



# Ircelyon

INSTITUT DE RECHERCHES  
SUR LA CATALYSE  
ET L'ENVIRONNEMENT

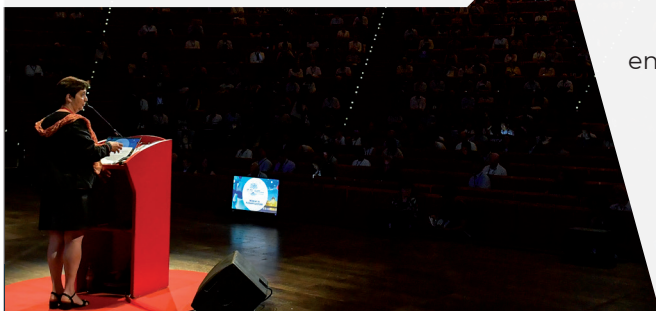
Catalytic microwave pyrolysis fluidised bed (TITAN Project) - © V. L'hopital

cnrs

Lyon1  
Université  
Claude Bernard

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The 18th ICC (International Congress on Catalysis) in 2024 was a great success. Our laboratory was heavily involved in this event, whether as part of the organising team, with its many volunteers, for the 'Roots and Wings events' or for exclusive interviews conducted by Ircelyon's CaptaScience unit. ICC 2024 included 510 oral presentations, 1,500 posters, 50 exhibitors and 2,256 participants on site! At this occasion, David Farrusseng took over the presidency of IACS (2024-2028).



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## Ircelyon

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The Research Institute on Catalysis and the Environment of Lyon (UMR 5256) is a joint Research Unit of the National Center of the Scientific Research (CNRS) and the University Claude Bernard Lyon 1 (UCBL). IRCELYON is eager to address key societal issues, such as air quality, climate change, pollution prevention, sustainable chemistry and energy production.

Pioneering heterogeneous catalysis, the Institute brings together outstanding know-how for the development of new catalysts, from their synthesis to their applications, supported by up-to-date instrumentation gathered within the IRCATECH platform. The institute research comes in support to several Sustainable Development Goals.

Therefore, IRCELYON builds a unique research environment, addressing new scientific breakthroughs and is challenging current frontiers in the field of catalysis and environmental research. Our expertise covers the design of materials having advanced properties, the full characterization of catalytic materials and reaction media, the development of unconventional catalysis, covering applications from model molecules to real feedstocks. In addition, by combining expertise in both environmental catalysis and atmospheric chemistry, we have created unique synergies to characterize and remediate air pollution, especially for ultrafine particles. The Institute is a member of local research structures (Institute of Chemistry at Lyon - ICL, consortium of Microscopy - CLYM, Federation of research in Engineering - INGELYSE). Through its scientific achievements, it is also involved in the French Excellence program (e.g., IMUST LabEX, MICA Carnot...) and innovative clusters (Axelera, Techtera, Tenerrdis...).

IRCELYON is developing its research activities in close connection with various insitutional and private partners. It is not only a key partner in national networks but also promotes international collaborations, with projects with more than thirty countries. More specifically, we initiated an International Research Project with Japan (SMOLAB). Naturally, the Institute has also strong links with a large set of European countries supported by various European programs.

Finally, IRCELYON promotes fundamental research but with a clear vision of its potential application in various industrial sectors, and therefore is intimately connected with a large number of national and international industrial partners.

**Christophe GEANTET**  
IRCELYON Director

**Pascal FONGARLAND, Christian GEORGE**  
Deputy Directors

**IRCELYON UMR 5256, CNRS, LYON1**



# Unique French European academic research center dedicated to a sustainable environment

Located on the LyonTech-la Doua campus, thanks to 7800 m<sup>2</sup> of lab-space, IRCELYON brings together **more than 170 scientists**, engineers, technicians, Ph.D. students, post-doctoral fellows and invited scientists from all over the world. (30 nationalities at IRCELYON).

The Institute sets up its research activities into **6 research teams** supported by **Ircatech, a unique R&D platform** and by technical, administrative and computer services.



## Ircelyon

### 6 RESEARCH TEAMS

### IRCATECH

Research facilities

### 4 SUPPORT SERVICES

Administrative - Instrumentation -  
Logistics - Information system



#### ATARI

Integrated thermodynamical,  
Reactional and Analytical Approaches



#### CARE

Catalytic and Atmospheric  
Reactivity for the Environment



#### CATREN

Heterogeneous Catalysis for  
Energy Transition



#### C'DURABLE

Sustainable Chemistry  
from Fundamental to Applications



#### ING

Catalyst and Process  
Engineering



#### MEME

Methodology in Environmental  
Microscopy

**Key figures**  
Per year

**150**  
articles

**5**  
patents  
filled

**50** ongoing projects  
funded by European  
(H2020, Horizon Europe, ERC)  
or National Research  
Agencies (ANR, ADEME...)  
*half coordinated by IRCELYON*

**Well-established national and international cooperations**

"Smolab" IRP - Japan

GDR Thermobio

Member of FR H2

Member of FR SPE

**20** ongoing collaborative  
projects with industrials



# IRCATECH platform

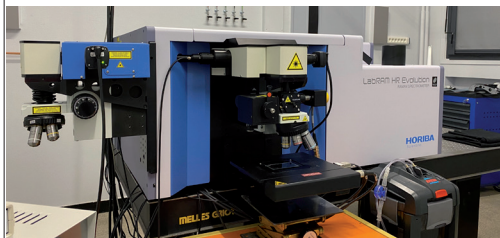
IRCELYON has a unique platform with wide and cutting-edge equipments, dedicated to the characterization of catalytic materials from ex-situ analysis to operando condition studies.



