RESEARCH INSTITUTE OF ADVANCED MATERIALS

Understanding and creating materials for a better future

Biennial report 2018- 2019

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1. Introduction

The Research Institute of Advanced Materials at the University Jaume I (Institute of Advanced Materials, INAM, www.inam.uji.es) is a center of research on interdisciplinary science and technology in the fields of physics, chemistry, and related fields, applied to advanced materials. INAM was created on 30th April 2015 by ***Generalitat Valenciana***. Our vision is **achieving a world class research center on the understanding and creation of materials, bringing scientific insight and producing advanced applications for a better future**.

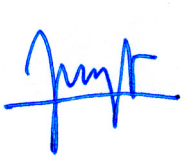
To reach this goal we work on physical chemical understanding of advanced materials properties and their operation, from molecules and interfaces to bulk compounds, connecting matter and light, to create new knowledge that bridges the gap between materials and devices. The fundamental and applied research at INAM is oriented at the frontier of knowledge with a global impact. INAM research teams aim at understanding and unravelling basic processes, the transformation of matter for useful purposes, as well as the physical and chemical interactions of molecules and materials. We pave the role for new functional materials that generate applications in clean energy supply and storage, lighting, and the creation of chemicals of high added value.

At the same time, INAM has established a strong program for realization of technological innovation, leading to activities that can transform knowledge into intellectual property for products of international impact and relevance in the global market. These activities are currently developed in the framework of the project ***Unitat Científica d'Innovació Empresarial*** (UCIE-INAM) funded by the Valencian Innovation Agency (AVI) with 250.000€ yearly with the principal aim of obtaining innovations that improve the productive model taking advantage of the innovative capacity of INAM researchers in the field of advanced materials. The aims of the UCIE-INAM are:

- Serve as the interface between the scientific teams and the industry
- Scan the industry needs and set the specific goals and projects of cooperation with industry.
- Develop active research for the transformation of scientific knowledge into technological results.

In combination of these strategies major infrastructure laboratories have been recently created to support both frontier science and upscaling of innovation for industry competitiveness.

Based on these perspectives here we present an outline of the main facts and results of INAM in the period 2018-2019. This period closes the first quadrennial research plan 2016-2019 of the Institute. It has been clearly a time of genesis of ideas, procedures, and consolidation of a new project by a set of ambitious researchers that need to establish a wider institutional framework. The combination of scientific excellence and new impulses for practical application has generated a shared project, and the growth in terms of projects and diversity of research areas is already visible. We believe we are in the right pathway for a community dedicated to world-class science and knowledge and also able to develop a significant impact in the much-needed solution of societal problems. INAM will take responsibility in the transformation of values by a decided contribution to clean and safe world and by the spread of education.



Juan Bisquert, director

2. Highlights

INAM Vision

Achieving a world-class research center on the **understanding** and **creation of materials**, bringing scientific insight and producing advanced applications for a better future.

INAM Mission

To reach this goal we work on **physical and chemical understanding** of the properties of advanced materials and their operation, from molecules and interfaces to bulk compounds, connecting matter and light, to create new **knowledge that bridges the gap between materials and devices**. We pave the way for new functional materials that generate applications in clean energy supply and storage, lighting, and the creation of chemicals of high added value.

The priorities of research

1. Understanding physical and chemical properties and operations of advanced materials, from molecules and interfaces to bulk matter.
2. Generate new knowledge that mediates the distance between materials and devices.
3. Develop new functional materials that generate applications in clean energy production and storage.
4. Exploiting the connection between light and matter for the development of devices and applications in the sectors of energy, lighting, sensing and chemical synthesis.
5. Create new chemical routes for the synthesis of products of high added value.
6. Transfer this knowledge to the industry to generate wealth and employment.

Main Research Areas

- Chemical synthesis
  Full equipment for molecular and materials synthesis: Molecules, quantum dots, nanoparticles, gels and polymers, bulk materials

- Advanced engineering & devices
  Technologies for the fabrication of films and coatings
  Multiple enabling technologies for continuous-flow manufacturing
  Ink-jet and 3D printing technologies
  Device fabrication: Solar cells, solar fuel production and lighting

- Structural & physicochemical characterization
  Facilities for structural and physicochemical analysis: Crystallinity, topology, composition, molecular structure, surface and textural characterization, testing, measuring and modeling.

- Opto-electronic characterization
  Full equipment for optical (Absorption, Fluorescence, Time-resolved luminescence, Quantum Yield…) and electrical characterization (voltammetry, impedance spectroscopy, solar simulator…).

- World class reputation
  Over the last years, some researchers at INAM have consistently ranked amongst the most renowned researchers in their own fields. In particular, as detailed below, researchers at INAM have demonstrated an excellent command in the characterization of optoelectronic devices by impedance spectroscopy, the preparation of perovskite-based solar cells and the study of the chemistry of N-heterocyclic carbene ligands.

- Impedance spectroscopy.
  The extensive and intensive application of impedance spectroscopy to the characterization of materials and devices is one of the main contributions of researchers at INAM to scientific community. This technique has been used in combination with theoretical models to unveil the physico-chemical processes of many different systems that range from photocatalytic materials (i.e. TiO_2, Fe_2O_3, $BiVO_4$, etc.) alone or in combination with specific catalysts (Ir_2O_3 or Co-Pi), solar cells of different kinds (silicon-based, Dye, quantum dot, organic, perovskites), microbial fuel cells, sensors, electron and hole conductors, etc. Remarkable properties characterized with this technique are the anomalous transport in nanoporous TiO_2, the introduction of the concept of chemical capacitance in semiconductors and the description of accumulation capacitance in perovskite-based solar cells. In terms of the development of tools to describe the performance of different systems, impedance spectroscopy has been used to describe the response of photocatalytic materials, the identification of surface states in hematite, modelling the electrical behavior of dye, QD and organic and solar cells (perovskite is on the way) and many other systems. It has been also described and evaluated the relevance of the resistive contributions from transport, charge transfer and recombination on the performance of these systems. Finally, the combined effect of the elements used in the impedance analysis have been used to describe the values obtained from other DC techniques as J-V curves or dynamic technics such as cyclic voltammetries or transient time responses. Many of these models and the physico-chemical concepts developed and tested using this technology have become standard characterization tools by researchers in these areas. Currently, we are extending the application of this technique to new fields (resistors, LEDs, enzymatic and Inmunosensors) and combining this technique with others such as Intensity Modulated Photocurrent Spectroscopy (IMPS) or Intensity Modulated Photovoltage Spectroscopy (IMVS) to decouple different electrochemical properties which otherwise are impossible to distinguish.

- Perovskite-based solar cells.
  Halide perovskites have revolutionized the optoelectronic field in the last decade due to their excellent optical and electrical properties and their high tolerance to the presence of chemical defects that allows their preparation using low cost processes with high performances. The chemistry of these perovskites allows for the replacement of elements in their formulation conferring to the materials a broad versatility for application-tailored properties. These facts have enabled their use not only in photovoltaic applications but also in other optoelectronic fields, such as light emitting diodes (LEDs), lasers or photodiodes. The INAM has been involved in the research of these materials and the devices formed with them since the outbreak of perovskite photovoltaics. INAM has

made important contributions on the field such as the discovery of the anomalous behavior of low frequency capacitance, the suppression of halide segregation in mixed halide perovskite nanoparticles or the perovskite phase stabilization with the use of PbS quantum dots. INAM is a world leading institution in the field of halide perovskite with publication of more than 100 research articles in the field and 2-4 researchers yearly listed within the top 1% most cited researchers worldwide (2014-2019, ISI Highly Cited Researchers). The clear interest of the work carried out in the field of halide perovskite by members of the INAM is reflected in more than 20 invited and keynote contributions in perovskite conferences provided by more than 5 members of INAM.

- N-heterocyclic carbene ligands (NHCs)
  rank among the most powerful tools in organic, inorganic and organometallic chemistry. Their ever-increasing applications range from the preparation of homogenous catalysts to the preparation of sophisticated metallosupramolecular assemblies. Willing to explore the wide possibilities offered by NHC ligands, the pioneering research group directed by Prof. Eduardo Peris has employed these ligands to move progressively from the design of simple catalysts for a wide range of organic transformations to unveil the importance of supramolecular tacking non-covalent interactions in homogeneously catalyzed reactions. The groups devoted to NHC-chemistry at INAM have achieved a worldwide reputation in the field over the last two decades. As an example, Prof. Eduardo Peris was invited as speaker at the *1st Stable Carbene Symposium* held at the University Paul Sabatier (Toulouse, France) in 2018.

- High impact research
  All researchers working at the INAM institute are committed to pursue high impact research. Evidence of this are the 145 peer-reviewed articles published in 2018-2019, which accumulated 1145 citations. This represents a 25% of the total number of citations of Universitat Jaume I during this period.

- Highly cited researchers and international awards
  The outstanding international reputation of INAM researchers is sustained by the consistent nomination in prestigious and elitist rankings. The INAM director Juan Bisquert has been a Highly Cited Researcher since 2014. The Highly Cited List indicates the 3000 persons with most influential research results across all disciplines and it is the basis for the calculation of Shanghai Academic Ranking of Universities, among others. Ivan Mora Seró is also included in this list since 2016. Germà Garcia Belmonte and Francisco Fabregat Santiago joined the list in 2018. Therefore, INAM has achieved the impressive result of 4 researchers in the Highly Cited List. Eduardo Peris is among the top 25 most-cited Spanish researchers in the field of Chemistry and has been awarded the prestigious Humboldt prize in 2019.

- European projects
  ERC No-Limit: Boosting photovoltaic performance by the synergistic interaction of halide perovskites and semiconductor quantum dots (Iván Mora-Seró)
  PEROXIS: Groundbreaking perovskite technologies for advanced X-Ray medical imaging systems (Germà Garcia-Belmonte)
  DROP-IT: Drop-on demand flexible optoelectronics and photovoltaics perovskites (Iván Mora-Seró)
  ALEAF: An artificial leaf, a photo-electro-catalytic cell from earth-abundant materials for sustainable solar production of CO_2-based chemicals and fuels (Juan Bisquert,

Sixto Giménez)
MAESTRO: Making perovskites truly exploitable (Francisco Fabregat-Santiago)

- Training activity
  INAM has a strong commitment to educate the new generations of outstanding researchers. We are eager to train PhD students in order to provide them the with skills and knowledge needed to boost their scientific careers. INAM also aims to encourage undergraduates to become members of the scientific community. By joining our institute, students are in contact with front-line science and technology, as well as having the opportunity to work in an inter-disciplinary research environment. INAM also ensures access to state-of-the-art equipment and highly specialized scientific personnel. Besides, INAM offers the opportunity to enjoy an international and multicultural working atmosphere, seeking to guarantee a good work-life balance.

- Training courses for undergraduate students.
  INAM offers two specific courses with ECTS credit recognition (cr) for undergraduate students, with a background in Chemistry and Chemical Engineering, during the second semester of each school year. These courses offer the opportunity to undergraduates to have a close contact with the activities performed at INAM and conduct research at the forefront of science in a multidisciplinary and international working atmosphere.

  1. Starting research course
  (30 hours, 1,5 cr, 1st year students)
  The objective of the course is to start and train attendees in the foundations of applied research in the field of renewable energies. In first place, a talk is given to the students to introduce them to the context of the current energy problem, the importance of renewable energies such as solar energy and the fundamentals of operation of the technology that will be developed during the course. Next, a research workshop is carried out. The student learns the basic characterization techniques of these devices. Finally, a report is prepared where the necessary skills for the development of research/technical reports will be developed.

  2. Renewable energies course
  (30 hours, 1,5 cr, 2nd and 3er year students)
  The objective of the course is to gain in-depth knowledge about catalytic and photo-active materials for energy harvesting from solar radiation. With a similar structure to the first course, students characterize their devices employing the basic characterization techniques used in research laboratories. Finally, a report is prepared where they train the skills in the preparation of technical and research reports.

- PhD Students training.
  The University Jaume I strongly supports doctoral training with a solid offer through a Doctoral School (https://www.uji.es/estudis/centres/escola-doctorat/). This training is based on the scientific career of the research groups that develop their activities in the campus. INAM, as a part of UJI, offers the opportunity to early-stage researchers enrolled in the Doctoral Program in Science to develop a scientific career in the field of Advanced Materials. This PhD program is designed to provide students with a broad and deep understanding on scientific topics related to Catalysis, Optoelectronics and Semiconductor Physics, setting the basis for a fruitful scientific career. Furthermore, the UJI Doctoral School offers a cross-disciplinary training program aimed at future

doctors in order to facilitate their development of transversal skills such as oral and written scientific communication, entrepreneurship and creation of technology-based companies.

INAM offers to PhD students the opportunity to attend to INAM seminars, which are regularly organized with invited prominent national and international speakers. INAM also offers complementary courses for PhD students on Impedance Spectroscopy School.

- Support to women in science

  The institute regards gender equality and creating equal opportunities as indispensable for facilitating this top-level research and attracting highly qualified scientists. We aim to attract more female scientists, and we are committed to increase the proportion of female scientists in permanent positions. This aim is realized by positive action measures including the preference for female scientists in equal CV conditions. The Institute takes measures in order to promote gender equality and equal opportunities integrated in the main principles described in the II Equality Plan (2016-2020) which has been developed by Universitat Jaume I. In addition, 4 gender equality measures are currently being developed:

  a) INAM participates as mentor in Erasmus+ Program from EU (E-STEAM ERASMUS project - Equality in Science, Technology, Engineering, Art and Mathematics)

  b) We are in negotiations for being part of Science by Women program coordinated by Foundation Women For Africa

  c) Mentoring young female scientists: INAMs PIs will mentor female postdocs and PhDs, who will also mentor graduate students.

  d) Training at Schools and High Schools: The Institute's female researchers will participate in the International Day of Women and Girls in Science.

3. The opinion of researchers

Some researchers (senior and students) at INAM have given testimonials of the impact that being a part of the institute have (or had) on their scientific careers:

Beatriz Julián-López (Principal Investigator at INAM, Associate Professor of Inorganic Chemistry)

I had the opportunity to join INAM as a founder member in 2015. The research at INAM is definitively being a beautiful experience since I can closely collaborate with outstanding researchers from different areas of chemistry, physics and engineering, all of them working on advanced functional materials for catalysis, photovoltaics, optoelectronics and energy. This interdisciplinary environment enriches my scientific vision and increases the impact of my research. Indeed, my research on the design of luminescent inorganic and hybrid materials has largely benefited from several fruitful cooperation with INAM colleagues and now it is more applied, and focused on lighting and solar fuels. For example, at present, I am participating in two H2020 European Projects on perovskites for flexible devices, and solar-driven CO2 reduction and conversion into added-value chemicals. Furthermore, we have launched a new research line on photoluminescent plastics for industrial applications targeting high technology readiness level (TRL). All these activities are possible due to the exciting environment, which has significantly influenced the quality of my research and my career development. In my opinion, the most attractive features of INAM relate to interdisciplinarity and cooperative spirit, rational management of resources, open-minded and world-recognized researchers, friendly atmosphere and passion for excellence.

Germà Garcia Belmonte (Principal Investigator at INAM, Full Professor of Applied Physics)

Germà Garcia Belmonte currently works as a Full Professor of Applied Physics (2010) at the Institute of Advanced Materials (INAM). He leads one of the original Research Divisions within the INAM since its creation in 2015. During the period 2018-2019, he has realized research activities in the fields of materials for energy storage (battery electrodes) and energy conversion (photovoltaics). He has conducted researches in the topic of perovskite-based solar cells. Device physics using impedance spectroscopy (including modeling and measuring) is his main subject. Convenient access to INAM facilities and full support from INAM technicians has allowed him to progress into the research lines. A total of three doctoral students has been supervised. As a consequence, a significant number of high-impact paper has been published. He has been listed as 2018 Highly Cited Researcher (Clarivate Analytics) in the cross-field category. Thanks to the interdisciplinary and excellent environment provided by INAM, he has managed to participate in a European project (H2020 program) on X-ray detection using perovskite compounds (PEROXIS).

Victor Sans Sangorrín (Principal Investigator at INAM, GenT fellow)

I joined the INAM in May 2019 to continue my career as an independent academic with the support of the Generalitat Valenciana and UJI through the program GenT (ca. €0.5M funding). From the very first moment, the INAM and the UJI have been extremely supportive of my activities. During the first year of my tenure, I have managed to establish a cutting-edge laboratory for the development of innovative and sustainable chemical manufacturing processes and to start a research group that is expected to grow this year to at least 3 members this year. The environment, facilities and colleagues have been excellent, supportive, inclusive and open-minded, and as a result I have manage to participate in 2 European projects and 1 large regional innovation and technology transfer project. This would not have been possible without the interdisciplinary and excellent environment provided by the Institute. Being part of INAM facilitates the streamlining of resources to maximise efficiency and enable the rapid translation of resources into tangible outputs. A significant number of joined high impact publications and subsequent project proposals are expected in the near future.

