogen bond in charged Watson-Crick pairs), structure of new organic, ceramic and coordination compounds and photocatalysis, as well as in new methods in through-the-substrate microdiffraction and in solution of complex minerals from PXRD.

FUNCTIONAL SURFACES AND INTERFACES



Functional Nanomaterials and Surfaces (FunNanoSurf)

FunNanoSurf has provided insight on the supramolecular organization of chiral/achiral block-copolymers, also, synthesized and tested new fullerenocurcuminoids in perovskite solar cell.



Physical Chemistry of Surfaces and Interfaces (SURFACES)

The group has contributed to the advance of interface engineering through control of the organic semiconductor growth and the use of dopants. By exploring and understanding the processes occurring at the surface of diverse organic-organic and organic-metal systems, we revealed the implications of structural details in device stability and performance.

NANOSTRUCTURED MATERIALS FOR OPTOELECTRONICS AND ENERGY HARVESTING



Laser Processing Research Group (LPR)

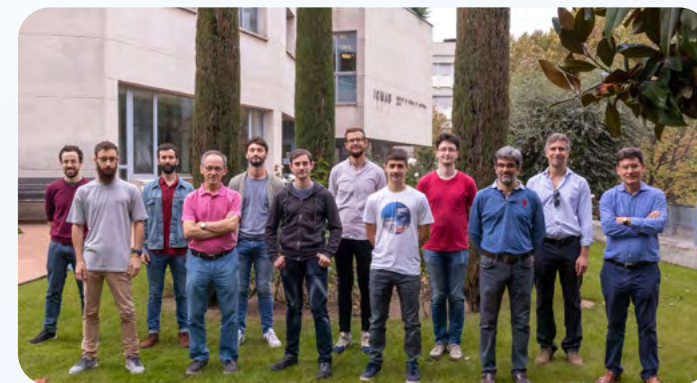
During 2020, the members of the group co-authored five works in high impact factor journals in the field of nanomaterials for environmental applications (energy storage, photocatalysis), and the already published works were cited about 200 times. A patent from the group was also awarded with the Gold Medal in PRO INVENT 2020.



Nanostructured Materials for Optoelectronics and Energy Harvesting (NANOPTO)

We use scientific knowledge to help provide clean energy by developing photovoltaic and thermoelectric technologies with new functionalized, low cost and higher environmental sustainability.

THEORY AND SIMULATION



Laboratory of Electronic Structure of Materials (LEEM)

We advance the state of the art in materials design by performing simulations for systems of technological relevance, and in turn by developing and implementing efficient computational methods.



Soft Matter Theory Group (SOFTMATTER)

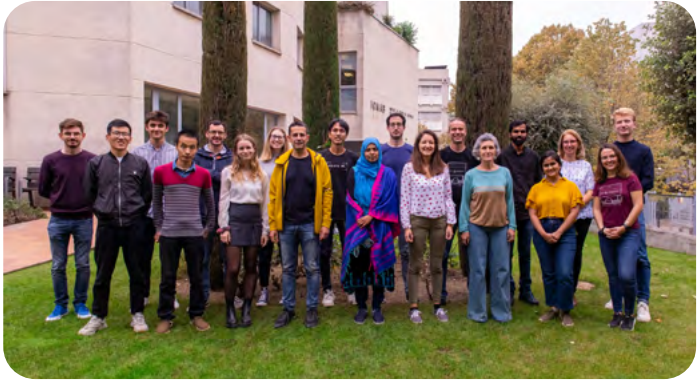
As a response to the world-wide COVID-19 pandemic, this year we added a new Research line about the interaction between SARS-CoV-2 virus and materials. We also continued on the planned Research in different aspects of Self-Assembly and SoftMatter.

SMART MOLECULAR INORGANIC AND HYBRID MATERIALS



Inorganic Materials and Catalysis Laboratory

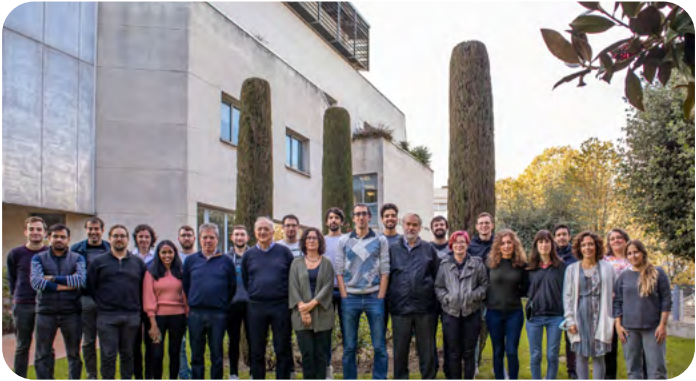
Our research has demonstrated that boron clusters are in many cases complementary to organic compounds in biomedical, materials or energy areas of research. The extraordinary stability is given by 3D-aromaticity. The new properties of these new materials along with the fact that they are not particularly expensive, foresee their applicability in many fields.



Nanoparticles and Nanocomposites Group (NN)

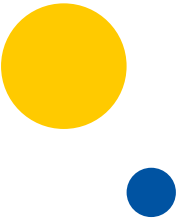
Our 2020 highlights are:
1.- Fundamental and applied research on bacterial nanocellulose,
2.- Reporting on new theranostic polymeric nanocarriers
3.- Advances on synthetic routes and structure/property studies of inorganic nanoparticles and finally
4.- Achieving microstructuration on epitaxial quartz on silicon.