10 engineers and experts supporting research projects, collaborations and services



Available to academic and industrial partners (pricing services)



© M. Fabre IRCELYON

Raman spectrometer



**Chemical and Textural Analysis**

**Electron Microscopy**

**NMR Spectroscopy**

**Optical Spectroscopy**

**Powder X-Ray Diffraction**

**Surface Analysis : XPS, UPS, LEISS**

**Thermal Analysis**



© C. Lorentz IRCELYON

ICP-OES



A LUMA Operando platform



PROGRAMME  
DE RECHERCHE  
INTERACTION  
LUMIÈRE MATIÈRE

**TeraHertz Absorption Spectrometry**

**Photoelectron Spectroscopy**

**Environmental Microscopy  
under illumination**

Contact: [chantal.lorentz@ircelyon.univ-lyon1.fr](mailto:chantal.lorentz@ircelyon.univ-lyon1.fr) - Tel: +33 (0)4 72 44 53 39



# From fundamental to applied research, a strong interaction with industrial partners

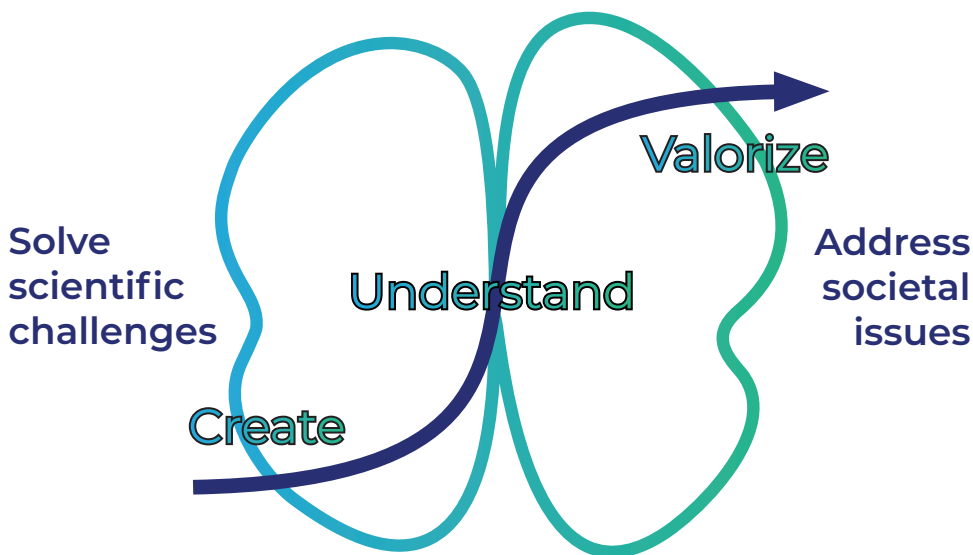
Our challenges are to create knowledge and technologies to meet the needs for alternative and green energies, safer environment and new materials. To address those, we develop approaches to characterize the catalytic materials and to understand at the fundamental level the underlying processes and mechanisms involved in the studies.

Evolving from (single steps/single site) model molecules up to complex mixtures (global processes) is essential to establish structure/activities correlations.

In the early years, most of the collaborations were established with French companies in the field of energy or petrochemistry. More recently, IRCELYON develops partnerships with large, medium and small companies in the field of fine chemistry, catalytic materials and the environmental sector.

The results of the study are patented when possible in collaboration with our industrial partners. As an example, the method for catalytic production of a methionine analogue was recently patented (WO2022084632). In the field of automotive depollution, some innovative particle filters were patented (WO2020084207 (A1)).

## IRCELYON VALUES



# A stimulating research environment for Training through Research

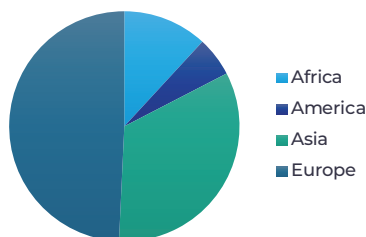
IRCELYON gives to Master and PhD students the opportunity of training through research within a stimulating environment, with high-quality supervision and access to cutting-edge equipments. IRCELYON is involved with the Doctoral School of Chemistry in Lyon and leads three mentions of Master's degrees. Moreover, IRCELYON organizes national and international training courses mainly aimed at young researchers. These summer schools focus on the last developments and provide state-of-the-art practical sessions.

**38** habilitated  
scientists (HDR)

**60** PhD  
students

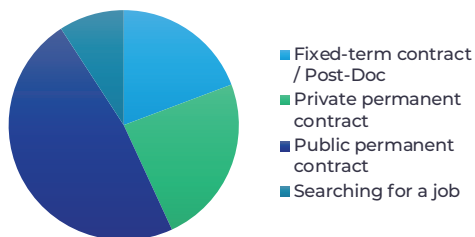
**25** Internships  
(M1, M2)

Hosting students from...