Gregorio Guisado-Barrios (MICINN-JIN post-doctoral fellow at INAM)

There are many key aspects that can aid to shape your future scientific carrier. I believe that your working environment is perhaps, one of most influencing ones. INAM was funded in spring 2015 and I have been working at this institution ever since. It is an interdisciplinary science and technology research center that counts with and all the state-of-the-art facilities and with experienced scientist which are internationally recognized such as Prof. Juan Bisquert (Director); Prof. Iván Mora (ERC-Consolidator Grant awarded) and Prof. Eduardo Peris (Humboldt Research Award recipient) all "ISI Highly cited". Thanks to its interdisciplinary nature and cooperative spirit, all groups are joining their efforts to develop more efficient photovoltaic devices, CO_2 conversion into liquid fuels and commodities for the chemical industry, sustainable hydrogen generation and storage to be used as an energy vector, active and smart devices manufactured by 3D printing, as well as ligand design, molecular recognition and supramolecular catalysis. I joined INAM as "Juan de la Cierva" Fellow working at the "Organometallic Chemistry and Homogenous Catalysis" (QOMCAT) research group leaded by Prof. E. Peris, where I had the opportunity to guide students at the undergraduate and postgraduate level from different nationalities. In addition, it gave me the opportunity to establish collaborations with other institutions and to secure funding from different agencies. Without a doubt, this period has been the most influential, maturing and memorable period as postdoctoral researcher.

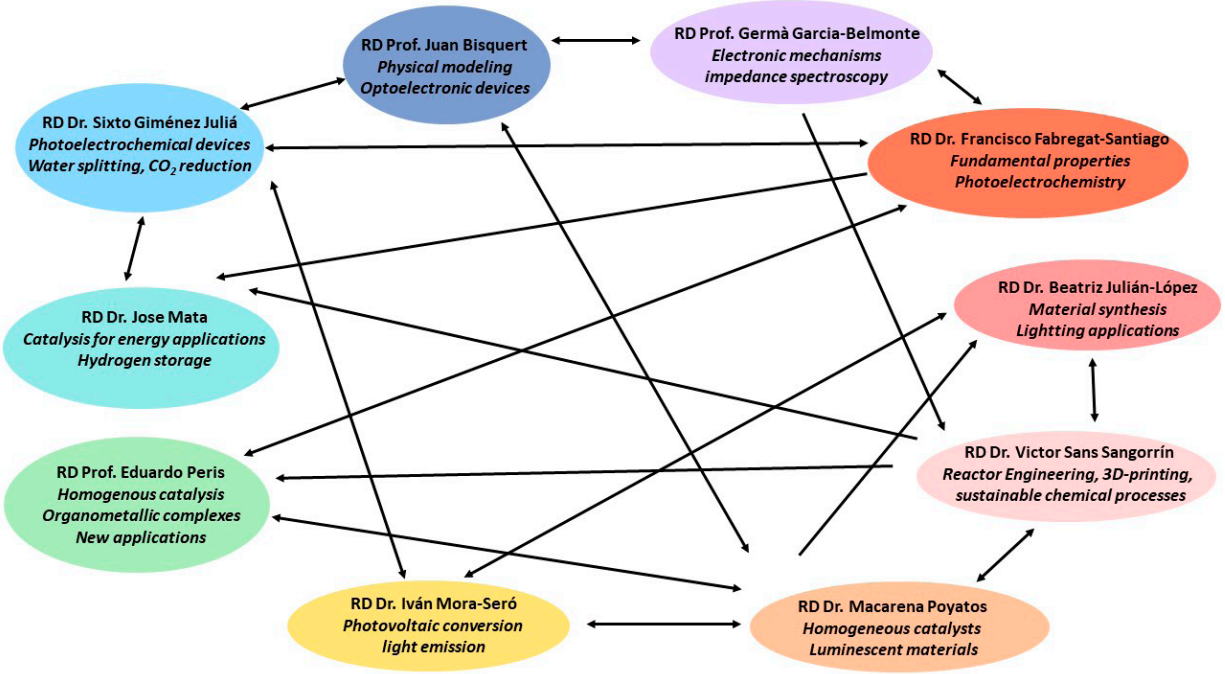
Drialys Cardenas Morcoso (PhD student at INAM)

I consider my experience at INAM as the launch point of my scientific career, and a fundamental stage of learning, maturity and development of essential skills for a future consolidation in the research field. I joined the INAM almost at the same

time of its inauguration, in September 2015, as a Grisolia granted pre-doctoral candidate under the supervision of Dr. Sixto Gimenez. The institute counts on a top-level scientific staff and the availability of the more advanced instrumental facilities that, joined to the dynamic research environment, has acquired a leading position as a highly prestigious research center of international impact. Their results are reflected in a large number of publications and citations in the fields of materials for solar energy conversion, sustainable fuels and added value compounds production, light-emission devices development and advanced molecular catalysis. In particular, I have had the opportunity to work in collaboration with prestigious researchers from the institute, as Prof. Juan Bisquert (Director) and Prof. Iván Mora-Seró (ERC-Consolidator Grant awarded), both "ISI Highly cited" scientists, in hot topics on the solar energy conversion field using advanced semiconductors materials. Moreover, I also had the opportunity to collaborate with recognized external researchers and institutions. This five years at INAM have brought me the possibility to participate in various national and European research projects, as well as several scientific congress, meetings and schools. In addition, I consider quite valuable the multicultural environment and the cooperative teamwork spirit. Therefore, I am convinced that this experience will allow me to develop a successful scientific career.

4. Interaction of research units

Representation of expertise of the Research Divisions and how they connect and complement each other. Interrelation of the different research lines/groups.



5. The strategic plan and research activities

The strategic plan for the period 2016-2019 was based on complementary sets of activities. The institute has developed a series of strategic lines of research that have concentrated the scientific activity. In addition, a plan for industrial innovation and technology transfer has been created, which provided the first results in 2019. The strategic plan of INAM for 2016-2019 included the following lines of action:

5.1. Thematic lines of research

- Advanced materials for energy conversion focusses on the development of materials for photovoltaic conversion, where the absorbed light is efficiently transformed into electricity or chemical fuel. The use of organic and inorganic materials and hybrids open opportunities beyond the materials present in the current photovoltaic market, in order to reduce costs and improve efficiencies. Special attention was paid to the physical processes that allow this energy conversion, as the special properties of each family of materials affect this conversion.

- Advanced materials for catalysis include activities related to the synthesis and characterization of molecular and solid materials with catalytic applications, for the production of organic molecules with high added value. This research front fulfills the requirements for the chemical industry from waste products or from raw chemical without any value.

- Advanced materials for light emission include the study of materials with luminescent properties, both photoluminescence and electroluminescence. A special interest in the light emission is to tune over a wide range of wavelengths from ultraviolet to infrared, visible through all be provided. The combination of materials for white light emission will also be studied.

5.2. Advanced research methods and tools

Regarding the methods and techniques, the strategic plan included the following lines of activities:

- New methods of synthesis and preparation of advanced materials and molecules. One of the main activities of the institute is the preparation of materials using novel synthetic or deposition methods, in the form of molecules, thin films and others.

- Models and simulation of materials and devices. Studies carried out from first principles to establish the physical properties of materials and interfaces. Moreover,

modeling and simulation of processes involved in the function of the devices are addressed: optical absorption, freight, cargo transfer, electrochemical reactions, etc.

- Design and optimization of interfaces, morphologies, nanostructures. The combination and morphologies of materials that can lead to the desired functionality. Study encompasses deposition methods and compatibility, contact formation, the study of load transfer interfaces, forming porous structures to increase the specific area, the functionalization and/or nanostructures sensitization.

- Structural characterization of materials, interfaces and devices. Complete structural characterization of materials and interfaces. This characterization allows us to relate the parameters of these processes with the methods of synthesis. Includes the extensive application of microscopies.

- Optoelectronic characterization of materials, interfaces and devices. A complete electrical, optical and physical-chemical characterization of materials and devices. This characterization is twofold, to understand the physico-chemical, photonic and electronic processes occurring in materials and devices.

5.3. Research lines of the strategic plan

The research activity has been focused on materials and devices for production and storage of clean energies, in particular photovoltaic devices, based on nanostructured metal oxides, semiconductor quantum dots, and organic conductors, and related applications such as luminescence. Our teams established an international reputation on the application of measurement techniques and physical modeling that relate device operation with the elementary steps that take place at the nanoscale dimension: charge transfer, carrier transport, chemical reaction, etc. An intense research activity has been also developed on the chemistry and catalytic applications of NHC-based organotransition metal catalysts. Most of the activity was devoted to the preparation of new catalysts for the activation of small molecules, paying special attention to processes implying the activation of C-H bonds, carbon dioxide, and reactions implying borrowing-hydrogen methodologies.

The main specific topics of research in the past few years were the following:

- Perovskite solar cells
- Quantum-dot solar cells and optoelectronics
- Solar fuel production using light absorbing semiconductors
- Characterization and modelling
- Molecular sensors and catalysts
- Molecular luminophores

6. Human resources and governance

The scientific and technological activities at INAM are organized by separate Research Divisions (RD), each one headed by experienced group leader (Principal Investigator, PI) with recognized scientific careers of great international impact. Interdisciplinary collaboration among researchers from different areas provides the ability to address novel research areas, thus allowing the emergence of innovative ideas and high-impact discoveries. Currently INAM is organized into 10 RD as follows:

Research Division	Staff	Postdoc	Predoctoral	Starting researcher	Admin/ technical staff	Total
Prof. Juan Bisquert	2	1	4	2		9
Prof. Eduardo Peris	1	1	1			3
Prof. Germà Garcia-Belmonte	1		3			4
Dr. Francisco Fabregat-Santiago	2	1	3			6
Dr. Jose Mata	1	1	1	1		4
Dr. Ivan Mora-Seró	1	5	7	1		14
Dr. Beatriz Julián	1		1	1		3
Dr. Sixto Giménez	1	1	2	0		4
Dr. Macarena Poyatos	1	1	1	2		5
Dr. Victor Sans	1		1			2
Total	**12**	**11**	**24**	**7**	**0**	**54**
Administration					2	2
Lab technicians					3	3
Innovation technicians					2	2
Total	**12**	**11**	**24**	**7**	**7**	**61**

Image 1. The members of the Advisory Board and the PIs of the different RDs

The management of the institute is established by a General Assembly that includes all members (according to membership rules established in the bylaws). The Governing Board is formed by the following members of the institute:

Director: Juan Bisquert
Deputy Director: Eduardo Peris
Secretary: Germà Garcia Belmonte

The directions of research at INAM are established by 4 years plans that indicate the purpose and direction of research objectives for the period. The activities of the Institute are evaluated from the perspective of the quadrennial plan by the Scientific Advisory Board, which is the regular organ for control and advice of the scientific activities of the institute. The composition of the Scientific Advisory Board at present is:

Prof. Miquel A. Pericàs, Institute of Chemical Research of Catalonia, Tarragona, Spain
Prof. James Durrant, Professor of Photochemistry, Imperial College, London, UK
Prof. Thuc-Quyen Nguyen, Professor of Chemistry and Biochemistry, University of California, Santa Barbara, CA, USA
Prof. Luis A. Oro, Instituto de Síntesis Química y Catálisis Homogénea, Dep. Inorganic Chemistry, University of Zaragoza-CSIC, Zaragoza, Spain.
Prof. Elisabeth von Hauff, Department of Physics and Astronomy, Vrije Universitat Amsterdam, The Netherlands.
Prof. Laura Lechuga Gómez, Institut Català De Nanociència i Nanotecnologia (ICN2), Universitat Autònoma de Barcelona, UAB Campus Bellaterra (Barcelona)

7. Summary of scientific results

7.1. Research highlights

All researchers working at the INAM institute are committed to pursue highly impactful research. The impact of the research of INAM members may be exemplified by the fact that in the 2018-2019 period INAM published 145 articles, which accumulated 1145 citations. These 1145 citations constitute a significant proportion (25%) of the total number of citations of Universitat Jaume I. It is also worth noting that 7 of these publications are rated as 'highly cited', according to the classification established by the Essentials Science Indicators, from Clarivate Analytics. This classification only includes just 1% of most cited papers. In addition, 32 out of these 145 publications were published in journals with an impact factor > 9.

The INAM Nature index (which is a well-accepted indicator of global high-quality research output and collaboration) reaches a significant 4.5 (from Dec 1 2018-30 Nov. 2019), a value that constitutes almost 50% of the total Nature index of Universitat Jaume I (9.25). Owing to the high impact of our work, the INAM has obtained an outstanding result in the Highly Cited international list, where four researchers of INAM have recently been included. The INAM director Juan Bisquert has been a Highly Cited Researcher since 2014. Ivan Mora Seró was awarded an ERC grant in 2017 and was also included in this list in 2016, due to major work on quantum dot and perovskite solar cells. In 2018, Germà Garcia Belmonte and Francisco

Fabregat Santiago also joined the list. Eduardo Peris is among the 25 most-cited Spanish researchers in the field of Chemistry. He has been recognized in 2019 with the prestigious Humboldt award.

Aiming for the sustained growth of the Institute, in 2019 the achievement of international impact has allowed for the attraction of talent supported by the research calls to bring excellent researchers to universities and research centers. Dr. Victor Sans Sangorrín (previously Associate Professor at the University of Nottingham) joined the INAM in May 2019 with a Distinguished Researcher CIDEGENT Fellowship from the *Generalitat Valenciana*. Noteworthy, the UJI has built a new laboratory for this new IP to establish his group. Novel methodologies will be developed for the direct translation of novel molecular and nanostructured materials with emerging properties into active devices with advanced and tailored geometries generated employing 3D printing.

7.2. Publications by journal impact factor

Impact Factor	Nº publications	Nº publications	Nº publications	Nº publications	Percentage
	2016-2017	2018	2019	2018-19	
>9	33	16	16	32	26
[3 to 9]	55	30	29	59	48
<3	18	12	19	31	25
	106	58	64	122	

7.3. Publications with highest impact factor

1. Smart N-Heterocyclic Carbene Ligands in Catalysis. E. Peris, Chemical Reviews, **2018**, 118, 9988-1003 (Impact factor **54.31**)

2. Key factors in pincer ligand design. E. Peris, R.H. Crabtree, Chemical Society Reviews, **2018**, 47, 1959-1968 (Impact factor **40.44**)

3. Quantum dot-sensitized solar cells. Z. Pan, H. Rao, I. Mora-Seró, J. Bisquert, X. Zhong, Chemical Society Reviews, **2018**, 47, 7659-7702 (Impact factor **40.44**)

4. Selective growth of layered perovskite for stable and efficient photovoltaics. K.Taek Cho, G. Grancini, Y. Lee, E. Oveisi, J. Ryu, O. Almora, M. Tschumi, P. Schouwink, G. Seo, S. Heo, J. Park, J. Jang, S. Paek, G. Garcia-Belmonte, M. Khaja Nazeeruddin, Energy & Environmental Science, **2018**, 11 , 952-959 (Impact factor **33.25**)

5. Kinetic and material properties of interfaces governing slow response and long timescale phenomena in perovskite solar cells. H. Wang, A. Guerrero, A. Bou, A.M. Al-Mayouf, J. Bisquert, Energy & Environmental Science, **2019**,12, 2054-2079 (Impact factor **33.25**)

6. 3D Printable photochromic molecular materials for reversible information storage, D.J. Wales, Q. Cao, K. Kastner, E. Karjalainen, G.N. Newton, V. Sans, Advanced Materials, **2018**, 30, 26, 1800159 (Impact factor **25.81**)

7. Device Physics of Hybrid Perovskite Solar cells: Theory and Experiment, P. Lopez-Varo, J. Antonio Jiménez-Tejada, M. Garcia-Rosell, S. Ravishankar, G. Garcia-Belmonte, J. Bisquert, O. Almora, Advanced Energy Materials, **2018**, 10.1002/aenm.201702772 (Impact factor **24.88**)

8. Switching off hysteresis in perovskite solar cells by fine-tuning energy levels of extraction layers. A. Guerrero, A. Bou, G.J. Matt, O. Almora, T. Heumüller, G. Garcia-Belmonte, J. Bisquert, Y. Hou, C.J. Brabec, Advanced Energy Materials, **2018**, 1703376 (Impact factor **24.88**)

9. Flash infrared annealing as a cost-effective and low environmental impact processing method for planar perovskite solar cells, S. Sanchez, M. Vallés-Pelarda, J.A. Alberola-Borràs, R. Vidal, J.J. Jerónimo-Rendón, M. Saliba, P.P. Boix, I. Mora-Seró, Materials Today, **2019**, 31, 39-46, 86 (Impact factor **24.37**)

