

ICIQ

Institut
Català
d'Investigació
Química

Annual Scientific Report Summary

'17

BIST

Barcelona Institute of
Science and Technology

LETTER FROM THE DIRECTOR



Dear friends,

Thank you for browsing the 2017 ICIQ Scientific Report. I hope you enjoy it.

In this booklet you will find a summary of ICIQ's achievements during 2017. Among them, our success in securing European funding. Specifically, **we obtained funding for three Innovative Training Networks (ITN) from the Marie Marie Skłodowska-Curie Actions programme.** We'll be coordinating two of them, Noah (focused in the design of new methodologies for molecular encapsulation) and Viro-Flow (ICIQ's first European Industrial Doctorate centered on the study new synthetic methodologies in flow chemistry). And we're part of another ITN, eSCALED, a European Joint Doctorate related to artificial photosynthesis. The overall funding awarded was €3.2M.

We're also proud of the creation of **ICIQ's first spin-off company, Orchestra Scientific.** Orchestra commercializes membrane technology to separate CO₂ from biogas and capture it from industrial emissions and scientific instrumentation developed in Prof. José-Ramón Galán-Mascarós' laboratory. This is a good example of extraordinary success in being in the position of transferring a technology to the industry.



With respect to research outputs, the institute continued being very active, publishing **173 high quality scientific papers during the year (86% in the first quartile and 61% decile journals)** with an average impact factor of nearly 9. The institute reached Hirsch index 127 in December and topped international rankings measuring scientific excellence like excellencemapping.net and <http://www.natureindex.com>.

Finally, I would like to emphasize the importance of the **culmination of ICIQ's strategic plan for the 2017-2021 period**. The plan is the result of the hard and many dedicated ICIQ researchers, technicians, management and administration staff members. Our goal is to make available to ICIQ's staff the resources and tools necessary to carry out an inclusive science for a sustainable society. We want to implement the different actions to be taken in order to make ICIQ a talent platform, increase and consolidate our collaboration with industry and implement the RRI (Responsible Research and Innovation) principles in all ICIQ's activities.

Best regards,

Miquel À. Pericàs

19 RESEARCH
GROUPS

1 ERC ADVANCED
GRANTS

1 ERC
CONSOLIDATOR
GRANTS

5 ERC STARTING
GRANTS

1 ERC PROOF OF
CONCEPT GRANTS

9 ICREA RESEARCH
PROFESSORS

FACTS & FIGURES 2017

Scientific Production

173

PEER-REVIEWED PUBLICATIONS IN 2017

1.741

TOTAL NUMBER OF PUBLICATIONS SINCE 2004

2017
173 Pubz.



87%

OF PAPERS IN Q1 JOURNALS

Q1

H-INDEX

127

44.7

AVERAGE CITATIONS PER PAPER SINCE 2004

3rd*

POSITION ON BEST PAPER RATE

3

*Mapping Scientific Excellence

Team ICIQ

344

STAFF MEMBERS



80% SCIENTIFIC PERSONNEL

42% RESEARCHERS FROM ABROAD

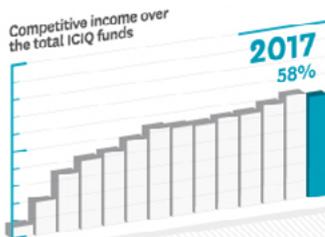
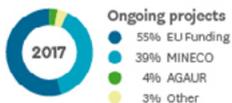


- 19 Group leaders
- 89 Postdocs
- 26 Project researchers
- 100 PhD students
- 6 Master students
- 9 Lab technicians
- 27 Scientific core facilities personnel

276

RESEARCH AREA PERSONNEL





European Research Council (ERC) Grants (2007-2017)



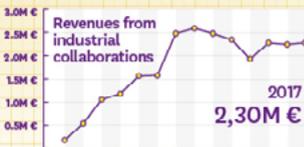
Innovation



ICIQ / Industry Joint Units



Technology Development Units



Spin-off Companies



Science Communication & Education

296 media impacts
 62 intl. impacts

f 2205 likes

t 3340 followers

Kids PRIMARY SCHOOLS



HIGHLIGHTS OF THE YEAR



€3.2M FOR ITN PROJECTS

Within Horizon 2020, the European Union funds the creation of innovative training networks (ITN). In the 2017 call, ICIQ was selected to coordinate two of these networks and participate as partner in a third.