...their future

(2016-2021)



**3 mentions of Master's degrees** of the University Lyon 1 lead by IRCELYON scientists

- ✓ "Catalysis and physical Chemistry" (M2) - Master's degree in Chemistry
- ✓ "Air quality and radiation protection" (M2) - Master's degree in Ocean Sciences, Atmosphere and Climate
- ✓ "Environment, industrial and urban risks" - Master's degree in Risks and Environment

**3 summer schools**

- ✓ Annual Summer School in Calorimetry and Thermal Analysis in France
- ✓ ELITECAT, an international training school dedicated to catalysts preparation, characterization and applications
- ✓ Sino-European School on Atmospheric Chemistry in cooperation with Fudan University



# International collaborations

IRCELYON is widely open to international collaborations through short-term projects, bilateral collaboration or institutionalized cooperation frameworks. The IRCELYON international academic and industrial partners are across more than thirty countries in Europe (eg. H2020 projects), America, China, Japan, Russia...

## CANADA

- ✓ Toronto University
- ✓ Ottawa University

## UNITED-STATES

- ✓ Berkeley University of California

## MEXICO

- ✓ Autonomous university Metropolitana Izta-palapa ECOS project

## CHILE

- ✓ University of Concepción and Santiago ECOS project

## LUXEMBOURG

- ✓ Luxembourg Institute of Science and Technology

## SPAIN

- ✓ Catalan polytechnic University Barcelona
- ✓ University of Castilla - La Mancha
- ✓ Basque Center for Materials, Applications and Nanostructures (BCMaterials) - Leioa

## ITALY

- ✓ Institute for Nanostructured Materials - Palermo

## BRASIL

- ✓ The Federal University of Ceará Bilateral cooperation
- ✓ The Federal University of São João del-Rei - Brazilian Program "Science Without Border"
- ✓ University of Campinas - Brazilian Program "Science Without Border"



## GERMANY

- ✓ Leibniz-Institute for Tropospheric Research ANRI, H2020 projects
- ✓ Karlsruhe Institute of Technology

## CHINA

- ✓ Shanghai Key Laboratory of Atmospheric Particle Pollution and Prevention Fundan University
- ✓ State Key Laboratory of Catalysis Dalian Institute of Chemical Physics Chinese Academy of Sciences
- ✓ Shandong University

## INDIA

- ✓ Malaviya National Institute of Technology Jaipur (MNIT)

## VIETNAM

- ✓ PHC project

## JAPAN

- ✓ “Small Molecule Lab” an International Associated laboratory with Kyoto University, Sorbonne University (IRCP) and Air Liquide group
- ✓ National Institute of Advanced Industrial Science and Technology
- ✓ Catalysis Research Center at Hokkaido University

## HONG-KONG

- ✓ Hong Kong Polytechnic University Bilateral ANR project

*Some of our international partnerships*

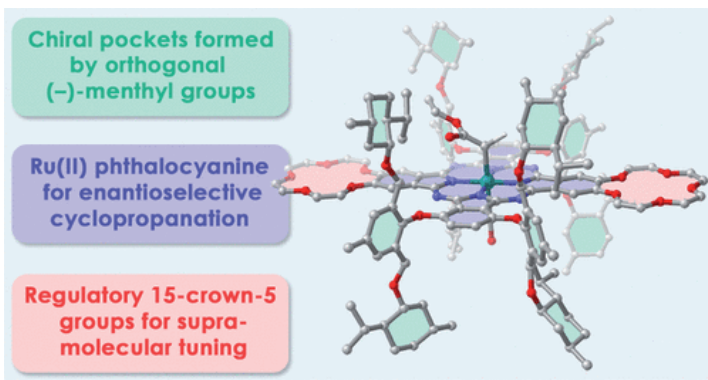


# Recent highlights

## Toward new materials

Not only we design new materials (organic, inorganic, MOF...) but we also evaluate their properties for specific applications.

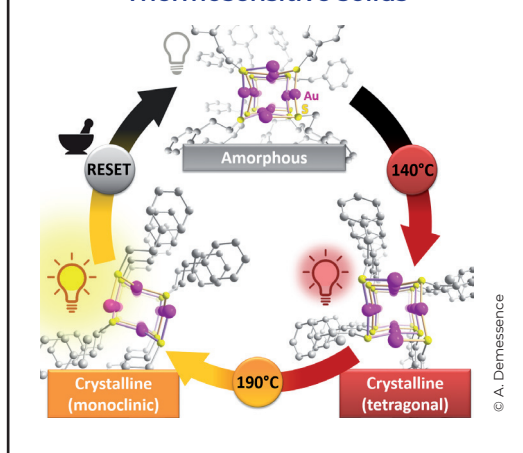
### First chiral phthalocyanine complex for efficient dia- and enantioselective catalysis: Cyclopropanation of olefins



*ACS Catal*, 2025, 15, 4984-5001

Outstanding diastereoselectivity: up to 499:1 ratio and promising enantioselectivity: up to 92:8 e.r.

### Thermosensitive solids



A Au-thiolate coordination polymer undergoes two successive phase changes on application of mild heating.