10. 1H-1,2,3-Triazol-5-ylidenes: Readily Available Mesoionic Carbenes. G. Guisado-Barrios, Accounts of Chemical Research, **2018**, 51, 12, 3236-3244, 85 (Impact factor **21.66**)

7.4. Most cited publications[b]

1. Smart N-Heterocyclic Carbene Ligands in Catalysis. E. Peris, Chemical Reviews, **2018**, 118, 9988-10031 (number of citations **220**)

2. Selective growth of layered perovskites for stable and efficient photovoltaics. K. T. Cho, G. Grancini, Y. Lee, E. Oveisi, J. Ryu, O. Almora, M. Tschumi, P. A. Schouwink, G. Seo, S. Heo, J. Park, J. Jang, S. Paek, G. Garcia-Belmonte, M. K. Nazeeruddin, Energy & Environmental Science, **2018**, 11, 952-959 (number of citations **74**)

3. Quantum dot-sensitized solar cells. Z. Pan, H. Rao, I. Mora-Sero, J. Bisquert, X. Zhong, Chemical Society Reviews, **2018**, 47, 7659-7702 (number of citations **75**)

4. Key factors in pincer ligand design. E. Peris, R. H. Crabtree, Chemical Society Reviews, **2018**, 47, 1959-1968 (number of citations **67**)

5. Device Physics of Hybrid Perovskite Solar cells: Theory and Experiment. P. Lopez-Varo, J. A. Jimenez-Tejada, M. Garcia-Rosell, S. Ravishankar, G. Garcia-Belmonte, J. Bisquert, O. Almora, Advanced Energy Materials, **2018**, 8, 1702772 (number of citations **48**)

6. Influence of Charge Transport Layers on Open-Circuit Voltage and Hysteresis in Perovskite Solar Cells. S. Rayishankar, S. Gharibzadeh, C. Roldan-Carmona, G. Grancini, Y. Lee, M. Ralaiarisoa, A. M. Asiri, N. Koch, J. Bisquert, M. K. Nazeeruddin, Joule **2018** 2 788-798 (number of citations **41**)

7. Quantification of Ionic Diffusion in Lead Halide Perovskite Single Crystals. W. Peng, C. Aranda, O. M. Bakr, G. Garcia-Belmonte, J. Bisquert, A. Guerrero, ACS Energy Letters, **2018**, 3 1477-1481 (number of citations **32**)

8. Unravelling the role of vacancies in lead halide perovskite through electrical switching of photoluminescence. C. Li, A. Guerrero, S. Huettner, J. Bisquert, Nature Communications **2019**,

b The number of citations has been consulted in the Web of Science the 1st of April 2020

5113 (number of citations **30**)

9. 3D Printable photochromic molecular materials for reversible information storage, D.J. Wales, Q. Cao, K. Kastner, E. Karjalainen, G.N. Newton, V. Sans, Advanced Materials, **2018**, 30, 26, 1800159 (number of citations **28**)

10. Selective CO2 Hydrogenation to Formic Acid with Multifunctional Ionic Liquids, A. Weilhard, M. I. Qadir, V. Sans, J. Dupont, ACS Catalysis, **2018**, 8, 1628–1634 (number of citations **26**)

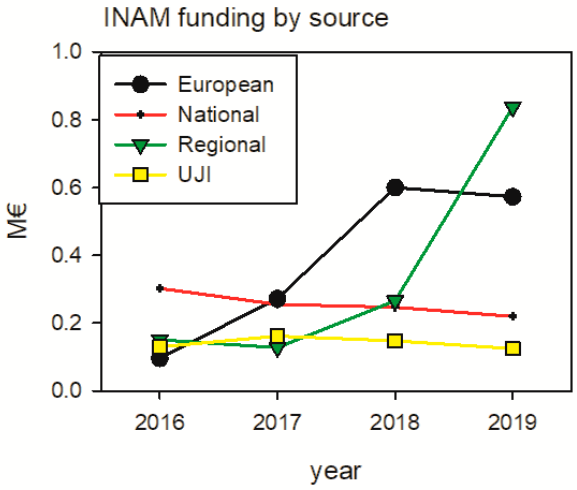
11. Discerning recombination mechanisms and ideality factors through impedance analysis of high-efficiency perovskite solar cells. O. Almora, K. T. Cho, S. Aghazada, I. Zimmermann, G. Matt, C. J. Brabec, M. K. Nazeeruddin, G. Garcia-Belmonte, Nano Energy, **2018**, 4863-72 (number of citations **22**)

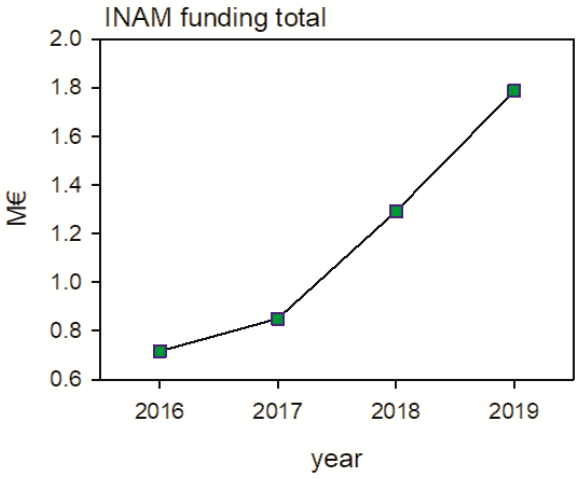
12. Impedance Spectroscopy Measurements in Perovskite Solar Cells: Device Stability and Noise Reduction. D. Pitarch-Tena, N. T. Thi, M. Valles-Pelarda, T. Pauporte, I. Mora-Sero, ACS Energy Letters, **2018**, 3, 1044-1048 (number of citations **21**)

13. Switching Off Hysteresis in Perovskite Solar Cells by Fine-Tuning Energy Levels of Extraction Layers. A. Guerrero, A. Bou, G. Matt, O. Almora, T. Heumueller, G. Garcia-Belmonte, J. Bisquert, Y. Hou, C. Brabec, Advanced Energy Materials **2018**, 8, 1703376 (number of citations **21**)

8. Financial Report

8.1. Distribution of funding by sources





8.2. Summary of funded projects

International Funding

Organization	Acronym, abstract	Principal Investigator
European Research Council	**No-Limit:** Boosting photovoltaic performance by the synergistic interaction of halide perovskites and semiconductor quantum dots	Iván Mora-Seró
European Commission	**PEROXIS:** Groundbreaking perovskite technologies for advanced X-Ray medical imaging systems	Germà Garcia-Belmonte
European Commission	**DROP-IT:** Drop-on demand flexible optoelectronics & photovoltaics perovskites	Iván Mora-Seró
European Commission	**ALEAF:** An artificial leaf: a photo-electro-catalytic cell from earth-abundant materials for sustainable solar production of CO2-based chemicals and fuels	Juan Bisquert, Sixto Giménez
European Union	**MAESTRO:** Making perovskites truly exploitable	Francisco Fabregat-Santiago

National Funding

Organization	Acronym, abstract	Principal Investigator
Ministerio de Ciencia e Innovación	**VALPEC:** Síntesis de productos de alto valor añadido mediante sistemas fotoelectrocatalíticos avanzados	Francisco Fabregat-Santiago, Sixto Gimenez
Ministerio de Ciencia e Innovación	**SUPRACAT:** Supramolecular Organometallic Structures for Catalysis and Molecular Recognition	Eduardo Peris y Macarena Poyatos
Ministerio de Economía y Competitividad	**FG-Cat:** Funcionalización de grafeno con complejos metálicos definidos en transformaciones catalíticas sostenibles: Almacenamiento de hidrógeno y conversión de biomasa	Jose Mata
Ministerio de Economía y Competitividad	**CATSURGRAPH:** Catalytic applications of organometallic complexes immobilized on the surface of graphene	Jose Mata
Ministerio de Economía y Competitividad	**PEREST:** Perovskitas fotovoltaicas de alto rendimiento	Juan Bisquert, Germà Garcia-Belmonte
Ministerio de Economía y Competitividad	Ramón y Cajal	Antonio Guerrero
Ministerio de Economía y Competitividad	Ayudas Juan de la Cierva-Incorporación	Eduardo Peris
Ministerio de Economía y Competitividad	**GRAPHCAT:** Catalytic applications of organometallic complexes immobilized on the surface of graphenes	Jose Mata
Ministerio de Ciencia e Innovación.	**Red Perovskita:** Perovskitas para conversión de energía solar y optoelectrónica	Juan Bisquert

Regional Funding

Organization	Acronym, abstract	Principal Investigator
Generalitat Valenciana	**CIDEGENT:** Integrating Design Across the Scales (IDEAS): from molecules to active devices with additive manufacturing	Victor Sans Sangorrin
Generalitat Valenciana	**UCIE INAM:** Creación de una unidad científica de la innovación empresarial en el INAM de la Universitat Jaume I	Juan Bisquert
Generalitat Valenciana	**IDIFEDER:** Síntesis de combustibles y valoración de aguas residuales a partir de energías renovables	Juan Bisquert
Generalitat Valenciana	**Q-DEVICES:** Sistemas cuánticos para el desarrollo de dispositivos optoelectrónicos	Iván Mora-Seró
Generalitat Valenciana	**NHCsforLIGHT:** Complejos poliaromáticos de Au(I) alquinilo: síntesis y propiedades fotofísicas	Macarena Poyatos

Local projects from UJI

Organization	Acronym, abstract	Principal Investigator
Universitat Jaume I. UJI	**DEPE2D:** Desarrollo de perovskitas bidimensionales (2D) para la mejora del transporte electrónico en dispositivos fotovoltaicos de alta estabilidad	Eva Mª Barea
Universitat Jaume I. UJI	**FOTOSIN:** Desarrollo de rutas fotoelectrocatalíticas para la síntesis de productos de alto valor añadido	Elena Mas Marzá
Universitat Jaume I. UJI	**SOLENPE:** Soluciones Inteligentes para la energía eléctrica basadas en dispositivos de células solares de perovskitas	Eva Mª Barea
Universitat Jaume I. UJI	**GRAPH@ORG:** Development of hybrid nanomaterials based on graphene@ organometallic complexes: Catalytic applications at the edge of homogeneous/ heterogeneous processes	Jose Mata
Universitat Jaume I. UJI	**CatLOHCs:** Design of catalysts for the development of efficient energy storage systems based on liquid organic hydrogen carrier	Jose Mata
Universitat Jaume I. UJI	**NENUPhAR:** New ENhanced Up-converting Photonic ARquitectures for advanced applications	Beatriz Julian-Lopez
Universitat Jaume I. UJI	**TRESCOPE:** Transformación de energía Solar en combustibles solares a partir de perovskitas	Antonio Guerrero
Universitat Jaume I. UJI	**SUPRACAT:** Nanoestructuras metalo-orgánicas para catálisis y reconocimiento molecular	Eduardo Peris
Universitat Jaume I. UJI	**PINCERCAT:** Diseño de ligandos NHC poliaromáticos capaces de coordinar en forma bis-pinza. Propiedades catalíticas y fotofísicas	Macarena Poyatos

Contracts with companies

Organization	Acronym, abstract	Principal Investigator
Keraben	**RADIAKER:** Estudio de materiales y recubrimientos avanzados para el enfriamiento de edificios.	Juan Bisquert

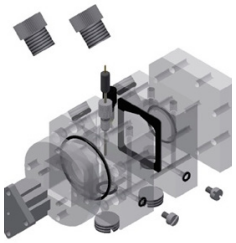
9. Equipment and instrumentation

A landmark result in 2019 was the achievement of the first integrated project. This project *Síntesis de combustibles y valoración de aguas residuales a partir de energías renovables* was prepared by a large team at INAM in cooperation with ITC (*Institut de Tecnologia Ceràmica at UJI*) under the call IDIFEDER, *Generalitat Valenciana, Convocatoria de ayudas para infraestructura y equipamiento de I+D+I PO FEDER 2018-2020*. It was awarded an amount of 600.000 euro (IDIFEDER/2018/012) coordinated by Juan Bisquert for the period 2018-01-01 to 2020-12-31.

The aims of this joint project can be outlined in two main topics of research:

1. Synthesis by electrochemical means of liquid and/or gaseous fuels (hydrogen, methane, ethanol) that act as an energy reserve when the renewable resource is not available
2. Development of new electrochemical applications for the treatment of wastewater that allows recovering and/or reusing as much as possible strategic metals. The funds of this project have been entirely devoted to infrastructure, that will support the technology transfer and will also expand the scientific activities of the Institute. To this end, a general-purpose laboratory has been created for all scientists of INAM and their associates. This laboratory is named “Photo-electrochemical reactor for the generation of solar and high added value chemicals”.

Pictures of the new equipment of the “Photo-electrochemical reactor for the generation of solar and high added value chemicals” Laboratory:



10. Benchmarking of the institute

In order to evaluate some major research output parameters, we took a set of selected Spanish reference research institutions, all of them Maria de Maeztu (MdM) Excellent Units.

ICMOL: Instituto de Ciencia Molecular (Valencia)
IFISC: Instituto de Física Interdisciplinar y Sistemas Complejos (Palma de Mallorca)
IFCA: Instituto de Física de Cantabria
IQTCUB: Institut de Química Teòrica i Computacional-Universitat Barcelona.

Table 1 shows a comparative study of reference data and Table 2 shows a comparative study that includes the bibliometric data and some other parameters that can be used for assessing the quality of the research output of the selected centers.

Table 1. Budget, size and scientific productivity of the five selected unitsa

	ICMOL	IFISC	IQTCUB	IFCA	INAM UJI
Budget[c]	>10	2,1	Not available	4,7	1,3
Staff/ Researchers	260	76	85	86	52
Publications[d]	108	73	98	202	49
Thesesa[c]	4	1	9	1	3
Publications/ staff	0,41	0,96	1,15	2,34	1,44
Budget/staff (€)	38400	27600	--	54600	25000
Budget/ publications (€)	>92000	28767	--	23267	26000

Table 2. Benchmarking of the unit against other centers/unitsa

Research center	Number publications[e]	Number citations[e]	h-index[e]	Citations/ article[e]	Citations/ staff	Highly cited researchers[f]	Nature indexd[g]
INAM-UJI	245	5413	37	22,09	104	4	4,45
ICMOL-UV	479	4898	33	10,23	18	0	18,54
IFISC	291	2060	21	7,08	27	0	3,86
IFCA	671	13638	53	20,32	158	0	1,31
IQTCUB	449	3964	24	8,83	76	0	3,11
Average	427	4955	34	13,71	76	0,8	6,1

c Budget in millions of euros.
d Data referred to 2019, taken from the annual reports published by each MdM unit.
e Data obtained from the Web of Science (02/12/2019)
f Data obtained from Clarivate analytics, referred to 2018.
g Data obtained from the Nature index webpage, referred to articles published in 2018. Values in bold represent the largest ones.

All the reference research units are long-existing institutions with a much larger number of researchers (the INAM has now 52 researchers), and much larger funding resources (see Table 1). This explains that the bulk number of publications produced during the last five years by members of INAM lie below the average number of publications produced by the members of the MdM units used in this comparison.

INAM is undoubtedly leading the only parameter that measures the relative impact of the scientific productivity of all five units: the **number of citations/article (22,09)**, by far the largest found for all five institutions. Another important parameter is the **number of highly cited researchers**, according to the 2019 highly-cited list provided by Clarivate-Analytics. Again, INAM is the highest ranked center, with four highly-cited researchers. None of the rest units has a single highly cited researcher among their members. Together with this, INAM occupies the second position in the number of citations and h-index, in both cases just behind IFCA. We also consider important to mention that the number of citations of INAM during the period of study (5413), is significantly larger than that provided by ICMOL during the same period (4898), despite the large differences in funding and human resources between these two institutions. With regard to the Nature index, as shown in Table 2, INAM provides the second highest number, just after ICMOL.

Of particular interest are the data shown in Table 1, which compare the relative productivity of each unit, averaged by the number of staff members and research funding. INAM institute is clearly the unit with the lower funding per researcher, but despite this fact, its productivity compares well with that shown by all other institutions. In fact, the cost per publication is the second lowest one, only after the cost of publications by IFCA. The cost per publication by IFCA must be taken with care given that most publications by this institution are collaborative studies that involve more than one research institution, therefore the global cost per publication is considerably larger than the number shown in Table 1. The number of 104 citations per capita of INAM shown in Table 1 is impressive.

If we look at the absolute numbers, clearly the IFCA dominates three out of the six parameters shown in Table 2. These parameters are the bulk number of publications, number of citations and h-index. However, it has to be pointed out that IFCA produces a large amount of publications in collaboration with other international research centers. This makes that the number of authors/article is often larger than 20, with a low percentage of them belonging to this MdM unit. Therefore, the relative bulk production of IFCA must be considered with care. ICMOL has an outstanding contribution in terms of bulk number of articles published, and has the largest Nature index. Again, we need to consider the size of ICMOL compared to INAM, to understand that these bulk numbers need to be considered carefully.