SUPERCONDUCTING MATERIALS AND LARGE SCALE NANOSTRUCTURES



Superconducting Materials and Large Scale Nanostructures

Nanostructured superconductors and oxide materials understanding provide a path towards an energy sustainable world.



SOLID STATE CHEMISTRY



Solid State Chemistry (SSC)

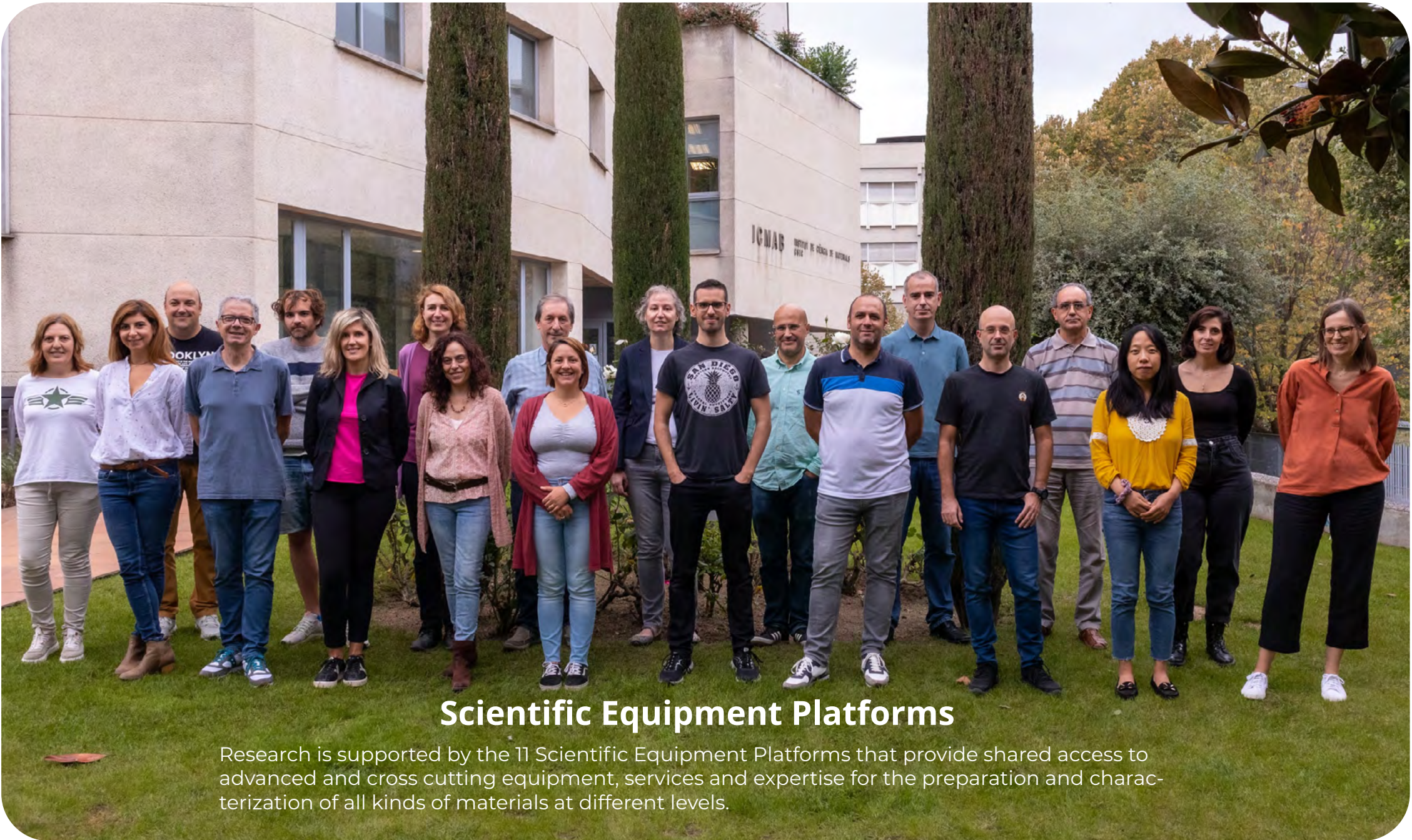
Activities have focused on the study of battery materials, the development of carbon nanomaterials and new porous nanostructures, the use of electrochemical methods for the synthesis and control of materials and the development of oxynitrides with new electronic properties.

MOLECULAR NANOSCIENCE AND ORGANIC MATERIALS (NANOMOL)



Centre of Nanotechnology and Molecular Materials (NANOMOL)

NANOMOL contributions have been focused to provide new molecule-based multifunctional advanced materials to be used in tissue engineering, in drug delivery and for the fabrication of electronic devices.



Scientific Equipment Platforms

Research is supported by the 11 Scientific Equipment Platforms that provide shared access to advanced and cross cutting equipment, services and expertise for the preparation and characterization of all kinds of materials at different levels.

Annual Report 2020

*Take a look at our Annual Report
2020 website to know more about
us, our research and activities:
annualreport2020.icmab.es*



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