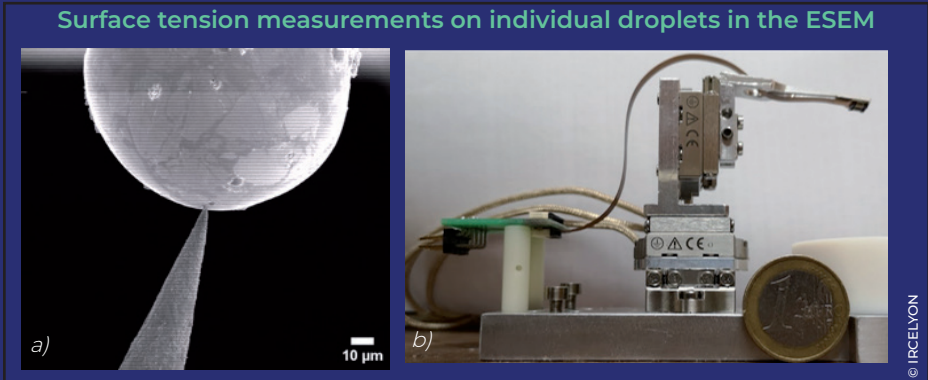
*Angew. Chem. Int. Ed.*, 2022, 61, e.202117261



## Toward a deeper characterisation

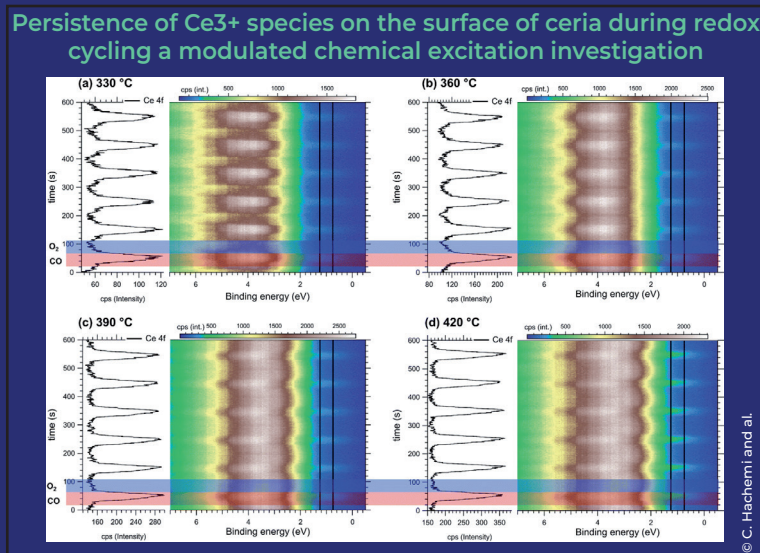
Operando investigations and in-situ analysis are performed to characterize the catalysts under working conditions.

### Surface tension measurements on individual droplets in the ESEM



a) Measurement of surface tension of micron and submicron particles: application to cloud formation, C. Chatre, UCBL Thesis, 2021 - b) Development of a nanotensiometer for the ESEM

### Persistence of Ce<sup>3+</sup> species on the surface of ceria during redox cycling a modulated chemical excitation investigation

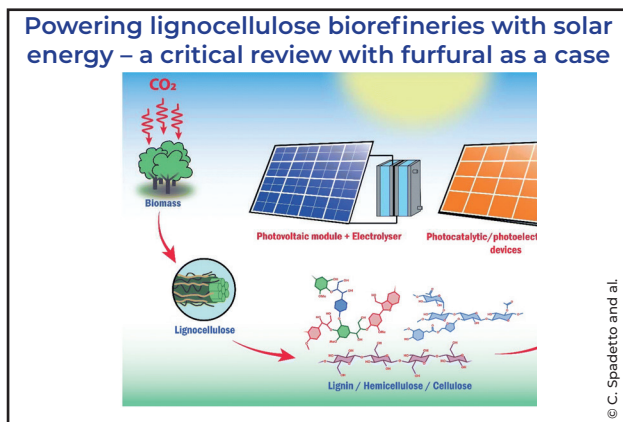


*Physical Chemistry Chemical Physics*, 2025, 27, 22, 12069-12079

Operando resonant photoelectron spectroscopy (RPES) combined with modulated chemical excitation revealed the dynamic evolution of Ce<sup>3+</sup>/Ce<sup>4+</sup> redox states at the surface of CeO<sub>2</sub> during the CO oxidation reaction.

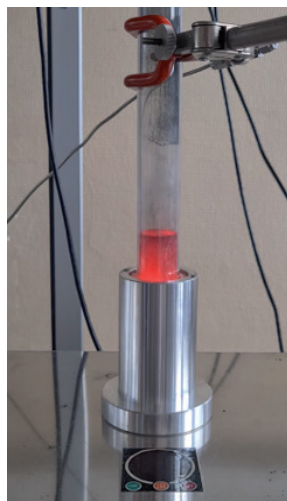
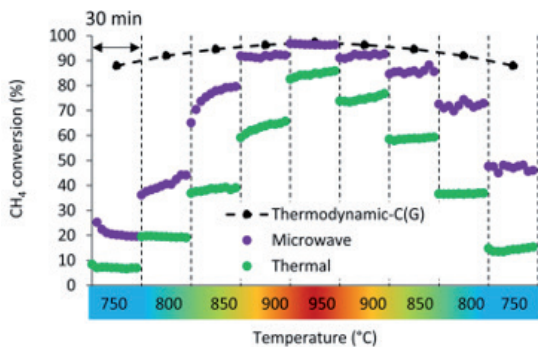
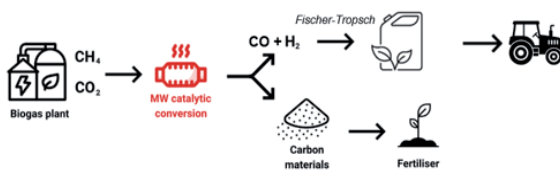
## Toward biomass upgrading

Studies from model molecules to real feedstock are carried out to optimize catalysts in lignocellulose reaction. Furthermore, associated processes are also studied to improve yields and selectivities.