In summary, by comparing six productivity parameters among all five units, INAM shows the highest numbers in two of them (citations/article and highly-cited researchers), and is the second largest one in three out of all these six parameters (number of citations, h-index and Nature index), outstanding values for a non-MdM unit. Despite the relatively small size of INAM, it is clear that the scientific contributions are distributed over a varied research time, and not by a single personality, as shown by the fact that four researchers have reached the level of Highly Cited Scientist, by the high number of citations per capita, and by the numerous invited and keynote talks in international conference of all principal investigators of the research unit.

11. The program of technology and innovation

After the first couple of years of operation of the institute, it became obvious that the production of excellent science with outstanding international impact was not matched by a similar rate of the correspondent development of practical results represented by patents and contracts with industry and creation of spin-off companies. Therefore, the management organisms of the institute established appropriate actions to promote the realization of technology and innovation. The priority is that the extensive knowledge of materials in INAM can be transformed into scalable applications in an industrial version, leading to effective innovations. In the initial phase of the strategy, the main factor is the realization of effective R&D work, aimed at carrying out programmed projects that allow obtaining visible results. Based on these innovations, we can begin a generic dialogue with the industrial environment, having already concrete demonstrators that present our capacity for invention and realization. At the same time, we must promote connections with the industry, in order to obtain information on objectives that have a market interest.

In a first step, we have established a detailed strategy that will ensure the realization of technological innovation in connection with the industries of the region, leading to activities that can transform knowledge into intellectual property for products of international impact and relevance in the global market. This objective is strongly aligned to the regional development objectives by the Valencian Government, which have recently awarded INAM with major projects for developing such strategy. RIS3 (Research and Innovation Smart Specialization Strategy) refers to the productive/corporate focus of a region, in our case the Valencian Community, in potentially competitive areas and development generators in the context of a global context. Within the RIS3-CV, the INAM activity focuses mainly on the objectives of:

- The progress in productivity and competitiveness of the industry.
- The development of new sectors and products or services that incorporate more content of technology and innovation.

The organizational structure to achieve these research and innovation goals, took the form of a project called *Unitat Científica d'Innovació Empresarial* (UCIE) at the INAM, with the principal aim of obtaining innovations that improve the productive model taking advantage of the innovative capacity of INAM researchers in the field of advanced materials. This project is funded by the Valencian Innovation Agency (AVI) with 250.000€ yearly (2019 and 2020). AVI is considered the meeting point of all the agents that are part of the Valencian Innovation System such as universities and higher research centers, technological institutes, centers of health research, financial institutions, public administrations and the entire business community of the Valencian Community. In 2019 the technology projects have been the following:

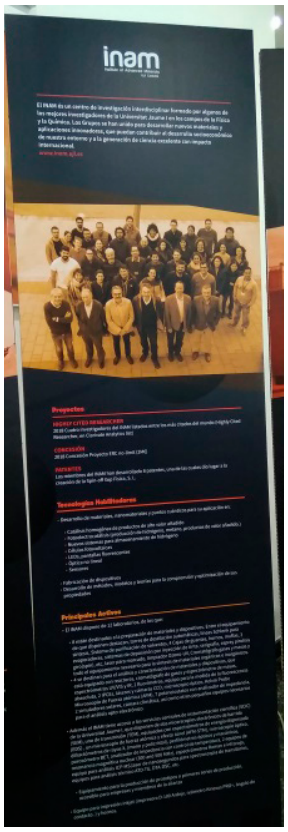
- Catalytic electrodes for industrial applications.
- Ceramic materials functionalization.
- Photoluminescent materials.

UCIE scientific workshops

November 2019

December 2019

INAM participated in the II #TECH4CV workshop, presenting the results obtained in UCIE project

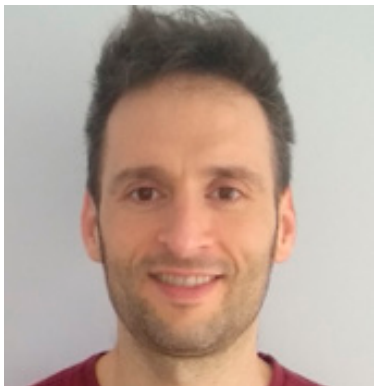


12. Training and employment

Training

INAM is aware of the importance of early-stage training, with the aim to prepare a new generation of outstanding scientists and technicians. During the period 2018-2019, the institute has trained researchers at different levels, from undergraduate to post-doctoral researchers. During this period, 13 students were enrolled in the two courses that we offer for undergraduates, 6 Master students did their experimental training at the institute and 5 undergraduates worked at the institute with a fellowship or contract for final year students. Concerning PhD students, 23 students have been developing their scientific career at the institute, completing their thesis 6 of them during this period. Additionally, 9 post-doctoral researchers have been working and trained at the institute during these two years. Besides, we have also hosted 37 visitors (more than 20 different nationalities) in this period, who have developed and broadened their knowledge at the institute in a multicultural and inter-disciplinary research environment.

Employment



Rafael Sánchez Sánchez (post-doctoral researcher at l'Institut des Sciences Moléculaires, ISM, Université de Bordeaux)

In 2012, I joined the Institute of Advanced Materials (INAM) as a postdoctoral researcher under the supervision of Prof. Juan Bisquert and Dr. Iván Mora, where I developed my research activity for five years. My main tasks were focused on the synthesis and electro-optical characterization of inorganic and hybrid organic/inorganic semiconductors for the construction of optoelectronic devices, principally solar cells and light emitting diodes (LEDs). The overall goals of my research were not only aimed at the development of innovative low-cost and efficient technologies, but also at elucidating the physicochemical mechanisms that determine the performance of the complete devices. My stay at INAM served as a valuable launch platform for enhancing my scientific career in several aspects; on one hand, the daily interaction with the internationally recognized scientists working at this institute allowed me to notably improve my scientific-technical skills and knowledge. On the other hand, the strong internationalization of the institute aided me to build up a fruitful contact network that boosted my visibility in the scientific community, which has permitted me to join prestigious research institutions after the completion of my activity at INAM

Sandheep Pulya Ravishankar (post-doctoral researcher at Forschungszentrum Juelich in Germany)

I spent a total of 5 years at INAM, completing a Masters degree in applied physics and a doctorate researching the physics of perovskite solar cells. During this time, I acquired the necessary skills that allowed me to enter the world

of academia, to frame and tackle complex research problems and thereafter, effectively disseminate the results obtained in the form of scientific publications. The interdisciplinary nature of the energy research at INAM provided me with knowledge and expertise in topics that are generally at the interface of physics, chemistry and materials science, which is hard to obtain from regular sources. Several collaborations with teams within INAM and other international groups in addition to the opportunity to attend several international conferences provided me with a broad range of experiences, scientific viewpoints and expertise to learn from. The above-mentioned points, in addition to the friendly and encouraging work atmosphere at INAM, allowed me to carry out influential work that was well received by the international community and complete my doctorate successfully, subsequently leading to a postdoctoral research position at Forschungszentrum Juelich in Germany.

Sergio Gonell Gómez (Marie-Curie post-doctoral fellow at ICIQ)

I received my PhD at the Universitat Jaume I in 2015, under the supervision of Prof. Eduardo Peris and Dr. Macarena Poyatos. Part of my PhD Thesis was performed at the Institute of Advanced Materials (INAM), a research institution clearly committed with excellence in science form the early stages of it foundation. Therefore, I could benefit from a multidisciplinary atmosphere, involving a variety of research groups working in different topics, including inorganic synthetic chemistry, catalysis, materials science and photoelectronics. This period at INAM encouraged me to pursue an academic career. After defending my PhD Thesis, I worked as a post-doctoral researcher in the group of Prof. Joost Reek at the University of Amsterdam (The Netherlands), one of the pioneering groups in the field of supra-molecular catalysis. Next, I moved to the University of North Carolina in Chapel Hill in Chapel Hill (USA), where I worked in the group of Prof. Alexander Miller under the Marie Sklodowska-Curie Global program. There, my research focused on unraveling mechanistic aspects of electrocatalysts for CO2 conversion to profitable fuels. Right now, I am working at the Institute of Chemical Reasearch of Catalonia (ICIQ) in the return phase of the Marie Sklodowska-Curie grant.

Teresa Ripolles Sanchis (researcher at University Rey Juan Carlos)

I actively participated in the group led by Prof. Bisquert from 2009 to 2014. Firstly, I started a collaboration scholarship, then I obtained my Master's Degree in Molecular Nanoscience and Nanotechnology, and, I completed my PhD program in Nanoscience and Nanotechnology under the supervision of Prof. Garcia-Belmonte and Dr. Guerrero. During my PhD, the Institute of Advanced Materials (INAM) was at the begging of its foundation. Here, a number of research groups with solid reputation created a research institute at University Jaume I with a clear vision to support high-level investigation. Having experience in this institute, I got knowledge not only about science but also about management, which leads me to where I am today with an independent career. I had opportunities to visit several international groups and to attend many conferences around the world, mainly, Italy, Taiwan, and the US. Due to

this international vision, I worked at Kyushu Institute of Technology in Japan as Assistant Professor for 4 years. Here, I got a Japanese research grant, Grant-in-Aid for Scientific Research, as a principal investigator for Young Scientists for 2 years. Currently, I am working at University Rey Juan Carlos as a researcher under the program 'Atracción de Talento' by the Community of Madrid. Recently, I got a Young Scientist research grant supported by Community of Madrid as principal investigator for 2 years.

13. Interaction with socioeconomic environment

Outreach activities in 2018

- European Night of Science, the group of Iván Mora-Seró showed its main research lines to the general audience with other groups of UJI.

- Juan Bisquert participated in the ACS Campus activities in Barcelona, as a Senior Editor of the Journal of Physical Chemistry Letters.

- Introduction course for 1st year students at the UJI. The aim of the course is to initiate and train attendees on the basic concepts of applied research in the field of renewable energy.

- Members of INAM participating in the Fair Firujiciencia organized by UJI where they did a workshop dedicated to the production, storage and consumption of energy. Demonstrators with photovoltaic cells, high and low efficiency LEDs, motors, electrolyzers and fuel cells have been used to introduce concepts such as the conversion of light into electricity, the electrolysis of water for production hydrogen, the use of hydrogen as fuel or efficient consumption to students.

- Official presentation at University of INAM results during the period 2016-2017.

- Promotion of Video demonstration of a prototype hydrogen car with LOHCs. Researchers at the INAM have successfully developed and tested a prototype at the car scale that safely stores and generates hydrogen and is able to use it as fuel. Hydrogen is stored in the form of chemical bonds through an organic fluid that carries hydrogen as a result of the combination between a silane and an alcohol. This organic liquid, in the presence of a catalyst, allows the hydrogen generation in a fast and controlled way.

- Members of INAM participating in the Fair Firujiciencia organized by University of Murcia. Members of INAM participated in 2 workshops dedicated to energy production, storage and consumption. Demonstrators with photovoltaic solar cells, motors, electrolyzers, fuel cells have been used to introduce concepts such as the conversion of light into electricity, the electrolysis of water by hydrogen production, the use of hydrogen as fuel and efficient consumption.

Outreach activities in 2019

- Participation at the exhibition “They have the formula”, a sample of the contribution of women to the development of Chemistry. The initiative was presented by Eduardo Peris, Professor of Inorganic Chemistry at the UJI, and scientific advisor to the Science Museum of Valencia, who has been actively involved in drafting the list of researchers and writing the reviews of the scientists.

- Members of INAM participating in the Fair Firujiciencia organized by UJI. INAM members participated in 3 workshops dedicated to the production, storage and consumption of energy. Demonstrators with photovoltaic solar cells, LEDs, quantum dots, motors, electrolyzers, fuel cells have been used to introduce concepts such as the conversion of light into electricity, the electrolysis of water for the production of hydrogen, the use of hydrogen as fuel, photoluminescence or efficient consumption.

- Juan Bisquert and Sixto Giménez Director of INAM participated in the Fair DESTACA organised by UJI.

- Juan Bisquert, Director of INAM participated in writing the article “Perovskite, the true for the future of renewable energy” promoted by Mapfre Global Risk.

Beatriz Julián, Sixto Giménez and Francisco Fabregat, senior researchers at INAM participated in the 1st edition of the Scientific Fair held in the city of Cieza (Murcia) on February 16, 2019. The event was organized by the Permanent Headquarters of the University of Murcia in Cieza and had numerous workshops from different Research groups from the University of Murcia in addition to the participation of the Universitat Jaume I. Between workshops and participants, approximately 1,000 people attended.

- Iván Mora-Seró, participated in the outreach event "Pint of Science" on May 21th 2019, with the talk "How some of the best scientists in history conspired to make my TV look so good".

- Francisco Fabregat and Sixto Giménez participated in two different editions of "Jornadas STEM+: Ciencia, Tecnología, Matemáticas y más" at Castelló Planetarium, in 2018 and 2109, respectively. These workshops organized by CEFIRE (GVA) focus on providing new tools to High School teachers for laboratory experiences in the scientific field, as well as to motivate them in the use of manipulative materials in their courses.

14. Gender Balance

The integration of *gender equality perspective* in research should pursue to avoid inequality relations between genders. Therefore, gender policies should not constitute only an isolated section but a *guiding principle* to design the guidelines for the different areas of action.

Table 3 shows the number of man and women working currently at INAM, distributed by position occupied at the institute. As reflected in the table, the number of men working at INAM doubles that of women. These data clearly show that our commitment on gender equality must take a step forward. In this regard, the future recruitment strategy aims for a representative gender balance, on the basis of equal opportunity. Recruitment strategy will follow the *"Code of Conduct for the recruitment of researchers"* adopted by the European Union, to ensure open, competitive, and equal opportunities recruitment. In order to implement gender policies, INAM will undertake other gender equality measures, as indicated in *Support to women in Science* of this report.

Table 3. Number of men and women working at INAM

	Men	Women	Total
Staff	8	4	12
Postdoctoral	9	2	11
Predoctoral	16	8	24
Starting Research	4	3	7
Admin/techinicians	2	5	7
Total	39	22	61

15. Conference organization

Conferences and workshops on Campus

Year	Start	End	Organizer	Title
2018	11 15	11 16	Francisco Fabregat	Impedance Spectroscopy School 2018
2019	06 12	06 14	Eduardo Peris/ Macarena Poyatos	International School on Organometallic Chemistry 'Marcial Moreno Mañas'
2019	05 06	05 07	Juan Bisquert	Meeting of the network PEROVSKITA

Other Conferences organized by INAM

Year	Start	End	Organizer	Conference	Title	Place
2018	05 14	05 14	Eduardo Peris	Organometallic Chemistry Day	GEQO-RSEQ-Symposium	Alcalá de Henares, Spain
2018	05 26	05 30	Macarena Poyatos	37 Bienal RSEQ	S15 Complejos de metales de transición con carbenos N-heterocíclicos (NHCs) y mesoiónicos (MICs)	San Sebastián, Spain
2019	11 04	11 08	Germà Garcia	nanoGe Fall Meeting19	#RadDet19. Radiation Detection Semiconductors Materials, Physics and Devices	Berlin, Germany

16. Conference presentations

2019					
Dates	**Author**	**Conference**	**Place**	**Contribution**	**Title of the contribution**
06 16 to 06 18	Juan Bisquert	Solid State Ionics Conference	Alpensia, South Korea	Invited Speaker	The Time Scales for Ionic and Electronic Phenomena in Perovskite Solar Cells
06 19 to 06 21	Juan Bisquert	8th Sungkyun International Solar Forum (SISF 2019)	Seoul, South Korea	Invited Speaker	Understanding Time Scales of Ionic and Electronic Phenomena in Perovskite Solar Cells
11 11 to 11 12	Juan Bisquert	JPCL Forum workshop "Physical Insights into Novel Materials	Jilin, China	Invited Speaker	Dynamic phenomena in halide perovskites and impact on new applications
05 05 to 05 07	Juan Bisquert	Interfaces in Organic and Hybrid Thin-Film Optoelectronics (INFORM)	Valencia, Spain	Oral Speaker	Interfacial phenomena governing kinetics of perovskite solar cells