NOAH: Prof. Pau Ballester coordinates this ITN focused on the design of new methodologies for molecular encapsulation. **It will train 10 new PhDs.**

VIRO-FLOW: ICIQ's technology unit ERTFLOW, coordinates **ICIQ's first European Industrial Doctorate** ITN network. **It will train 3 new PhDs** who will carry out half of their research at AiCuris, a German company specialised in the development of new antibiotics and antivirals.

eSCALED: Prof. Antoni Llobet participates as a partner in eSCALED, a **European Joint Doctorate that will train 11 PhDs.** Their research will be focused on artificial photosynthesis.

CELEBRATING 10 YEARS OF ERC

The European Research Council turned 10 in 2017. At ICIQ we wanted to join this celebration. To do so, we organised a full “ERC Day” on March 16th, at the ICIQ Auditorium. The event featured invited talks by Prof. Andreu Mas-Colell (BIST President and former ERC Secretary General), Dr. Esther Rodríguez Blanco (ERC National Contact Point), and Prof. Antonio Echavarren (ICIQ Group Leader and ERC Advanced grantee) among other contributions.

Since the ERC started, ICIQ has been awarded 15 projects, meaning **more than €17 million in competitive funding**. This money has helped ICIQ create a total of 125 jobs between PhD students, Postdocs and Technicians. Thanks to ERC funding, groups were able to buy state of the art equipment to develop their research, making a total of 71 devices. One of the main goals of the ERC is promoting high quality, high impact research that can be transferred to society. In this regard, ICIQ published 215 peer-reviewed papers and was granted two patents thanks to ERC funding.

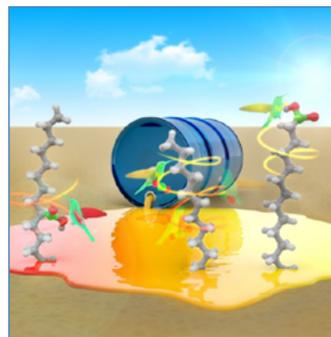


A TASTE OF OUR 2017 HARVEST

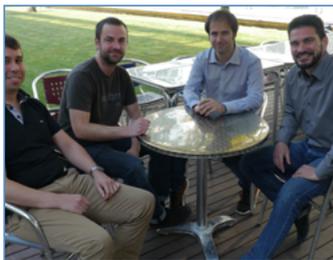
Nickel: a greener route to fatty acids

A team led by Prof. Rubén Martín designed a nickel catalyst that easily transforms petroleum feedstocks into valuable compounds like fatty acids. The process is environmentally friendly: not only does it work at room temperature and atmospheric pressure, but it also recycles carbon dioxide, contributing to the fight against climate change.

Fatty acids are key in several industrial processes like the manufacture of soaps, plastics –such as nylon– and dyes. Experts estimate that the global market for these compounds could reach \$20 billion in the next few years. Classical synthetic methods for obtaining fatty acids often require toxic and hazard-



ous reagents like carbon monoxide and extreme pressures and temperatures. But Prof. Martín synthesized a sustainable nickel catalyst that solves both problems. It leads to pure fatty acids from raw hydrocarbons and CO₂, which is less toxic than carbon monoxide. This work was published in *Nature*.

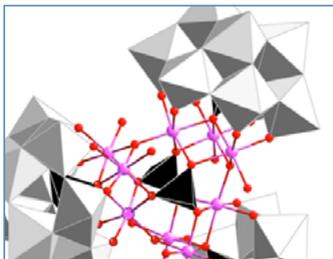


From left, Y.P. Rey, C.Verrier, L. Buzzetti and P. Melchiorre

New catalysts mimic human vision

Photoreceptors in vertebrates typically consist of two different, colourless parts: an organic pigment and a protein. When both pieces combine, they create a colourful, light-sensitive molecule –an iminium ion– that triggers vision upon light excitation. Inspired by this mechanism, a team of researchers at ICIQ created a new family of sustainable, environmentally friendly catalysts that can be ‘switched on’ using purple LEDs.

“Despite being a well-known mechanism in biochemistry, the photo-excitation of iminium ions hadn’t been used to make chiral molecules yet,” said Paolo Melchiorre, ICIQ Group Leader and ICREA Professor, who led the study. “Thanks to this novel approach, triggered by visible light, we can obtain products that were impossible to achieve using traditional thermally-activated transformations,” he added.



The new cobalt-tungsten polyoxometalate

Cobalt and tungsten – together to produce cheaper, cleaner hydrogen

Electrolysis, splitting the water molecule with electricity, is the cleanest way to obtain hydrogen, a clean and renewable fuel. Researchers at ICIQ and URV, led by Prof. José Ramón Galán-Mascarós, designed a new catalyst that reduces the cost of electrolytic hydrogen production.