*Green Chem., 2025, 27, 13529–13557*

## Reactor electrification - syngas from catalytic pyrolysis of biogas



© V. L'hospital

TITAN is a European Project (n° 101069474, 2022-2026) for direct biogas conversion to green hydrogen and carbon materials by scalable microwave heated catalytic reactor for soil amendment and silicon carbide production.



Funded by  
the European Union

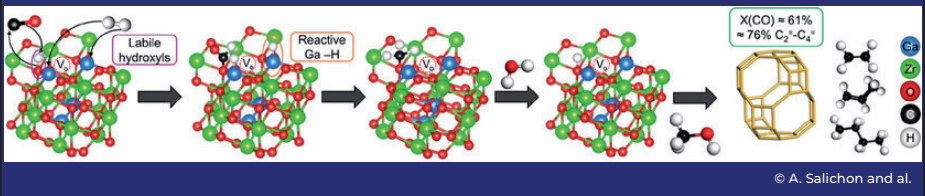


titan  
microwave biogas cracking

# Toward sustainable energy

Targetting low carbon emissions, we focus the development of catalysts for hydrogen production and storage.

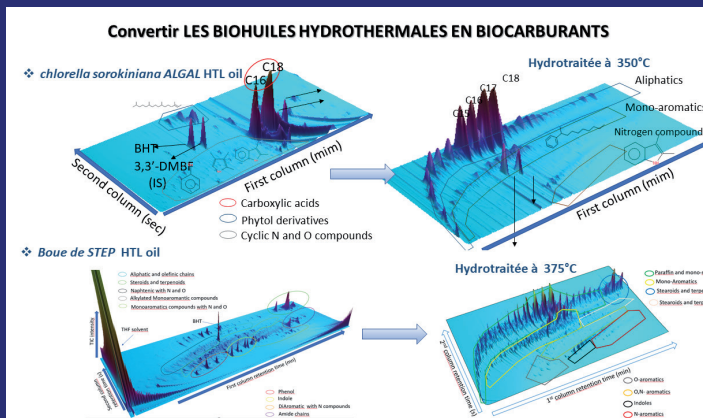
## Origin of the high Performance of GaZrOx composite for the methanol-mediated CO hydrogenation to light Olefins in tandem with SAPO-34 zeotype



A. Salichon et al., *ACS Catal.* 2024, 14, 243

A. Salichon et al., *ChemCatChem.* 2025, 17, e202401995.

## Synthesis of biofuels by hydroconversion of hydrothermal bio oils. Algal HTL and sewage sludge HTL oils upgrading illustrated with comprehensive GC



*Biomass & bioenergy* 2023, 173, 106798

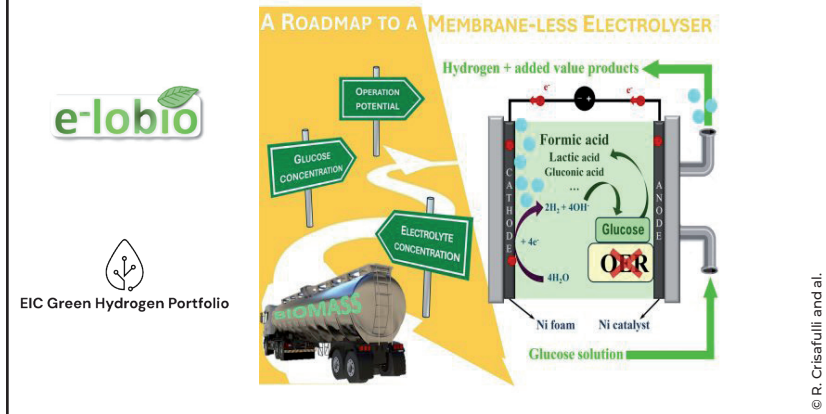
*Energy & fuels* 2024, 38, 11793-11804



## Toward depollution

We investigate water and air treatment: from the development of catalytic materials to the study of the underlying mechanism.

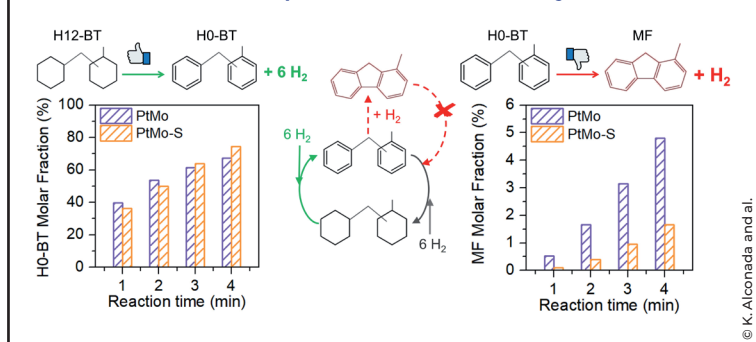
### Studying the Competition between Glucose Oxidation and Oxygen Evolution Reaction: Toward a Membrane-Free Electrolyzer for the Production of H<sub>2</sub> and Added Value Products



*ACS Sustainable Chem. Eng.* 2025, 13, 13, 4963–4974

ELOBIO is a European project (No 101070856, 2023-2026) that targets the large-scale production of green hydrogen from renewable cellulosic biomass.