02 24 to 02 27	Juan Bisquert	nanoGe International Conference on Perovskite Solar Cells, Photonics and Optoelectronics (NIPHO19)	Jerusalem, Israel	Oral Speaker	Electrical Switching of Photoluminescence by Ion Displacement in Metal Halide Perovskite
11 03 to 11 08	Juan Bisquert	nanoGe Fall Meeting19	Berlin, Germany	Keynote Speaker	Understanding the physical response of perovskite solar cells by frequency domain and time transient decay methods
01 27 to 01 29	Juan Bisquert	International Conference on Perovskite and Organic Photovoltaics and Optoelectronics (IPEROP19)	Kyōto-shi, Japan	Oral Speaker	Dynamic response of perovskite solar cells: characterization of ionic effects and quantum efficiency
09 22 to 09 27	Beatriz Julian	5th International Workshop on Nano- and Bio-Photonics 2019	Saint-Nectaire, France	Invited Speaker	Exploring sensitization of NIR-to-VIS upconverting lanthanide-doped fluorides by colloidal nanocrystals
06 03 to 06 06	Beatriz Julian	4th International Conference on Nanomaterials & Applications (NanoApp 2019)	Ljubliana Slovenia	Invited Speaker	Towards more industrially attracting NIR-to-VIS up-converting materials
02 15 to 02 15	Eduardo Peris	WWU-Muenster	Muenster, Germany	Invited Speaker	N-Heterocyclic carbenes: a door open to supramoleclar organometallic chemistry
04 08 to 04 08	Eduardo Peris	Sorbonne University Paris	Paris, France	Invited Speaker	N-Heterocyclic carbenes: a door open to supramoleclar organometallic chemistry
08 25 to 08 30	Eduardo Peris	SILQCOM-2019	Cartagena de Indias, Colombia	Invited Speaker	Metallosupramolecular assemblies with polyaromatic-adorned N-heterocyclic carbene.
01 31 to 02 01	Eduardo Peris	Journées de Chimie de Coordination 2019	Montpellier, France	Keynote Speaker	Polyaromatic-adorned N-Heterocyclic Carbenes. From Homogeneous Catalysis to Host-guest chemistry studies
09 01 to 09 04	Eduardo Peris	12th-International School on Organometallic Chemistry	Camerino, Italy	Keynote Speaker	Supramolecular interactions in Polyaromatic N-heterocyclic carbenes. Host-Guest chemistry properties and catalytic implications.
09 06 to 09 07	Eduardo Peris	Symposium on Molecular chemistry	Xi'An, China	Keynote Speaker	N-Heterocyclic carbenes: a door open to supramolecular organometallic chemistry
11 03 to 11 08	Elena Mas	nanoGe Fall Meeting19	Berlin, Germany	Oral Speaker	"Photoelectrosynthesis of Imines

09 11 to 09 14	Francisco Fabregat	7th International Conference on Semiconductor Photochemistry	Milan, Italia	Oral Speaker	Photoelectrocatalytic production of aromatic imines
11 03 11 08	Germà Garcia	nanoGe Fall Meeting19	Berlin, Germany	Invited Speaker	Capacive Response of Photovoltaic Perovskites: Defects, Interfaces and Contact Reactivity
10 16 to 10 18	Jose Mata	First International Conference on Unconventional Catalysis, Reactors and Applications (UCRA)	Zaragoza, Spain	Invited Speaker	
05 26 to 05 30	Jose Mata	XXXVII Reunión Bienal de la Real Sociedad Española de Química	San Sebastian, Spain	Oral Speaker	Polymetallic complexes with rigid polyaromatic ligands as improved homogeneous catalysts
09 11 to 09 14	Sixto Gimenez	7th International Conference on Semiconductor Photochemistry (SP7)	Milano, Italy	Keynote Speaker	Spectroscopic tools to understand photoelectrochemical water oxidation
05 26 to 05 30	Sixto Gimenez	XXXVII Bienal de la RSEQ 2019	San Sebastian, Spain	Oral Speaker	Mechanistic Insights on Solar Water Splitting with Metal Oxide Semiconductor Materials
11 06 to 14 06	Victor Sans	Nanoinnovation 2019	Rome, Italy	Invited Speaker	Capture and valorisation of CO2 with 3D printable ionic and polyionic liquids
31 03 to 04 04	Victor Sans	ACS National meeting	Orlando, USA	Invited Speaker	Towards compact configurable flow devices for synthesis and crystallisation
04 11 to 07 11	Victor Sans	XVI SIMPOSIO DE JÓVENES INVESTIGADORES DE LA REAL SOCIEDAD ESPAÑOLA DE QUÍMICA, RSEQ	Valencia, Spain	Oral Speaker	Base-free hydrogenation of carbon dioxide with ionic liquids
22 09 to 25 09	Victor Sans	EuGSC4	Tarragona, Spain	Oral Speaker	Efficient Base-Free Selective CO2 Hydrogenation with Multifunctional Ionic Liquids
2108					
10 08 to 10 10	Beatriz Julian	V Congreso Hispano-Luso de Cerámica y Vidrio	Barcelona, Spain	Keynote Speaker	NIR-light sensitive hybrid sol-gel systems: from soft gels to glassy materials
09 19 to 09 19	Eduardo Peris	HKU University	Hong-Kong, China	Invited Speaker	Polyaromatic-adorned N-Heterocyclic Carbenes. From Homogeneous Catalysis to Host-guest chemistry studies

07 15 to 07 20	Eduardo Peris	28 th International Conference on Organometallic Chemistry (ICOMC)	Firenze, Italy	Invited Speaker	Non-covalent interactions in Polyaromatic N-Heterocyclic Carbenes. Host-guest chemistry studies
09 2	Eduardo Peris	Norteast University China	Xi'An, China	Keynote Speaker	Polyaromatic-adorned N-Heterocyclic Carbenes. From Homogeneous Catalysis to Host-guest chemistry studies
08 22 to 08 25	Eduardo Peris	4h International Conference on Organometallic Chemistry and Catalysis (OM&CAT)	Taipei, Taiwan	Keynote speaker	Non-covalent interactions in Polyaromatic N-Heterocyclic Carbenes. Host-guest chemistry studies
11 30 to 12 01	Eduardo Peris	1st Stable Carbene Symposium	Toulouse, France	Keynote Speaker	N-Heterocycic carbenes: a new door to supramoleclar organometallic chemistry
01 28 to 01 30	Francisco Fabregat	Asian-Pacific Hybrid and Organic Photovoltaics conference (AP-HOPV18)	Kitakyushu, Japón	Invited Speaker	Electrical properties of perovskite solar cells
09 26 to 09 29	Francisco Fabregat	Materials & Technologies for Energy Conversion and Storage (M-TECS 2018)	Bombai, India	Keynote Speaker	Photovoltaic Solar Technologies: A review of different alternatives and applications
08 20 to 08 23	Francisco Fabregat	European Advanced Materials Congress	Stockholm, Sweden	Keynote Speaker	New horizons for solar energy
05 28 to 05 31	Francisco Fabregat	Hybrid and Organic Photovoltaics Conference (HOPV18)	Benidorm, Spain	Oral Speaker	Photoluminiscence of dual ion perovskite monocrystals
09 17 to 09 20	Germà Garcia	E-MRS 2018 Fall Meeting	Warsaw, Poland	Invited Speaker	Electronic recombination and accumulation effects at hybrid perovskite and selective contact interfaces
07 17 to 07 18	Jose Mata	ISEnEC 2018 Integration of Sustainable Energy	Nuremberg, Germany	Invited Speaker	
10 18 to 10 19	Jose Mata	2nd Trans Pyrenean Meeting in Catalysis	Tarragona, Spain	Oral Speaker	
06 06 to 06 08	Jose Mata	XI International School on Organometallic Chemistry Marcial Moreno Mañas	Oviedo, Spain	Oral Speaker	

07 29 to 08 04	Juan Bisquert	22nd International Conference on Photochemical Conversion and Storage of Solar Energy (IPS)	Hefei, China	Invited Speaker	Quantum-dots for waste water treatment and energy production
02 19 to 02 21	Juan Bisquert	Stability of Emerging Photovoltaics from Fundamentals to Applications (SEPV18)	Barcelona, Spain	Invited Speaker	Review on electrical properties of perovskite based solar cells
07 04 to 07 05	Juan Bisquert	ICFO School on the Frontiers of Light	Barcelona, Spain	Oral Speaker	Characterization methods of solution processed solar cells
05 28 to 05 31	Juan Bisquert	10th international Conference on Hybrid and Organic Photovoltaics (HOPV)	Benidorm, Spain	Oral Speaker	
01 28 to 01 30	Juan Bisquert	2nd Asia-Pacific Hybrid and Organic Photovoltaics (AP-HOPV18)	Kitakyushu, Japan	Oral Speaker	
12 04 to 12 04	Macarena Poyatos	WWW-Münster	Münster, Germany	Invited Speaker	Complex Metal Oxides for Ceramic Glasses with Up-converting Properties
07 15 to 07 20	Macarena Poyatos	28th International Conference on Organometallic Chemistry ICOMC	Florence, Italy	Oral Speaker	Fc-based N-heterocyclic carbenes for the design of redox-switchable catalysis
08 03 to 08 05	Sixto Gimenez	International Workshop on Water Splitting: Challenges and Opportunities	Xi'an, China	Invited Speaker	Solar Water Splitting with Metal Oxide Semiconductor Materials
07 29 to 08 02	Sixto Gimenez	The 22nd International Conference on Photochemical Conversion and Storage of Solar Energy	Hefei, China	Invited Speaker	Water Oxidation with Metal Oxide Semiconductor Materials
10 22 to 10 26	Sixto Gimenez	Nanoge Fall Meeting: Symposium on Water Splitting	Torremolinos, Spain	Oral Speaker	Solar Water Splitting with Metal Oxide Semiconductor Materials
10 22 to 10 26	Sixto Gimenez	Nanoge Fall Meeting: Symposium on Water Splitting	Torremolinos, Spain	Oral Speaker	Photocatalytic and Photoelectrochemical Degradation of Organic Pollutants with All-Inorganic Metal Halide Perovskite Quantum Dots

17. Full list of publications

2019

1. Electronic effects determine the selectivity of planar Au-Cu bimetallic thin films for electrochemical CO2 reduction. Liu, K.; Wu, L.; Valenti, M.; Cardenas-Morcoso, D.; Hofmann, J.P.; Bisquert, J.; Giménez, S.; Smith, W.A. ACS *Applied Materials and Interfaces*. **2019**, 8,11, 16546-16555.

2. The Role of Underlayers and Overlayers in Thin Film BiVO4 Photoanodes for Solar Water Splitting. Garcia-Tecedor, M.; Cardenas-Morcoso, D.; Fernández-Climent, R.; Giménez, S. *Advanced Materials Interfaces*. **2019**, 1900299, 1-8.

3. A Size-Flexible Organometallic Box for the Encapsulation of Fullerenes. Martínez-Agramunt, V.; Eder, T.; Darmandeh, H.; Guisado-Barrios, G.; Peris, E. *Angewandte Chemie International Edition*. **2019**, 58, 5682-5686.

4. Outstanding nonlinear optical properties of methylammonium- and Cs-PbX3 (X = Br, I, and Br–I) perovskites: Polycrystalline thin films and nanoparticles. Suárez, I.; Vallés-Pelarda, M.; Gualdrón-Reyes, A.Fabián; Mora-Seró, I.; Ferrando, A.; Michinel, H.; Salgueiro, J.Ramón; Pastor, J.P.Martine APL *Materials*. **2019**, 7, 41106.

5. A palladium-hinged organometallic square with a perfect-sized cavity for the encapsulation of three heteroguests. Martínez-Agramunt, V.; Peris, *E. Chemical Communications*. **2019**, 55, 14972-14975.

6. A matter of fidelity: self-sorting behavior of di-gold metallotweezers. Ibáñez, S.; Peris, E. *Chemistry - A European Journal.* **2019**, 35, 8254-8258.

7. Hybrid Assemblies for Light-Energy Conversion. Kamat, P.V.; Bisquert, J. *ChemPhysChem*. **2019**, 20, 2579.

8. Impact of Oxygen Vacancy Occupancy on Charge Carrier Dynamics in BiVO4 Photoanodes. Selim, S.; Pastor, E.; Garcia-Tecedor, M.; Morris, M.R.; Francàs, L.; Sachs, M.; Moss, B.; Corby, S.; Mesa, C.A.; Giménez, S.; Kafizas, A.; Bakulin, A.A.; Durrant, J.R. *Journal of American Chemical Society*. **2019**, 141, 47, 18791−18798.

9. A Metal-Organic Framework Converted Catalyst that Boosts Photo-Electrochemical Water Splitting. Cardenas-Morcoso, D.; Ifraemov, R.; Garcia-Tecedor, M.; Liberman, I.; Giménez, S.; Hod, I. Journal of Materials Chemistry A. **2019**, 7, 11143-11149.

10. Impedance analysis of perovskite solar cells: a case study. Contreras-Bernal, L.; Ramos-Terrón, S.; Riquelme, A.; Boix, P.P.; Idígoras, J.; Mora-Seró, I.; Anta, J.A. Journal of Materials Chemistry A. **2019**, 7, 12191-12200.

11. Effect of Environmental Humidity on the Electrical Properties of Lead Halide Perovskites. García-Fernández, A.; Moradi, Z.; Bermúdez-García, J.Manuel; Sánchez-Andújar, M.; Gimeno,

V.A.; Castro-García, S.; Señarís-Rodríguez, M.Antonia; Mas-Marzá, E.; Garcia-Belmonte, G.; Fabregat-Santiago, F. *The Journal of Physical Chemistry* C. **2019**, 123, 2011-2018.

12. Interaction between Colloidal Quantum Dots and Halide Perovskites: Looking for Constructive Synergies. Ngo, T.T.; Mora-Seró, I. The Journal of Physical Chemistry Letters. **2019**, 10, 1099-1108.

13. Understanding the Improvement of Stability in Self-Assembled Multiple Quantum Wells Perovskite Light-Emitting Diode. Li, C.; Wang, N.; Guerrero, A.; Zhong, Y.; Long, H.; Miao, Y.; Bisquert, J.; Wang, J.; Huettner, S. *The Journal of Physical Chemistry Letters*. **2019**, 10, 21, 6857-6864.

14. Single-Exciton Amplified Spontaneous Emission in Thin Films of CsPbX3 (X = Br, I) Perovskite Nanocrystals. Navarro-Arenas, J.; Suárez, I.; Chirvony, V.S.; Gualdrón-Reyes, A.F.; Mora-Seró, I.; Martínez-Pastor, J.P. *The Journal of Physical Chemistry Letters*. **2019**, 10, 6389-6398.

15. Structural characterization of bulk and nanoparticle lead halide perovskite thin films by (S) TEM techniques. Fernández-Delgado, N.; Herrera, M.; Delgado, J.Luis; Tavabi, A.H.; Luysberg, M.; Dunin-Borkowski, R.E.; Juárez-Pérez, E.J.; Hames, C.; Mora-Seró, I.; Suárez, I.; Martínez-Pastor, J.P.; Molina, S.I. Nanotechnology. **2019**, 30, 135701.

16. Partial coverage methylammonium lead bromide films for solar cell application. Mhamdi, A.; Vicente, N.; Bouazizi, A.; Garcia-Belmonte, G. *Thin Solid Films*. **2019**, 690, 137567.

17. Enhanced Open-Circuit Voltage of WideBandgap Perovskite Photovoltaics by Using Alloyed (FA1−xCsx)Pb(I1−xBrx)3 Quantum Dots. Suri, M.; Hazarika, A.; Larson, B.W.; Zhao, Q.; Vallés-Pelarda, M.; Siegler, T.D.; Abney, M.K.; Ferguson, A.J.; Korgel, B.A.; Luther, J.M. *ACS Energy Letters*. **2019**, 4, 1954−1960.

18. Controlling the Phase Segregation in Mixed Halide Perovskites through Nanocrystal Size. Gualdrón-Reyes, A.Fabián; Yoon, S.Joon; Barea, E.M.; Agouram, S.; Muñoz-Sanjosé, V.; Meléndez, Á.M.; Niño-Gómez, M.E.; Mora-Seró, I. *ACS Energy Letters*. **2019**, 4, 54-62.

19. Operation Mechanism of Perovskite Quantum Dot Solar Cells Probed by Impedance Spectroscopy. Zolfaghari, Z.; Hassanabadi, E.; Pitarch-Tena, D.; Yoon, S.Joon; Shariatinia, Z.; van de Lagemaat, J.; Luther, J.M.; Mora-Seró, I. *ACS Energy Letters*. **2019**, 4, 251-258.

20. A Twisted Tetragold Cyclophane from a Fused Bis-Imidazolindiylidene. Gutierrez-Blanco, A.; Ibáñez, S.; Hahn, E.; Poyatos, M.; Peris, E. *Organometallics*. **2019**, 38, 4565-4569.

21. Synthesis and Catalytic Applications of Heterobimetallic Carbene Complexes Obtained via Sequential Metalation of Two Bisazolium Salts. Böhmer, M.; Guisado-Barrios, G.; Kampert, F.; Roelfes, F.; Tan, T.Tsai Yuan; Peris, E.; Hahn, E. *Organometallics*. **2019**, 38, 2120-2131.

22. Structural Features of Mono- and Dimetallic Complexes of Palladium Combining Two Types of Aromatic NHC Ligands. Gonell, S.; Peris, E.; Poyatos, M. *European Journal of Inorganic Chemistry*. **2019**, 33, 3776-3781.