‘Normally, hydrogen is obtained from using a cheap process called steam reforming. But this is not clean hydrogen, this process uses natural gas and

produces carbon dioxide and other contaminants,' explained Galán-Mascarós. 'Breaking the water molecule is cleaner, but it's not easy. We need to develop new cheap, efficient catalysts that allow us to obtain hydrogen at a competitive price,' he says. To date, the best catalysts are based in iridium oxides, but iridium is a very expensive and scarce precious metal.

A CASE OF SUCCESS

Orchestra Scientific: a new spin-off to capture CO₂

In 2017, ICIQ researchers discovered a blue material capable of 'trapping' CO₂ molecules. This new material – a metal-organic framework– slows down CO₂ molecules, allowing the separation of carbon dioxide in a mixture of gases. This novel technology has been commercialised by ICIQ's new spin-off company – Orchestra Scientific. The project was born in Prof. José Ramón Galán-Mascarós' group, and grew thanks to the support of the Obra Social "la Caixa" Foundation in ICIQ's Incubator Call.

The technology incorporates the blue MOF into thin plastic layers that, rolled up, can be fitted in gas pipes and reactors. When gas mixtures circulate through these rolls, CO₂ molecules are slowed down and separated from the mixture, which is particularly useful for biogas refinery.



ONE CLICK AWAY CHEMISTRY

ICIQ Virtual Laboratory

In 2017 we launched the ICIQ Virtual Lab, an online platform providing open access to educational materials to better understand chemistry. The Virtual Lab presents experiments and information specially designed for the educational community as well as showcasing the ICIQ researchers and the institute's main fields of research. ICIQ's outreach strategy is focused on raising



public awareness of chemical research as a key factor in the progress of society and of its benefits in terms of health, energy and environmental sustainability. In this sense, the main concern is to contribute to improving chemical learning and, in doing so, encouraging young people to pursue a career in chemistry research.



ICIQ meeting to map out ICIQ's new strategic plan

OUR FUTURE

ICIQ's new strategic plan

On June 20th-21st ICIQ group leaders, area managers and members from most of the ICIQ units got together in Falset (Priorat) to review and make proposals to map out our institute's strategic plan for 2017-2021. Working sessions were held to define ICIQ's common scientific challenges, discuss the different actions to be taken in order to make ICIQ a talent platform, increase and consolidate our collaboration with the industry and implement the RRI (Responsible Research and Innovation) principles in all ICIQ's activities.

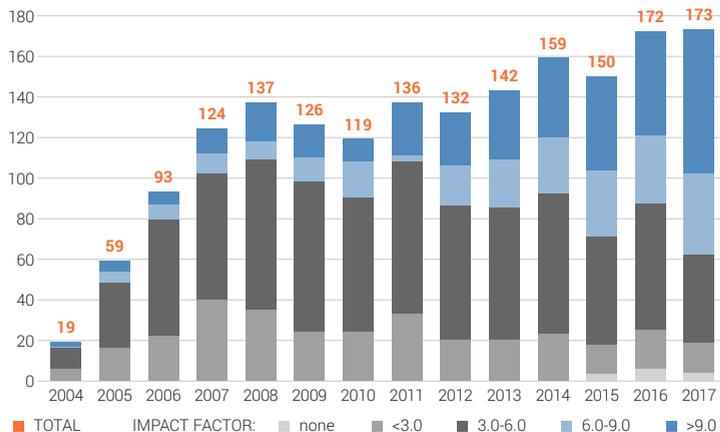
The ultimate goal is to create the conditions to undertake first-rate research, attract the best international talent and support researchers in each stage of their careers, strengthen our capacity to facilitate the transference of knowledge and engage young people, and the general public, in our passion for chemistry.

In 2017, the web application Mapping Scientific Excellence ranked ICIQ in third position on “Best Paper Rate” (proportion of highly cited papers published by an institution) and second on “Best Journal Rate” (ratio of papers published in the most influential journals) in the field of Chemistry worldwide.

ICIQ’s privileged position in this list confirms the Institute’s strong evolution towards scientific excellence since the beginning of its research activities in 2004. Since then, ICIQ has published more than 1700 scientific articles. In 2017, 86% of the publications have been published in the most influential chemical research journals in the world, those ranked in the first quartile (Q1-journals within the top 25 % of journals with highest IF).

ICIQ has made a firm commitment to facilitate access to the research carried out at the Institute. Thus, we follow a policy of publishing in open access, as far as possible, the results of our research, as a way to improve the dissemination of knowledge and innovation. Our publications are available in the open access Recercat (CSUC) repository.