### Exploring Perhydro-Benzyltoluene Dehydrogenation Using Sulfur-Doped PtMo/Al<sub>2</sub>O<sub>3</sub> Catalysts



*Catalysts* 2025, 15(5), 485

UNLOHCKED is a European project (No 101111964, 2023-2026) focuses on developing a CO<sub>2</sub>-free technology to convert Liquid Organic Hydrogen Carriers (LOHC) into hydrogen, facilitating clean electricity generation.

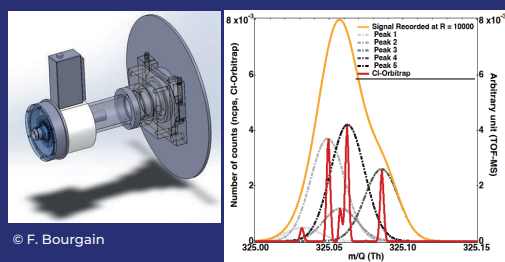
# Chemistry and photochemistry of aerosol

## MAARvEL (2020-2025)

Starting ERC (M. Riva)

The MARVEL project (A Missing Key Property in Atmospheric AeRosol ChEmistry: the Laplace Pressure) aims at elucidating the key processes driven by the Laplace pressure in atmospheric aerosols, and how they impact on the growth, evolution and physicochemical properties of submicron particles.

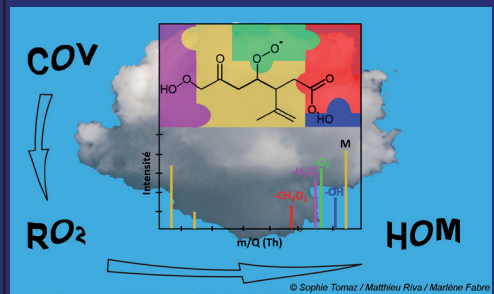
*Nature Communications, 2021, 12, 300*



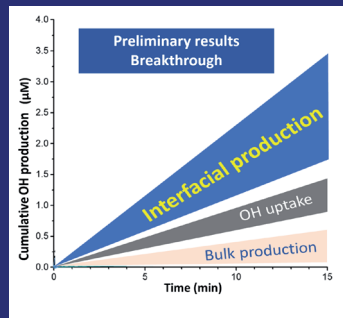
© F. Bourgain

© M. Riva

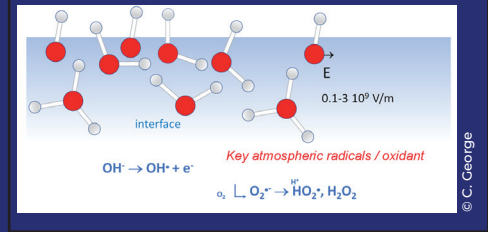
## Understanding the atmospheric radical chemistry by online tandem Mass Spectrometry ERC MARVEL



© Sophie Tornaz / Matthieu Riva / Marlène Faivre



## Spontaneous interfacial oxidant formation as a key driver for aerosol oxidation ERC SOFA



## SOFA (2022-2027)

Advanced ERC (C. George)

The SOFA project (Spontaneous Interfacial Oxidant Formation as a Key Driver for Aerosol Oxidation) aims at exploring interfacial chemistry and quantify the formation of atmospheric oxidants, by combining an experimental approach in the laboratory, field measurements and modeling digital.

# Recent awards

## CNRS medals



© IFPEN

David FARRUSSENG  
silver medal - 2020



© S. Paumard

Noémie PERRET  
bronze medal - 2021



© R. Checa

Chantal LORENTZ  
crystal medal - 2023

## James J. Morgan Environmental Science & Technology Early Career Award



© C. Riva

Matthieu RIVA - 2022

## Chinese embassy prize



© C. George

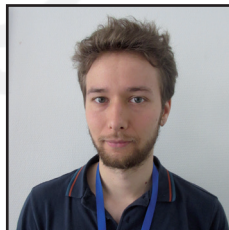
Nolwenn DARIDON - 2024

## SCF Thesis prize



© D. Laurenti

Daria RYABOSHAPKA  
DivCat - 2024



© Marie-Laure Venditti

Cyril HACHEMI  
DivCat - 2026



© D. Cazoir

Sonia GIL VILLARINO  
DivCat - 2026



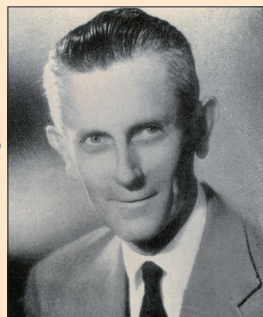
## A pioneering Research Institute on Catalysis

Main organizer of the 1<sup>st</sup> international congress on absorption and heterogeneous catalysis in Lyon in 1949, director of the School of Chemistry of Lyon and the INSA chemistry department, Prof. Marcel PRETTRE is the founder and the first director of the Institute of Research on Catalysis.