23. An Oxalate-Bridged Binuclear Iron(III) Ionic Liquid for the Highly Efficient Glycolysis of

Polyethylene Terephthalate under Microwave Irradiation. Cot, S.; Leu, M.K.; Kalamiotis, A.; Dimitrakis, G.; Sans, V.; de Pedro, I.; Cano, I. *ChemPlusChem*. **2019**, 84, 7, 786-793.

24. Investigation of pressure drop in 3D replicated open-cell foams: coupling CFD with experimental data on additively manufactured foams. Bracconi, M.; Ambrosetti, M.; Okafor, O.; Sans, V.; Zhang, X.; Ou, X.; Da Fonte, P.; Fan, X.; Maestri, M.; Groppi, G.; Tronconi, E. *Chemical Engineering Journal*. **2019**, 377, 120123.

25. TiO2 Nanotubes for Solar Water Splitting: Vacuum Annealing and Zr Doping Enhance Water Oxidation Kinetics. Shaddad, M.N.; Cardenas-Morcoso, D.; Garcia-Tecedor, M.; Fabregat-Santiago, F.; Bisquert, J.; Al-Mayouf, A.M.; Giménez, S. *ACS Omega*. **2019**, 4, 14, 16095−16102.

26. One-step methylammonium lead bromide films: Effect of annealing treatment. Mhamdi, A.; Mehdi, H.; Bouazizi, A.; Garcia-Belmonte, G. *Journal of Molecular Structure*. **2019**, 1192, 1-6.

27. PbS quantum dots as additives in methylammonium halide perovskite solar cells: the effect of quantum dot capping. Ngo, T.Tuyen; Masi, S.; Méndez, P.Fabiola; Kazes, M.; Oron, D.; Mora-Seró, I. *Nanoscale Advances*. **2019**, 1, 4109-4118.

28. Photocurrents in crystal-amorphous hybrid stannous oxide/alumina binary nanofibers. Ling, J.K.; Pal, B.; Chong, K.F.; Schmidt-Mende, L.; Bisquert, J.; Jose, R. *Journal of the American Ceramic Society*. **2019**, 102, 10, 6337-6348.

29. Analysis of the UV–Ozone-Treated SnO2 Electron Transporting Layer in Planar Perovskite Solar Cells for High Performance and Reduced Hysteresis. Méndez, P.Fabiola; Muhammed, S.K.M.; Barea, E.M.; Masi, S.; Mora-Seró, *I. Solar RRL*. **2019**, 1900191, 1-6.

30. Light capacitances in silicon and perovskite solar cells. Almora, O.; Garcia-Belmonte, G. *Solar Energy*. **2019**, 189, 103-110.

31. Continuous-flow crystallisation in 3D-printed compact devices. Okafor, O.; Robertson, K.R.; Goodridge, R.; Sans, V. *Reaction Chemistry and Engineering*. **2019**, 4, 1682-1688.

32. Chain length effects on the size, stability, and electronic structure of redox-active organic-inorganic hybrid polyoxometalate micelles. Amin, S.; Cameron, J.; Watts, J.; Walsh, D.A.; Sans, V.; Newton, G. *Molecular Systems Design and Engineering*. **2019**, 4, 995-999.

33. Reversible Formation of Gold Halides in Single-Crystal Hybrid-Perovskite/Au Interface upon Biasing and Effect on Electronic Carrier Injection. Pospisil, J.; Guerrero, A.; Zmeskal, O.; Weiter, M.; Gallardo, J.Jesús; Navas, J.; Garcia-Belmonte, G. *Advanced Functional Materials*. **2019**, 29, 1900881.

34. A size-flexible organometallic box for the encapsulation of fullerenes. Martinez-Agramunt, V.; Eder, T.; Darmandeh, H.; Guisado-Barrios, G.; Peris, E. *Angewandte Chemie International Edition*. **2019**, 131, 5738-5742.

35. A Rigid Trigonal-Prismatic Hexagold Metallocage That Behaves as a Coronene Trap. Ibáñez, S.; Peris, E. *Angewandte Chemie International Edition*. **2019**, 58, 6693-6697.

36. Probing the 3-step Lithium Storage Mechanism in CH3NH3PbBr3 Perovskite Electrode by Operando-XRD Analysis. Vicente, N.; Bresser, D.; Passerini, S.; Garcia-Belmonte, G. *ChemElectroChem*. **2019**, 6, 456–460.

37. Improving Catalyst Activity in Hydrocarbon Functionalization by Remote Pyrene-Graphene Stacking. Ballestin, P.; Ventura-Espinosa, D.; Martín, S.; Caballero, A.; Mata, J.A.; Pérez, P.J. *Chemistry - A European Journal*. **2019**, 25, 9534 – 9539.

38. Crystalline Clear or not: Beneficial and Harmful Effects of Water in Perovskite Solar Cells. Aranda, C.; Guerrero, A.; Bisquert, J. *ChemPhysChem*. **2019**, 20, 20, 2587-2599.

39. Kinetic and material properties of interfaces governing slow response and long timescale phenomena in perovskite solar cells. Wang, H.; Guerrero, A.; Bou, A.; Al-Mayouf, A.M.; Bisquert, J. *Energy & Environmental Science*. **2019**, 12, 2054-2079.

40. Impedance Spectroscopy of Perovskite/Contact Interface: Beneficial Chemical Reactivity Effect. Aranda, C.; Bisquert, J.; Guerrero, A. *Journal of Chemical Physics*. **2019**, 151, 124201.

41. Potassium ions as a kinetic controller in ionic double layers for hysteresis-free perovskite solar cells. Kim, S.G.; Li, C.; Guerrero, A.; Yang, J.M.; Zhong, Y.; Bisquert, J.; Huettner, S.; Park, N.G. *Journal of Materials Chemistry A*. **2019**, 7, 18807–18815.

42. Intensity Modulated Photocurrent Spectroscopy (IMPS) and its Application to Perovskite Solar Cells. Ravishankar, S.; Riquelme, A.; Sarkar, S.S.; García-Batlle, M.; Garcia-Belmonte, G.; Bisquert, J. *The Journal of Physical Chemistry C*. **2019**, 123, 41, 24995-25014.

43. Perovskite Solar Cell Modeling Using Light- and Voltage-Modulated Techniques. Ravishankar, S.; Aranda, C.; Sanchez, S.; Bisquert, J.; Saliba, M.; Garcia-Belmonte, G. *The Journal of Physical Chemistry C*. **2019**, 123, 6444-6449.

44. The Causes of Degradation of Perovskite Solar Cells. Juárez-Pérez, E.J.; Bisquert, J. *The Journal of Physical Chemistry Letters*. **2019**, 10, 5889-5891.

45. Utilization of Temperature-Sweeping Capacitive Techniques to Evaluate Band-Gap Defect Densities in Photovoltaic Perovskites. Almora, O.; García-Batlle, M.; Garcia-Belmonte, G. *The Journal of Physical Chemistry Letters*. **2019**, 10, 3661−3669.

46. Photocatalytic and Photoelectrochemical Degradation of Organic Compounds with All-Inorganic Metal Halide Perovskite Quantum Dots. Cardenas-Morcoso, D.; Gualdrón-Reyes, A.Fabián; Vitoreti, A.Beatriz Fe; Garcia-Tecedor, M.; Yoon, S.Joon; de la Fuente, M.Solis; Mora-Seró, I.; Giménez, S. *The Journal of Physical Chemistry Letters*. **2019**, 10, 630-636.

47. Ionic dipolar switching hinders charge collection in perovskite solar cells with normal and inverted hysteresis. Almora, O.; Lopez-Varo, P.; Cho, K.Taek; Aghazada, S.; Meng, W.; Hou, Y.; Echeverría-Arrondo, C.; Zimmermann, I.; Matt, G.J.; Jiménez-Tejada, J.Antonio; Brabec, C.J.; Nazeeruddin, M.Khaja; Garcia-Belmonte, G. *Solar Energy Materials & Solar Cells*. **2019**, 195, 291-298.

48. Ionic Effect Enhances Light Emission and the Photovoltage of Methylammonium Lead Bromide Perovskite Solar Cells by Reduced Surface Recombination. Aranda, C.; Guerrero, A.;

Bisquert, J. *ACS Energy Letters*. **2019**, 4, 741–746.

49. The Bloom of Perovskite Optoelectronics: Fundamental Science Matters. Gong, J.; Flatken, M.; Abate, A.; Correa-Baena, J.P.; Mora-Seró, I.; Saliba, M.; Zhou, Y. *ACS Energy Letters*. **2019**, 4, 861-865.

50. Unraveling Charge Transfer in CoFe Prussian Blue Modified BiVO4 Photoanodes. Moss, B.; Hegner, F.Simone; Corby, S.; Selim, S.; Francàs, L.; López, N.; Giménez, S.; Galán-Mascarós, J.Ramón; Durrant, J.Robert *ACS Energy Letters*. **2019**, 4, 337−342.

51. On the real catalytically active species for CO2 fixation into cyclic carbonates under near ambient conditions: Dissociation equilibrium of [BMIm][Fe(NO)2Cl2] dependant on reaction temperature. Leu, M.K.; Vicente, I.; Fernandes, A.; de Pedro, I.; Dupont, J.; Sans, V.; Licence, P.; Gual, A.; Cano, I. *Applied Catalysis B: Environmental*. **2019**, 245, 240-250.

52. Tris-triazolium Salts as Anion Receptors and as Precursors for the Preparation of Cylinder-like Coordination Cages. Al-Shnani, F.; Guisado-Barrios, G.; Sainz, D.; Peris, E. *Organometallics*. **2019**, 38, 697-701.

53. The non-innocent role of graphene in the formation/immobilization of ultra-small gold nanoparticles functionalized with N-heterocyclic carbene ligands. Ventura-Espinosa, D.; Martín, S.; Mata, J.A. *Journal of Catalysis*. **2019**, 375, 419 – 426.

54. Suppressing H2 Evolution and Promoting Selective CO2 Electroreduction to CO at Low Overpotentials by Alloying Au with Pd. Valenti, M.; Prasad, N.P.; Kas, R.; Bohra, D.; Ma, M.; Balasubramanian, V.; Chu, L.; Giménez, S.; Bisquert, J.; Dam, B.; Smith, W.A. *ACS Catalysis*. **2019**, 9, 3527−3536.

55. An Equivalent Circuit for Perovskite Solar Cell Bridging Sensitized to Thin Film Architectures. Yoo, S.M.; Yoon, S.Joon; Anta, J.A.; Lee, H.Joong; Boix, P.P.; Mora-Seró, I. *Joule*. **2019**, 3, 10, 2535-2549.

56. Optical Characterization of Lead-Free Cs2SnI6 Double Perovskite Fabricated from Degraded and Reconstructed CsSnI3 Films. Lopez-Fraguas, E.; Masi, S.; Mora-Seró, I. *ACS Applied Energy Materials*. **2019**, 2, 12, 8381-8387.

57. WO3/BiVO4: impact of charge separation at the timescale of water oxidation. Selim, S.; Francàs, L.; Garcia-Tecedor, M.; Corby, S.; Blackman, C.; Giménez, S.; Durrant, J.Robert; Kafizas, A. *Chemical Science*. **2019**, 10 (9), 2643-2652.

58. Aggregation-induced heterogeneities in the emission of upconverting nanoparticles at the submicron scale unfolded by hyperspectral microscopy. Gonell, F.; Botas, A.M.P.; Brites, C.D.S.; Amorós, P.; Carlos, L.D.; Julián-López, B.; Ferreira, R.A.S. *Nanoscale Advances*. **2019**, 1, 2537-2545.

59. Flash infrared annealing as a cost-effective and low environmental impact processing method for planar perovskite solar cells. Sanchez, S.; Vallés-Pelarda, M.; Alberola-Borràs, J.A.; Vidal, R.; Jerónimo-Rendón, J.J.; Saliba, M.; Boix, P.P.; Mora-Seró, I. *Materials Today*. **2019**, 31, 39-46.

60. Optical Amplification in Hollow-Core Negative-Curvature Fibers Doped with Perovskite CsPbBr3 Nanocrystals. Navarro-Arenas, J.; Suárez, I.; Martínez-Pastor, J.P.; Ferrando, A.; Gualdrón-Reyes, A.F.; Mora-Seró, I.; Gao, S.F.; Wang, Y.Y.; Wang, P.; Sun, Z. *Nanomaterials*. **2019**, 9, 868.

61. Welcoming the First Decade of Perovskite Solar Cells. Zhou, Y.; Saliba, M.; Mora-Seró, I. *Solar RRL*. **2019**, 3, 1900325.

62. Easy Formation of Functional Liposomes in Water Using a pH-Responsive Microbial Glycolipid: Encapsulation of Magnetic and Upconverting Nanoparticles. Van Renterghem, L.; Guzzetta, F.; Le Griel, P.; Selmane, M.; Ben Messaoud, G.; Teng, T.Tan Su; Lim, S.; Soetaert, W.; Roelants, S.; Julián-López, B.; Baccile, N. *ChemNanoMat*. **2019**, 5, 9, 1188-1201.

63. Tuning the Reactivity of TEMPO during Electrocatalytic Alcohol Oxidations in Room-temperature Ionic Liquids. Delorme, A.E.; Sans, V.; Licence, P.; Walsh, D.A. *ACS Sustainable Chemistry & Engineering*. **2019**, 7, 11691-11699.

64. Photocatalytic Properties of a Palladium Metallosquare with Encapsulated Fullerenes via Singlet Oxygen Generation. Martínez-Agramunt, V.; Peris, E. *Inorganic Chemistry*. **2019**, 58, 11836-11842.

2018

65. 1H-1,2,3-Triazol-5-ylidenes: Readily Available Mesoionic Carbenes. Guisado-Barrios, G.; Soleihavoup, M.; Bertrand, G. *Accounts of Chemical Research*. **2018**, 51,12, 3236-3244.

66. Perovskite-Polymer Blends Influencing Microstructures, Nonradiative Recombination Pathways, and Photovoltaic Performance of Perovskite Solar Cells. Fakharuddin, A.; Seybold, M.; Agresti, A.; Pescetelli, S.; Matteocci, F.; Haider, M.Irfan; Birkhold, S.T.; Hu, H.; Giridharagopal, R.; Sultan, M.; Mora-Seró, I.; Di Carlo, A.; Schmidt-Mende, L. *ACS Applied Materials and Interfaces*. **2018**, 10, 49, 42542-42551.

67. Switching off hysteresis in perovskite solar cells by fine-tuning energy levels of extraction layers. Guerrero, A.; Bou, A.; Matt, G.J.; Almora, O.; Heumüller, T.; Garcia-Belmonte, G.; Bisquert, J.; Hou, Y.; Brabec, C.J. Advanced Energy Materials. 2018, 8, 1703376.

68. Integrated Optical Amplifer–Photodetector on a Wearable Nanocellulose Substrate. Suárez, I.; Hassanabadi, E.; Maulu, A.; Carlino, N.; Maestri, C.Ada; Latifi, M.; Bettotti, P.; Mora-Seró, I.; Martínez-Pastor, J.P. *Advanced Optical Materials*. **2018**, DOI: 10.1002/adom.201800201.

69. Origin of photovoltage in perovskite solar cells probed by first-principles calculations. Echeverría-Arrondo, C. *Applied Physics Letters*. **2018**, 112, 233902.

70. Smart N-Heterocyclic Carbene Ligands in Catalysis. Peris, E. *Chemical Reviews*. **2018**, 118, 9988-10031.

71. A Shape-Adaptable Organometallic Supramolecular Coordination Cage for the Encapsulation of Fullerenes. Martínez-Agramunt, V.; Gussev, D.; Peris, E. *Chemistry - A*

European Journal. 2018, 24, 14802-14807.

72. Improving the Back Surface Field on an Amorphous Silicon Carbide Thin-Film Photocathode for Solar Water Splitting. Perez-Rodriguez, P.; Cardenas-Morcoso, D.; Digdaya, I.A.; Raventos, A.Mangel; Procel, P.; Isabella, O.; Giménez, S.; Zeman, M.; Smith, W.A.; Smets, A.H.M. *ChemSusChem*. 2018, 11, 1797– 1804.

73. Perovskite solar cells with versatile electropolymerized fullerene as electron extraction layer. Suárez, B.; Aranda, C.; Macor, L.; Durantini, J.; Heredia, D.; Durantini, E.N.; Otero, L.; Guerrero, A.; Gervaldo, M. *Electrochimica Acta*. 2018, 292, 697-706.

74. Defect Tolerant Perovskite Solar Cells from Blade coated Non-Toxic Solvents. Bi, Z.; Rodríguez-Martínez, X.; Aranda, C.; San José, E.Pascual; Goñi, A.R.; Campoy-Quiles, M.; Xu, X.; Guerrero, A. *Journal of Materials Chemistry A*. 2018, 6, 19085-19093.