Publications



SCIENTIFIC PRODUCTION

Articles in 2015

173

Total articles (2004-2017)

1,741

h-Index

127

Citations in 2017

11,113

Total citations (2004-2017)

80,151

Average citations (2004-2017)

44.7

KNOWLEDGE AND TECHNOLOGY TRANSFER

Research projects

16

Patents

22

Technology Development Units

3



CRYFORMA



CSOL
Catalytic Solutions

ERTFLOW
Efficient Reaction Technology

Joint Units ICIQ-Industry

2

unitas
materia
ICIQ³
ESTEVE



Spin-off companies

1



Orchestra Sci.
Catalytic Solutions

REACHING OUT TO THE CHEMICAL AND PHARMACEUTICAL INDUSTRY

Transfer of knowledge and technology to the industrial sector is an integral part of the institute's activities.

Globally, **16 research projects with industry were active during 2017**, including the Esteve-ICIQ and Henkel-ICIQ joint units. In 2017 we created our first spin-off company: **Orchestra Scientific**, which has developed an economically affordable, modular and eco-friendly technology to separate CO₂ from biogas and capture it from industrial emissions.

5 new patents were applied for, arising from the research results from ICIQ's groups. **CSOL** was involved in 9 valorization projects to further develop inventions or know-how from ICIQ's groups. Additionally, CSOL was involved in two collaborations with industrial partners.

Cryforma increasingly collaborated with international companies in the field of solid state development of APIs. Collaborations in 2017 included German, Chinese, Dutch and Irish companies.

Ertflow continued to generate long-term collaborations with industrial partners in the field of flow chemistry. During 2017, in collaboration with the German biotech company Aicuris, Ertflow was granted a European Industrial Doctorate project involving 3 PhD students.

PREPARING THE NEXT GENERATION OF TOP RESEARCHERS

ICIQ has a strong commitment to offer training programmes for under-graduates, graduate students and doctoral researchers. We prepare a new generation of researchers with the skills and knowledge needed to tackle the most important challenges in chemical research. We are also eager to prepare graduate and post-graduate students to undertake research careers in chemistry. Our Complementary Training Programme offers training such as weekly scientific seminars, technical workshops, international research stages, language courses, ICIQ Summer School, and other soft skills courses and activities.

Programmes



ICIQ Summer Fellowship Programme



ICIQ-URV Master in Synthesis, Catalysis and Molecular Design



BIST-UPF Master of Multidisciplinary Research in Experimental Sciences



SO-ICIQ Graduate Students Programme



ICIQ International Postdoctoral Mobility Programme

ADVANCED TRAINING

Seminars

38

ICIQ Seminar Programme funded by

 **BASF**
The Chemical Company

Theses defended

32

Summer fellows

10

Master students

9

PhD students

100

Postdoctoral researchers

89

PUBLIC ENGAGEMENT



ENGAGING YOUTH TO PURSUE A CAREER IN CHEMISTRY

We seek to raise public awareness of chemical research as a key factor in the progress of our society. ICIQ is also committed to engage and encourage youngsters to pursue a career in chemistry research. To this end we carry out several outreach activities to audiences of all ages as a way to get chemistry closer to society.

In 2017 we implemented three new activities: the **ICIQ Virtual Laboratory**, an online platform that gives **open access to educational materials** to better understand chemistry; the **“Science of Chocolate”** programme, aimed at reaching out to primary school students and **particularly focused in raising girls’ interest in science**; and the first workshop (“Colors”) within the **“Banc d’Espanya” project**, Tarragona’s future science education center.

Moreover, we carried out our traditional “Química en família” workshop for children; **ICIQ’s summer camp** in chemistry for primary school and ESO students; scheduled weekly chemistry workshops addressed to high school in the **ICIQ Teaching and Learning Laboratory**; carried out the **“From the Lab to the Classroom Programme”** to inspire and train teachers in topics and methodologies to teach chemistry; and our PhD students delivered talks about their research within the frame of the **“Science at School”** programme of FCRI. We also participated in science fairs and visits to primary schools to perform chemistry experiments.

Finally, we organized the fourth edition of **“Crazy about Chemistry”**. A year-long course in chemistry addressed to high school students with a special interest and talent on chemistry and research. We also participated in the second edition of **BIYSC** (Barcelona International Youth Science Challenge) with a project on artificial photosynthesis. Both programmes are funded by the Fundació Catalunya-La Pedrera.





Institut
Català
d'Investigació
Química

Institute of Chemical Research of Catalonia

Av. Països Catalans 16,
43007 Tarragona (Spain)

Tel. +34 977 920 200

iciq@iciq.es

www.iciq.es

Trustees:



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