His research focused on adsorbent solids and heterogeneous catalysts.

He worked on Fisher-Tropsch synthesis or partial oxidation of methane.

His multiple awards and distinctions underline his key role in the history of catalysis.



© IRCELYON Archive Image

**Marcel  
PRETTRE**  
(1905-1976)

The Research Institute on Catalysis (IRC), impulsed by Marcel PRETTRE, was built in 1958 by the CNRS. Within three years, IRC reached a staff of 160 researchers, engineers, technicians and administrative staff. The objective of his fonder: “the analysis of the transformation mechanisms of matter” was achieved by developing at IRC the most advanced techniques. Over the years, the Institute has been a forerunner in the development of concepts and new fields in catalysis. Initially mainly dedicated to the development of catalysts characterization methods, research activities focused on types of catalysts, major reactions and industrial issues have emerged. IRC researchers spread their influence throughout France and abroad, creating new research teams. IRC became an attractive research Institute for foreign researchers and students. The Institute built continuously strong relationships with international research institutes on catalysis (eg. in Russia, Japan, China...).

From the beginning, the Institute promoted fundamental research with potential industrial applications. This spirit has been extended since mid-80's. Therefore, the Institute has established strong partnerships with the major chemical corporations. Moreover, three joint research CNRS-Industry units have been emerged with researchers originated from IRC.

In 2007, IRC merged with the Applied Chemistry for the Environment Laboratory (LACE) and became IRCELYON, a world-class research center dedicated to the overall understanding of catalyzed reactions applied to industrial and societal issues in the fields of Energy, Chemistry and Environment.



# IRC-IRCELYON timeline

**1958-1959**

## IRC creation

*A Research CNRS Unit (UPR 5401)*

*Decree of December 16, 1958*

**Since 1958**

*Study of catalytic solids and improvement of physical characterization techniques*

**Since 1984**

*Design of active and selective catalysts for energy catalytic reactions*

**1958**

**M.PRETTRE**

**1972**

**B. IMELIK**

**1984**

**R. MAUREL**

**1989**

**D. OLIVIER**

**1973**

*IRC Researchers created a new research unit "Laboratoire thermodynamique et cinétique chimique"*

**1980**

*IRC Researchers created a new research unit "Laboratoire des matériaux organiques à propriétés spécifiques" in Solaize*

**1984**

*IRC Photocatalysis group created a new research unit associated to the "Ecole Centrale Lyon"*

**1985**

*IRC homogeneous catalysis group joined the Laboratoire de Chimie de Coordination in Toulouse*

*Creation of a new axis at IRC: Theoretical chemistry group*





## 2007 creation of IRCELYON merging IRC and LACE

*As a result of the merging of Institut de Recherches sur la Catalyse (IRC) and Laboratoire d'Application de la Chimie à l'Environnement (LACE) headed by Jean-Marie HERRMANN.  
Joint research unit CNRS - Lyon 1 University (UMR 5256)*

*and chemical applications modeling of catalytic sites catalysis via catalytic materials -*

### Since 2007

*Environmental applications and atmospheric chemistry*

1993

*I. TKATCHENKO*

1998

*B. BIGOT*

2002

*T. DES COURIERES*

2006

*M. LACROIX*

2016

*C. PINEL*

2024

*C. GEANTET*

1992

*IRC Researchers created a new research unit "Laboratoire de chimie Organométallique de surface" at the "Ecole Supérieure de Chimie Physique Electronique" in Lyon*

1993

*IRC Researchers created a new research unit "Laboratoire d'Application de la chimie à l'environnement" at Lyon1 university*

2005

*IRC Theoretical chemistry group joined the "Laboratoire de Chimie" at Ecole Normale Supérieure de Lyon*

## Key data

*since 1959*

**6600** Articles

**720** PhD Thesis defended

**410** Patents



# Selected highlights over the decades

Over the years, the Institute of Research on Catalysis has been a pioneer in the development of concepts and new fields in Catalysis.

## 60's Understanding catalysis with physico-chemical methods

The initial spirit of the Institute based on the analysis of the transformation mechanisms of matter has marked its lifetime with the development of techniques dedicated to the study of catalysts. Specific applications such as SAXS, magnetism, Mossbauer, neutron spectroscopies, ESR... were applied for the characterization of metals, sulphides or oxides, and still now many in situ or operando methods are developed.

Furthermore, as early as 1962, IRC researchers were working on catalytic converters or fuel cells that were not yet commercially existing.

## 70's First photocatalytic studies and catalytic hydrotreatment

Even if the remarkable properties of  $\text{TiO}_2$  have been previously noticed, the first photocatalytic reactions and fundamentals of photocatalysis on this oxide were carried out at IRC in the early 70's under the leadership of S. Teichner. This specific domain of heterogeneous catalysis, working at room temperature is still a very active topic that found industrial applications in the 90's.

*Formenti M., Juillet F., Teichner S.J., Comptes Rendus Acad. Sci. (Paris), 270C, 138, 1970*

In the late 70's, under the impetus of IFP, IRC investigated catalytic hydrotreatments and quickly became a reference in the field. In depth analysis of the reaction kinetics and the determination of Transition Metal Sulphides activities allowed to describe the reaction pathways and to understand the role of the catalysts.