75. Homeopathic Perovskite Solar Cells: Effect of Humidity during Fabrication on the Performance and Stability of the Device. Contreras-Bernal, L.; Aranda, C.; Vallés-Pelarda, M.; Ngo, T.T.; Ramos-Terrón, S.; Gallardo, J.Jesús; Navas, J.; Guerrero, A.; Mora-Seró, I.; Idígoras, J.; Anta, J.A. *The Journal of Physical Chemistry C*. 2018, 122, 5341−5348.

76. Analysis of the Influence of Selective Contact Heterojunctions on the Performance of Perovskite Solar Cells. Garcia-Rosell, M.; Bou, A.; Jiménez-Tejada, J.Antonio; Bisquert, J.; Lopez-Varo, P. *The Journal of Physical Chemistry C*. 2018, 122, 13920-13925.

77. Enhancing the Optical Absorption and Interfacial Properties of BiVO4 with Ag3PO4 Nanoparticles for Efficient Water Splitting. Shaddad, M.N.; Cardenas-Morcoso, D.; Arunachalam, P.; Garcia-Tecedor, M.; Ghanem, M.A.; Bisquert, J.; Al-Mayouf, A.M.; Giménez, S. *The Journal of Physical Chemistry C*. 2018, 122, 11608−11615.

78. Top Selected Papers in the Physical Chemistry of Energy Materials 2016–2017. Bisquert, J. *The Journal of Physical Chemistry Letters*. 2018, 9, 5897–5905.

79. Unravelling the role of vacancies in lead halide perovskite through electrical switching of photoluminescence. Li, C.; Guerrero, A.; Huettner, S.; Bisquert, J. *Nature Communications*. 2018, 9, 5113.

80. Relative impacts of methylammonium lead triiodide perovskite solar cells based on life cycle assessment. Alberola-Borràs, J.A.; Vidal, R.; Juárez-Pérez, E.J.; Mas-Marzá, E.; Guerrero, A.; Mora-Seró, I. *Solar Energy Materials & Solar Cells*. 2018, 179, 169-177.

81. Impedance Spectroscopy Measurements in Perovskite Solar Cells: Device Stability and Noise Reduction. Pitarch-Tena, D.; Ngo, T.T.; Vallés-Pelarda, M.; Pauporté, T.; Mora-Seró, I. *ACS Energy Letters*. 2018, 3, 1044-1048.

82. Perovskite-quantum dots interface: Deciphering its ultrafast charge carrier dynamics. Galar, P.; Piatkowski, P.; Ngo, T.Tuyen; Gutiérrez, M.; Mora-Seró, I.; Douhal, A. *Nano Energy*. 2018, 49, 471-480.

83. Evaluation of multiple cation/anion perovskite solar cells through life cycle assessment. Alberola-Borràs, J.A.; Vidal, R.; Mora-Seró, I. *Sustainable Energy & Fuels*. 2018, 2, 1600-1609.

84. Ir-III/Au-I and Rh-III/Au-I Heterobimetallic Complexes as Catalysts for the Coupling of Nitrobenzene and Benzylic Alcohol. Böhmer, M.; Kampert, F.; Tan, T.Tsai Yuan; Guisado, G.; Peris, E.; Hahn, E. *Organometallics*. 2018, 37, 4092–4099.

85. Tetra-Au(I) Complexes Bearing a Pyrene Tetraalkynyl Connector Behave as Fluorescence Torches. Gutierrez-Blanco, A.; Fernández-Moreira, V.; Gimeno, M.Concepció; Peris, E.; Poyatos, M. *Organometallics*. 2018, 37, 1795-1800.

86. A Dinuclear Au(I) Complex with a Pyrene-di-N-heterocyclic Carbene Linker: Supramolecular and Catalytic Studies. Nuevo, D.; Poyatos, M.; Peris, E. *Organometallics*. 2018, 37, 3407-3411.

87. Quantum dot-sensitized solar cells. Pan, Z.; Rao, H.; Mora-Seró, I.; Bisquert, J.; Zhong, X. *Chemical Society Reviews*. 2018, 47, 7659-7702.

88. High Production of Hydrogen on Demand from Silanes Catalyzed by Iridium Complexes as a Versatile Hydrogen Storage System. Ventura-Espinosa, D.; Sabater, S.; Carretero-Cerdán, A.; Baya, M.; Mata, J.A. *ACS Catalysis*. 2018, 8, 2558−2566.

89. Influence of Charge Transport Layers on Open-Circuit Voltage and Hysteresis in Perovskite Solar Cells. Ravishankar, S.; Gharibzadeh, S.; Roldán-Carmona, C.; Grancini, G.; Lee, Y.; Ralaiarisoa, M.; Asiri, A.M.; Koch, N.; Bisquert, J.; Nazeeruddin, M.Khaja *Joule*. 2018, 2, 788–798.

90. Ruthenium(II) pincer complexes featuring an anionic CNC bis(1,2,3-triazol-5-ylidene) carbazolide ligand coordinated in a meridional fashion. Kleinhans, G.; Guisado-Barrios, G.; Peris, E.; Bezuidenhout, D.I. *Polyhedron*. 2018, 143, 43-48.

91. Spray-Pyrolyzed ZnO as Electron Selective Contact for Long-Term Stable Planar CH3NH3PbI3 Perovskite Solar Cells. Ngo, T.Tuyen; Barea, E.M.; Tena-Zaera, R.; Mora-Seró, I. *ACS Applied Energy Materials*. 2018, 1, 8, 4057−4064.

92. Optical Optimization of the TiO2 Mesoporous Layer in Perovskite Solar Cells by the Addition of SiO2 Nanoparticles. Aeineh, N.; Castro-Méndez, A.F.; Rodríguez-Cantó, P.J.; Abargues, R.; Hassanabadi, E.; Suárez, I.; Behjat, A.; Ortiz, P.; Martínez-Pastor, J.P.; Mora-Seró, I. *ACS Omega*. 2018, 3, 9798−9804.

93. Perovskite Photovoltaic Modules: Life Cycle Assessment of Pre-industrial Production Process. Alberola-Borràs, J.A.; Baker, J.A.; De Rossi, F.; Vidal, R.; Beynon, D.; Hooper, K.E.A.; Watson, T.M.; Mora-Seró, I. *iSciencie*. 2018, 9, 542-551.

94. Imidazolium Iodide-Doped PEDOT Nanofibers as Conductive Catalysts for Highly Efficient Solid-State Dye-Sensitized Solar Cells Employing Polymer Electrolyte. Kim, T.Y.; Wei, W.; Lee, T.Kyung; Kim, B.Su; Park, S.Chan; Lee, S.; Suh, E.Hyun; Jang, J.; Bisquert, J.; Kang, Y.Soo *ACS Applied Materials and Interfaces*. 2018, 10, 2537-2545.

95. Device Physics of Hybrid Perovskite Solar cells: Theory and Experiment. Lopez-Varo, P.; Jiménez-Tejada, J.Antonio; Garcia-Rosell, M.; Ravishankar, S.; Garcia-Belmonte, G.; Bisquert, J.; Almora, O. *Advanced Energy Materials*. 2018, 10.1002/aenm.201702772.

96. 3D Printable photochromic molecular materials for reversible information storage. Wales, D.J.; Cao, Q.; Kastner, K.; Karjalainen, E.; Newton, G.N.; Sans, V. *Advanced Materials*. 2018, 30, 26, 1800159.

97. The Complex Coordination Landscape of a Digold(I) U-Shaped Metalloligand. Ibáñez, S.; Poyatos, M.; Peris, E. *Angewandte Chemie International Edition*. 2018, 57, 16816-16820.

98. New approaches to the lithiation kinetics in reaction-limited battery electrodes through electrochemical impedance spectroscopy. Vicente, N.; Haro, M.; Garcia-Belmonte, G. *Chemical Communications*. 2018, 54, 1025.

99. Fullerene-Based Materials as Hole-Transporting/Electron Blocking Layers. Applications in Perovskite Solar Cells. Delgado, J.Luis; Hueso, L.E.; Zuccatti, E.; Collavini, S.; Völker, S.F.; Pascual, J.; TenaZaera, R.; Vallés-Pelarda, M.; Mora-Seró, I.; Ruiperez, F. *Chemistry - A European Journal*. 2018, 24,34, 8524-8529.

100. Chemically Tunable Formation of Different Discrete, Oligomeric, and Polymeric Self-Assembled Structures from Digold Metallotweezers. Ibáñez, S.; Peris, E. *Chemistry - A European Journal*. 2018, 24, 8424-8431.

101. In situ Biofilm Quantification in Bioelectrochemical Systems by using Optical Coherence Tomography. Molenaar, S.D.; Pereiraa, J.; Sleutels, T.; Borsjea, C.; Zamudio, J.A.; Fabregat-Santiago, F.; Buisman, C.J.N.; Heijne, A.Ter *ChemSusChem*. 2018, 11, 2171– 2178.

102. Selective growth of layered perovskite for stable and efficient photovoltaics. Cho, K.Taek; Grancini, G.; Lee, Y.; Oveisi, E.; Ryu, J.; Almora, O.; Tschumi, M.; Schouwink, P.; Seo, G.; Heo, S.; Park, J.; Jang, J.; Paek, S.; Garcia-Belmonte, G.; Nazeeruddin, M.Khaja *Energy & Environmental Science*. 2018, 11, 952-959.

103. Study of the Partial Substitution of Pb by Sn in Cs–Pb–Sn–Br Nanocrystals Owing to Obtaining Stable Nanoparticles with Excellent Optical Properties. Vitoreti, A.Beatriz Fe; Agouram, S.; de la Fuente, M.Solis; Muñoz-Sanjosé, V.; Schiavon, M.Antônio; Mora-Seró, I. *The Journal of Physical Chemistry C*. 2018, 122,39, 14222-14231.

104. Do Capacitance Measurements Reveal Light-Induced Bulk Dielectric Changes in Photovoltaic Perovskites?. Almora, O.; Aranda, C.; Garcia-Belmonte, G. *The Journal of Physical Chemistry C*. 2018, 122, 13450-13454.

105. Crystalline-Size Dependence of Dual Emission Peak on Hybrid Organic Lead-Iodide Perovskite Films at Low Temperatures. Chulia-Jordan, R.; Mas-Marzá, E.; Segura, A.; Bisquert, J.; Martínez-Pastor, J.P. *The Journal of Physical Chemistry C*. 2018, 122, 22717−22727.

106. Effects of Frequency Dependence of the External Quantum Efficiency of Perovskite Solar Cells. Ravishankar, S.; Aranda, C.; Boix, P.P.; Anta, J.A.; Bisquert, J.; Garcia-Belmonte, G. The Journal of *Physical Chemistry Letters*. 2018, 9, 3099-3104.

107. Quantification of bio-anode capacitance in bioelectrochemical systems using Electrochemical Impedance Spectroscopy. terHeijne, A.; Liu, D.; Sulonen, M.; Sleutels, T.; Fabregat-Santiago, F. *Journal of Power Sources*. 2018, 400, 533-538.

108. Tuning optical/electrical properties of 2D/3D perovskite by the inclusion of aromatic cation. Rodríguez-Romero, J.; Hames, B.Clasen; Galar, P.; Fakharuddin, A.; Suárez, I.; Schmidt-Mende, L.; Martínez-Pastor, J.P.; Douhal, A.; Mora-Seró, I.; Barea, E.M. *Physical Chemistry Chemical Physics*. 2018, 20, 30189-30199.

109. Tunable Open Circuit Voltage by Engineering Inorganic Cesium Lead Bromide/Iodide Perovskite Solar Cells. Ng, C.Huey; Ripollés-Sanchis, T.; Hamada, K.; Teo, S.Hwa; Lim, H.Ngee; Bisquert, J.; Hayase, S. *Scientific Reports*. 2018, 8, 2482.

110. Quantification of Ionic Diffusion in Lead Halide Perovskite Single Crystals. Peng, W.; Aranda, C.; Bakr, O.M.; Garcia-Belmonte, G.; Bisquert, J.; Guerrero, A. *ACS Energy Letters*. 2018, 3, 1477−1481.

111. Discerning recombination mechanisms and ideality factors through impedance analysis of high-efficiency perovskite solar cells. Almora, O.; Cho, K.Taek; Aghazada, S.; Zimmermann, I.; Matt, G.J.; Brabec, C.J.; Nazeeruddin, M.Khaja; Garcia-Belmonte, G. *Nano Energy*. 2018, 48, 63-72.

112. Recent insights for achieving mixed halide perovskites without halide segregation. Gualdrón-Reyes, A.Fabián; Joon, Y.Seog; Mora-Seró, I. *Current Opinion in Electrochemistry*. 2018, 11, 84-90.

113. Pyrene-Connected Tetraimidazolylidene Complexes of Iridium and Rhodium. Structural Features and Catalytic Applications. Gutierrez-Blanco, A.; Peris, E.; Poyatos, M. *Organometallics*. 2018, 37, 4070-4076.

114. IrIII/AuI and RhIII/AuI Heterobimetallic Complexes as Catalysts for the Coupling of Nitrobenzene and Benzylic Alcohol. Böhmer, M.; Kampert, F.; Tan, T.Tsai Yuan; Guisado-Barrios, G.; Peris, E.; Hahn, E. *Organometallics*. 2018, 37, 4092-4099.

115. Immobilization of Pyrene-Adorned N-Heterocyclic Carbene Complexes of Rhodium(I) on Reduced Graphene Oxide and Study of their Catalytic Activity. Ruiz-Botella, S.; Peris, E. *ChemCatChem*. 2018, 10, 1874-1881.

116. Key factors in pincer ligand design. Peris, E.; Crabtree, R.H. *Chemical Society Reviews*. 2018, 47, 1959-1968.

117. A Comparative Study of Light-Emitting Diodes Based on All-Inorganic Perovskite Nanoparticles (CsPbBr3) Synthesized at Room Temperature and by a Hot-Injection Method. Clasen, B.; Sánchez, R.; Fakharuddin, A.; Mora-Seró, I. *ChemPlusChem*. 2018, 83, 294-299.

118. How Do Perovskite Solar Cells Work?. Mora-Seró, I. *Joule*. 2018, 2, 583-593.

119. Iridium complexes catalysed selective dehydrogenation of glucose to gluconic acid in water. Borja, P.; Vicent, C.; Baya, M.; Garcia, H.; Mata, J.A. *Green Chemistry*. 2018, 20, 4094 – 4101.

120. Stabilization of nanoparticles produced by hydrogenation of Palladium-NHC complexes on the surface of graphene and implications in catalysis. Mollar-Cuni, A.; Ventura-Espinosa,

D.; Martín, S.; Mayoral, A.; Borja, P.; Mata, J.A. *ACS Omega*. 2018, 3, 11, 15217–15228.

121. Insight into Photon Recycling in Perovskite Semiconductors from the Concept of Photon Diffusion. Ansari-Rad, M.; Bisquert, J. *Physical Review Applied*. 2018, 10, 034062.

122. Semiconductor α-Fe2O3 Hematite Fabricated Electrode for Sensitive Detection of Phenolic Pollutants. Rahman, M.M.; Fabregat-Santiago, F.; Guerrero, A.; Asiri, A.M.; Bisquert, J. *ChemistrySelect*. 2018, 3, 12169.

123. Selective CO2 Hydrogenation to Formic Acid with Multifunctional Ionic Liquids, Weilhard, A., Qadir, M. I., Sans, V., Dupont, J. *ACS Catalysis*, 2018, 8, 1628–1634

18. Book chapters

1. Title: Impedance Spectroscopy in Molecular Devices
   Autors: Francisco Fabregat-Santiago, Eva Mª Barea, Juan Bisquert, Sixto Giménez
   Edition: Molecular Devices for Solar Energy Conversion and Storage, 2018 Eds.; Tian, Haining; Boschloo, Gerrit; Hagfeldt, Anders Springer, Singapore, pp 353 - 384.

2. Title: Photoelectrochemical Tools for the Assessment of Energy Conversion Devices
   Author: Isaac Herraiz Cardona; Sixto Gimenez
   Edition: In Nanomaterials for Energy Conversion and Storage, 1-9, pp. 361-395. World Scientific, 2018.