*Vrinat M.L., Gachet C.G., de Mourgues L.D., J. Chimie Physique et de Physico-Chimie Biologique, 77(4), 283-288, 1980*





80's

## Initiating surface organometallic chemistry

In the 80's, surface organometallic chemistry developed by J. M. Basset appeared and led to the design of well-defined single site catalysts deposited on a well-defined surface, this support acting as a rigid ligand. This concept, bridging the gap between homogeneous and heterogeneous catalysis, has been applied to many "difficult reactions" as well as a tool for preparing well designed heterogeneous catalysts.

*Smith A.K., Besson B., Basset J.M. and al., Journal of Organometallic Chemistry, 192 (2), C31-C34, 1980*

90's

## Opening new dimensions: DFT application, catalytic biomass transformation

In the 90's, the use of theoretical chemistry opened a new dimension to the understanding of catalysis by describing the sequential mechanism of reaction at the surface, opening the route for predictions of the reactivity of new catalysts. In this domain, IRC has been a pioneer, under the lead of P. Sautet, in the application of DFT for the elucidation of catalytic mechanisms as well as for the simulation of spectroscopies approaches used for catalysts characterization.

*Paul J.F., Sautet P., Physical Review B, 53(12), 8015-8027, 1996*

In the same period, IRC, under the impulse of P. Gallezot, initiated the development of catalytic biomass transformation, for instance in the catalytic oxidation or hydrogenation of glucose. This topic is nowadays an important aspect of academic and industrial heterogeneous catalysis research in line with sustainability.

*Besson M., Lahmer F., Gallezot P., Journal of Catalysis, 152 (1), 116-121, 1995*

XX's

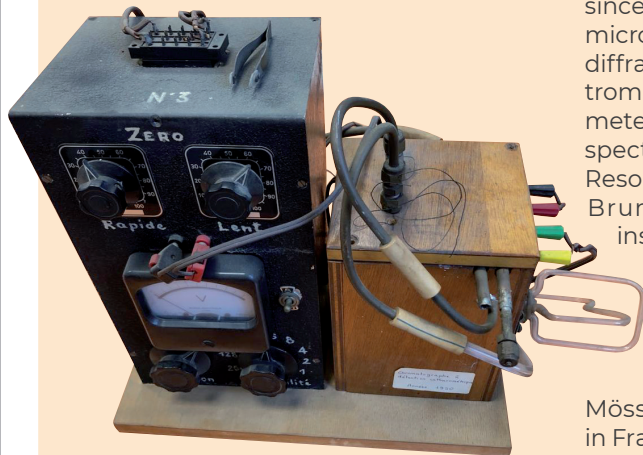
## Advanced Kinetics

Kinetic approaches such as isotopic exchange, TAP system for transient kinetic studies, micro kinetic methods based on the combination of FTIR and MS High-throughput experimentations were investigated. Micro catalytic tests for kinetic determination were licensed or sold in several countries.

*Schuurman Y., Catalysis Today, 121(3-4), 187-196, 2007*



## Over the years, leading-edge equipment at IRC



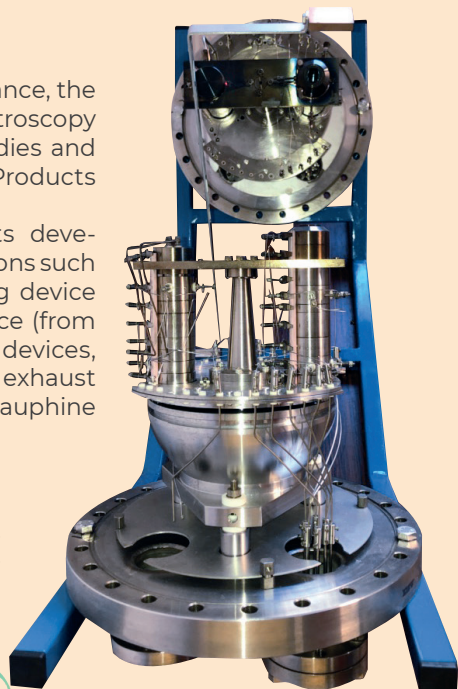
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*Chromatograph with Catharometer detector in 50's*

first HREELS spectrometer in France, the first X-ray photoelectron spectroscopy (XPS) dedicated to catalysis studies and the first Temporal Analysis of Products (TAP) in France...

Moreover, IRC technical experts developed also original instrumentations such as a small-angle X-ray scattering device (patented in 1965), thermobalance (from vacuum to 300 bars), ultrahigh vacuum devices, and even a test bench of catalytic exhaust gas purification, tested on a Dauphine Renault engine in the early 60's!

*Electrons source and analyzer of the first HREELS spectrometer spectrometer in France*



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# Challenging Catalysis for environmental friendly technologies

Founded in 1959 to accelerate research on catalysis in France, IRCELYON is a world-class research center with a tremendous know-how and outstanding equipment. Through both fundamental and applied research, training and continuous innovation, IRCELYON pursues its ambition: an overall understanding of catalysts and catalyzed reactions for green chemistry, sustainable energy applications, and environmental preservation.



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