19. Thesis

1. Title: Bulk and Interfacial Engineering to Enhance Photovoltaic Properties of Iodide and Bromide Perovskite Solar Cells
   Author: Clara Aranda Alonso
   Supervised by: Prof. Juan Bisquert and Antonio Guerrero
   Date: 27/11/2019

2. Title: Mesoscale additively manufactured flow reactors for synthetic, crystallisation and bio-transamination applications
   Author: Obinna Okafor
   Supervised by: Victor Sans and Ruth Goodridge
   Date: 14/11/2019

3. Title: Analysis of the Interaction of Halide Perovskite with Other Materials and its Effect on the Performance of Optoelectronic Devices
   Author: Thi Tuyen Ngo
   Supervised by: Ivan Mora-Seró
   Date: 20/11/2019

4. **Title:** TEMPO and RTILs for the Sustainable Development of TEMPO - mediated Alcohol Electrooxidation
Author: Astrid Delorme
Supervised by: Victor Sans Sangorrin, Darren Walsh, Peter Licence
Date: 12/11/2019

5. **Title:** Sistemas de baja dimensionalidad para aplicaciones fotovoltaicas y optoelectrónicas
Author: Bruno Clasen
Supervised by: Ivan Mora-Seró
Date: 24/09/2019

6. **Title:** Device Modeling of Perovskite Solar Cells using Small Perturbation Methods
Author: Sandheep Ravishankar
Supervised by: Juan Bisquert
Date: 16/09/2019

7. **Title:** Design, Synthesis, and Characterization of New Generation Lithium Batteries
Author: Nuria Vicente
Supervised by: Germà Garcia-Belmonte
Date: 26/06/2019

8. **Title:** Novel Catalytic Systems for Carbon Dioxide Activation
Author: Andreas Weilhard
Supervised by: Victor Sans Sangorrin
Date: 22/05/2019

9. **Title:** Rationale Design of Inorganic Up-converting Nanophosphors Towards Advanced Optical Applications
Author: Fabrizio Guzzetta
Supervised by: Beatriz Julián Lopez
Date: 17/09/2018

20. New trends of scientific publication

INAM is engaged in the publication of the results in open access, using open access journals and the repository of UJI (http://repositori.uji.es/xmlui/). Most of INAM publications are managed in such a way to comply with “open access” requirement. Journals are generally selected among those that both respect the authors’ interests and accept open access publication (with an embargo period). INAM researchers use an open access repository at UJI, connected to the tools proposed by the European Commission (open AIRE), to grant access to the publications and to a bibliographic metadata in a standard format including information requested by the funding agencies.

21. Research Projects

1. International funding

Title: Ground- breaking Perovskite Technologies for Advanced X Ray medical imaging systems
Acronym of the project: PEROXIS
Funding entity: European Commission
Modality: H2020-ICT-2018-2020
Entity code: 7836/2018
Principal researchers: Germà Garcia-Belmonte
Dates: 2020-2022
Total amount: 5.977.499,00 €

Title: DROP-IT – Drop-on demand flexible optoelectronics & photovoltaics perovskites
Acronym of the project: DROP-IT
Funding entity: European Commission
Modality: FETOPEN-01-2019
Entity code: 862656
UJI accounting code: 19I410
Principal researchers: Iván Mora-Seró
Dates: 2019-2022
Total amount: 424.277,00€

Title: No-Limit - Boosting Photovoltaic Performance By The Synergistic Interaction Of Halide Perovskites And Semiconductor Quantum Dots
Acronym of the project: NO LIMIT
Funding entity: ERC- European Research Council
Modality: ERC consolidator
Entity code: ERC-2016-COG/ERC-2016-COG-724424
Principal researchers: Iván Mora-Seró
Dates: 2017-2022
Total amount: 2.000.000 €

Title: An Artificial Leaf: a photo-electro-catalytic cell from earth-abundant materials for sustainable solar production of CO2-based chemicals and fuels
Acronym of the project: ALEAF
Funding entity: European Commission
Modality: Collaborative project H2020-FETPROACT
Entity code: 732840
Principal researchers: Juan Bisquert, Sixto Giménez
Dates: 2017-2020
Total amount: 443.770 €

Title: Making Perovskites Truly Exploitable
Acronym of the project: MAESTRO
Funding entity: European Union
Modality: European Training Networks (MSCA-ITN-ETN)
Entity code: 764787

Principal researchers: Francisco Fabregat-Santiago
Dates: 2017-2021
Total amount: 3.852.446 €

2. National projects

Title: Síntesis de productos de alto valor añadido mediante sistemas fotoelectrocatalíticos avanzados
Acronym of the project: VALPEC
Funding entity: Ministerio de Ciencia e Innovación
Modality: Convocatoria de ayudas correspondientes al programa estatal fomento de la investigación científica y técnica de excelencia
Entity code: ENE2017-85087-C3-1-R
Principal researchers: Francisco Fabregat-Santiago/Sixto Gimenez
Dates:2018-2020
Total amount:194.810 €

Title: Supramolecular Organometallic Structures for Catalysis and Molecular Recognition
Acronym of the project: SUPRACAT
Funding entity: Ministerio de Ciencia e Innovación
Modality: Ayuda Estatal Fomento de la Excelencia
Entity code: PGC2018-093382-B-I00
Principal researchers: Eduardo Peris and Macarena Poyatos
Dates: 2019-2021
Total amount: €

Title: Funcionalización de grafeno con complejos metálicos definidos en transformaciones catalíticas sostenibles: Almacenamiento de hidrógeno y conversión de biomasa.
Acronym of the project: FG-Cat
Funding entity: MINECO
Modality: Programa Estatal de I+D+i Orientada a los Retos de la Sociedad
Entity code: RTI2018-098237-B-C22
Principal researchers: Jose Mata
Dates: 2019-2021
Total amount: 60.000 €

Title: Catalytic applications of organometallic complexes immobilized on the surface of graphenes.
Acronym of the project: CATSURGRAPH
Funding entity: MINECO
Modality: Programa Estatal de I+D+i Orientada a los Retos de la Sociedad
Entity code: CTQ2015-69153-C2-2-R
Principal researchers: Jose Mata
Dates: 2016-2018
Total amount: 65.000 €

Title: Perovskita fotovoltaicas de alto rendimento
Acronym of the project: PEREST
Funding entity: Ministerio de Economía y Competitividad

Modality: Programa Estatal de I+D+i Orientada a los Retos de la Sociedad
Entity code: MAT2016-76892-C3-1-R
Principal researchers: Juan Bisquert, Germà Garcia-Belmonte
Dates: 2016-2019
Total amount: 200.000 €

Title: RYC Antonio Guerrero
Acronym of the project: RYC-2014-16809
Funding entity: Ministerio de Economía y Competitividad
Modality: Ramon y Cajal
Entity code: RYC-2014-16809
Principal researchers: Antonio Guerrero
Dates: 2015-2020
Total amount: 40.000 €

Title: Ayudas Juan de la Cierva-Incorporación
Acronym of the project: JdC
Funding entity: Ministerio de Economía y Competitividad
Modality: Formación Del Subprograma Estatal de Incorporación del Programa Estatal de Promoción Del Talento y Su Empleabilidad.
Entity code: IJCI-2015-23407
Principal researchers: Eduardo Peris
Dates: 2017-2019
Total amount: 64.000 €

Title: Catalytic applications of organometallic complexes immobilized on the surface of graphenes
Acronym of the project: GRAPHCAT
Funding entity: Ministerio de Economía y Competitividad
Modality: Programa Estatal de I+D+I Orientada a losRetos de la Sociedad
Entity code: CTQ2015-69153-C2-2-R
Principal researchers: Jose Mata
Dates: 2016-2018
Total amount: 55.000 €

Title: Perovskitas para conversión de energía solar y optoelectrónica
Acronym of the project: Red Perovskita
Funding entity: Ministerio de Ciencia e Innovación
Modality: Convocatoria de ayudas correspondientes al programa estatal fomento de la investigación científica y técnica de excelencia
Entity code: ENE2017-90565-REDT
Principal researchers: Juan Bisquert
Dates: 2019-2020
Total amount: 19.000 €

3. Regional projects

Title: Integrating Desing Across the Scales (IDEAS): from molecules to active devices with Additive manufacturing

Acronym of the project: CIDEGENT
Funding entity: Generalitat Valenciana
Modality: Convocatoria 2018 de subvenciones del programa para el apoyo a personas investigadoras con talento-plan GENT
Entity code: CIDEGENT/2018/036
Principal researchers: Víctor Sans Sangorrín
Dates:2019-2022
Total amount: 368.665 €

Title: Creación de una unidad científica de la innovación empresarial en el INAM de la Universitat Jaume I
Acronym of the project: UCIE INAM
Funding entity: Generalitat Valenciana
Modality: Agencia valenciana de la innovació
Entity code: A11I - CONTRACTES ART 83 LOU
UJI accounting code: 19I039
Principal researchers: Juan Bisquert
Dates: 2019
Total amount:250.000 €

Title: Sintesis de combustibles y valoración de aguas residuales a partir de energías renovables
Acronym of the project: IDIFEDER
Funding entity: Generalitat Valenciana
Modality: Convocatoria de ayudas para infraestructura y equipamiento de I+D+I PO FEDER 2018-2020
Entity code: IDIFEDER/2018/012
Principal researchers: Juan Bisquert
Dates: 2018-2020
Total amount: 577.792 €

Title: Sistemas cuánticos para el desarrollo de dispositivos optoelectrónicos
Acronym of the project: Q-DEVICES
Funding entity: Generalitat Valenciana
Modality: Programa PROMETEU
Entity code: PROMETEO/2018/098
Principal researchers: Iván Mora-Seró
Dates: 2018-2021
Total amount: 312.595 €

Title: Complejos poliaromáticos de Au(I) alquinilo: síntesis y propiedades fotofísicas
Acronym of the project: NHCsforLIGHT
Funding entity: Generalitat Valenciana
Modality: Programa AICO (Subvencions per a grups d'investigació consolidables)
Entity code: AICO/2019/149
Principal researchers: Macarena Poyatos
Dates: 2019-2020
Total amount: 40.000 €

4. Local projects from UJI

Title: Desarrllo de perovskitas bidimensionales (2D) para la mejora del transporte electrónico en dispositivos fotovoltaicos de alta estabilidad
Acronym of the project: DEPE2D
Modality: Pla de Promoció de la Investigació UJI
Entity code: UJI-B2019-09
Principal researchers: Eva Mª Barea
Dates: 2020-2022
Total amount: 18.000 €

Title: Desarrollo de rutas fotoelectrocatalíticas para la síntesis de productos de alto valor añadido
Acronym of the project: FOTOSIN
Modality: Pla Propi d'Investigació UJI
Entity code: UJI-B2019-20
Principal researchers: Elena Mas Marzá
Dates: 2020-2022
Total amount: 24.000 €

Title: Soluciones Inteligentes para la energía eléctrica basadas en dispositivos de células solares de perovskitas
Acronym of the project: SOLENPE
Modality: Pla de Promoció de la Investigació UJI
Entity code: UJI-B2016-05
Principal researchers: Eva Mª Barea
Dates: 2016-2019
Total amount: 30.000 €

Title: Development of hybrid nanomaterials based on graphene@organometallic complexes: Catalytic applications at the edge of homogeneous/heterogeneous processes.
Acronym of the project: GRAPH@ORG
Modality: Pla Propi d'Investigació UJI - Modalitat B) Grups consolidats investigador individuals
Principal researchers: Jose Mata
Dates: 2016-2018
Total amount: 20.000 €

Title: Design of catalysts for the development of efficient energy storage systems based on liquid organic hydrogen carriers.
Acronym of the project: CatLOHCs
Modality: Pla Propi d'Investigació UJI - Modalitat B) Grups consolidats i investigador individuals
Entity code: UJI-B2018-23
UJI accounting code: 18I401.01/1
Principal researchers: Jose Mata
Dates: 2019-2021
Total amount: 22.000 €

Title: New ENhanced Up-converting Photonic ARquitectures for advanced applications

Acronym of the project: NENUPhAR
Modality: Ayudas para el fomento de la investigación científíca
Entity code: B2018-71
Principal researchers: Beatriz Julian-Lopez
Dates: 2019-2021
Total amount: 15.882 €

Title: Transformación de Energía Solar en Combustibles solares a partir de Perovskitas
Acronym of the project: TRESCOPE
Modality: Programa de Fomento de proyectos de investigación
Entity code: UJI-B2017-32
Principal researchers: Antonio Guerrero
Dates: 2018-2020
Total amount: 29.122 €

Title: Nanoestructuras metalo-orgánicas para catálisis y reconocimiento molecular
Acronym of the project: SUPRACAT
Modality: Pla Propi d'Investigació UJI - Modalitat B) Grups consolidats i investigador individuals
Entity code: UJI-B2017-07
Principal researchers: Eduardo Peris
Dates: 2018-2020
Total amount: 40.000 €

Title: Diseño de ligandos NHC poliaromáticos capaces de coordinar en forma bis-pinza. Propiedades catalíticas y fotofísicas
Acronym of the project: PINCERforCAT
Modality: Pla Propi d'Investigació UJI - Modalitat B) Grups consolidats i investigador individuals
Entity code: UJI-B2018-46
Principal researchers: Macarena Poyatos
Dates: 2019-2021
Total amount: 25.813 €

5. Contracts with companies

Title: Estudio de materiales y recubrimientos avanzados para el enfriamiento de edificios
Acronym of the project: RADIAKER
Funding entity: KERABEN
Modality: A11I - CONTRACTES ART 83 LOU
Entity code: 26599
Principal researchers: Juan Bisquert
Dates: 2019-2020
Total amount: 16.500 €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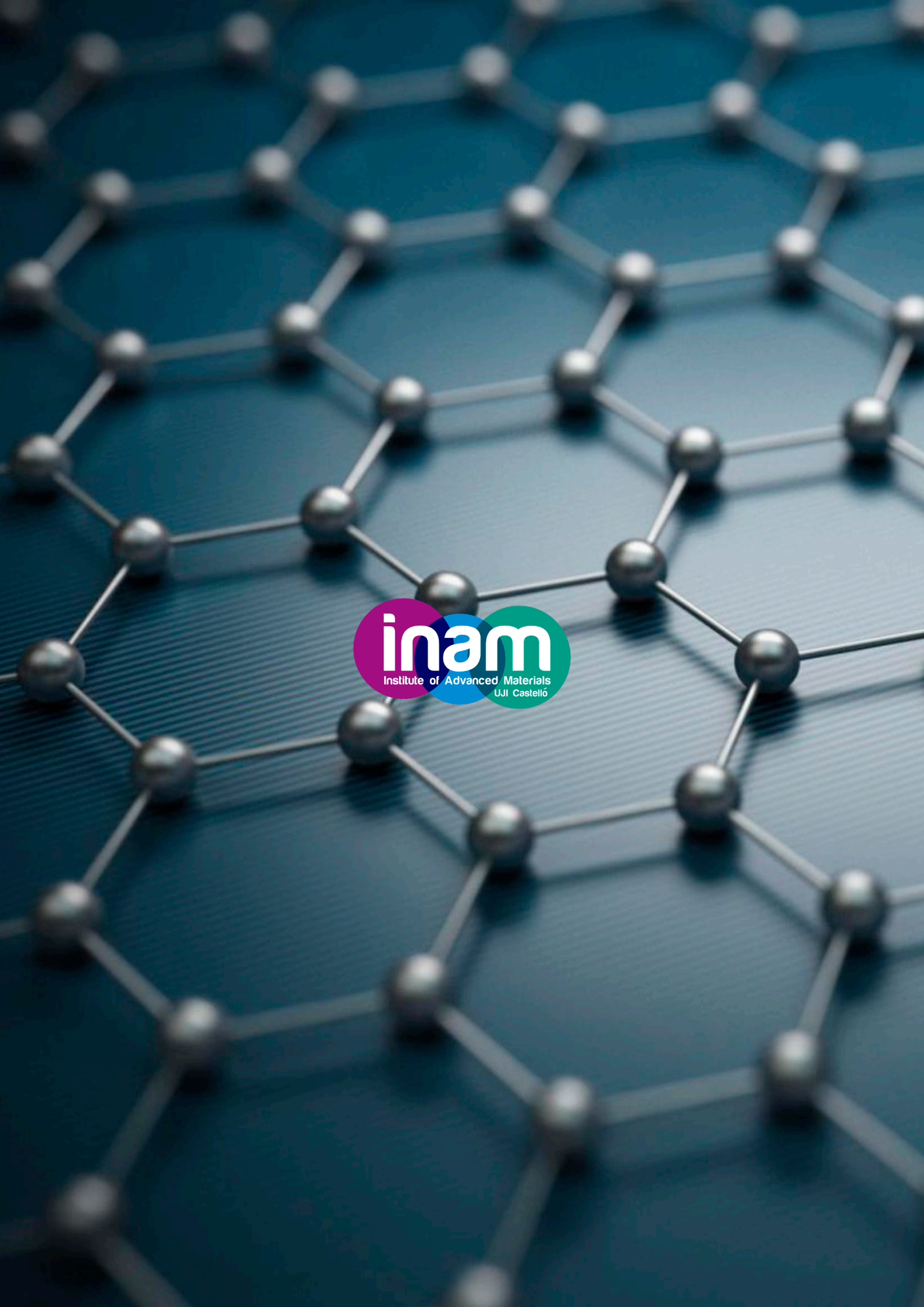
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