7th NOVEMBER 2025
9:30 – 19:00

Madrid UCM Student Chapter

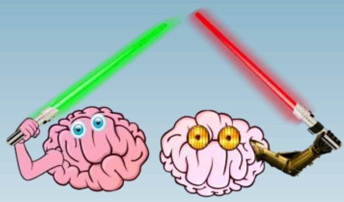
FACULTAD DE CIENCIAS QUÍMICAS

VI

BRAIN WARS

BOOK OF ABSTRACTS

THE FUTURE IS IN YOUR HANDS



THE
SCIENTISTS
STRIKE BACK

Sección Territorial de Madrid

RSEQ Real Sociedad Española de Química

JÓVENES INVESTIGADORES QUÍMICOS

semana de la ciencia y la innovación

HISTORY OF
MADRID UCM STUDENT CHAPTER

The ECS Complutense University of Madrid (UCM) Student Chapter was founded in May 2018 at UCM as the first ECS-Student Chapter in Spain. This Student Chapter provides a valuable link between graduate and undergraduate students of all departments both in our university and other universities and research centers located in Spain, creating a framework of collaboration in different areas and techniques. Since May 2018, the great enthusiasm from the directive committee and the participation of more than 100 students and young postdocs made possible the organization of multiple activities at UCM.

May 2018: *Workshop: Experimental Techniques*. Experimental techniques at UCM were described by experts in the area. Guided visit to the research facilities available at UCM (CAIs, CNME, etc).

September 2018: visit from Prof. Kazuhiko Mukai (Frontier Research-Domain, Toyota Central Research & Development Laboratories, Japan), who discussed with students his research on lithium-ion batteries.

October 2018: I Edition of the research contest *Brain Wars: The future is in your hands*, where the Prof. Nazario Martín (chapter's faculty advisor), gave a keynote titled "[60] Fullerene Sugar Balls for the Infection by the Ebola Virus."

January 2019: Dr. Beatriz Molero Sanchez, co-founder, CTO & director of SeeO2 Energy Inc. (Calgary, Canada) gave an invited talk titled *Converting greenhouse gases to useful products using renewable energy and reversible fuel cells*.

May 2019: Workshop *I finished my PhD: What's next?* It covered effective proposal preparation for grants and working possibilities in academia and companies. Dr. Joaquín García (UCLM, Albacete) talked about *Steps for starting a Science career*.

May 2019: Dr. Alicia Manjón, (MSPD beamline at ALBA, Barcelona), showed us the possibilities it has to offer to Material Science research and gave us details about "Pair Distribution Function" technique and its applications.

October 2019: The *II Brain Wars*. Dr. Bernardo Herradón (IQOG-CSIC, RSEQ-STM) gave the keynote lecture: "*Priorities' wars in the discovery of chemical elements. The role of women in the development of Periodic Table"*.

November 2020: Renewance of Chapter's Committie, and *III Ed. Brain Wars*. Prof. Gabriel Pinto Cañón (UPM) gave the keynote lecture "*From the thermodynamics of the botijo to the popularization of the periodic table: examples of science outreach*".

December 2020: *El Mal Del Sabio – Aprendiendo A Transmitir La Ciencia* workshop focused on learning how to communicate and promote the scientific research, by experts in the area.

May to June 2021: several virtual lectures where organized to explore alternatives after the college degree, efective job search, preparing an interview and designing and atractive CV.

July 2021: Workshop *Materials For Energy And Sustainability*. Several lectures where organized relating thermoelectrics, batteries, superconductors and fuel cells by experts in the area.

November 2021: *IV Ed. Brain Wars*. Prof. María Escudero Escribano (Copenhagen University) gave the keynote lecture "*Electrochemistry for a decarbonised future*".

April 2022: Dr. Maria Antonia Señaris (UDC) gave us an insight in "*Perovskitas Híbridas Orgánicasinorgánicas: Materiales (Multi)Funcionales Emergentes Con Enorme Riqueza Composicional Y Estructural*"

June 2022: *Jornada del Carbón en la Electroquímica*, where Dr. Joaquín Chacón lecture on the history, advances and future of the carbonaceous materials as electrodes.

October 2022: Promotion for the 2nd SuperBat – International Course on batteries and Supercaps, carried out at the UCM.

June 2023: *Workshop on New Batteries*. Dr. Paloma Almodóvar Losada (Albufera Energy Storage S.L.) gave a lecture on lithium-ion and emerging battery technologies, including live demonstrations.

December 2024: Dr. Matthieu Dubarry (HNEI) gave a lecture titled *"Data-driven battery diagnosis and prognosis: HNEI battery work"*.

December 2024: *Dr. Xiao Hua* (Lancaster University) gave a lecture titled *"Understanding battery electrode performance through in-situ X-ray scattering techniques."*

September 2025: *5th SUPERBAT International School on Batteries and Supercapacitors*, organized by Dr. Elizabeth Castillo-Martínez (UCM) and Dr. Javier Carretero-González (ICTP-CSIC), gathered international experts to discuss fundamentals and advances in battery and supercapacitor technologies.

September 2025: *2nd Watts Up Conference*, organized by PhD candidates from ICTP-CSIC and KIT, focused on recent advances in energy storage research, including post-lithium batteries, electrolytes, and operando characterization.

September 2025: *1st International Conference on Potassium-based Batteries (KIC-25)*, organized by Dr. Javier Carretero-González (ICTP-CSIC), Dr. Maider Zarrabeitia (HIU), and Dr. Elizabeth Castillo-Martínez (UCM), brought together academia and industry to discuss the latest developments in potassium-based battery technologies.

HOW TO BECOME A MEMBER

Student chapter membership program

As a participating member of a student chapter, ECS offers FREE annual student memberships to qualified full-time students. Eligible students must be full-time undergraduate or graduates enrolled in a degree in natural science or engineering. This promotion is renewable on a yearly basis; student chapter members must reapply each year.
Apply on this website:

http://www3.electrochem.org/jw/membership/newMember.jsp?d519=3

Benefits of student membership

– Students receive the same benefits of members at a highly discounted price.
– Eligible to apply for ECS awards, summer fellowships and travel grants to ECS biannual meetings.
– Network with other students, faculty and professionals in the field.
– **And much more!**

VI BRAIN WARS

The future is in your hands

The aim of the **VI Edition** of the research contest *BRAIN WARS: The future is in your hands* is to promote research, debate, critical evaluation and dissemination of knowledge by young researchers, encouraging interest in science and technology. Participant must present their research work as an oral communication (10 min) or flash communication (3 min), detailing how their work would contribute to the improvement and development of the society "*in a not far far future*…". The best oral communications and posters will be awarded with the following prizes:

ORAL COMMUNICATION

1st place: 150 €

2nd place: 100 €

FLASH COMMUNICATION

1st place: 60 €

2nd place: 40 €

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Jesús Prado Gonjal

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Dr. David López Iglesias – Dpto. Química Inorgánica (UCM)

Ms. Elena Mª Mesa Bribián – Dpto. Química Inorgánica y Química Técnica (UNED)

SPONSORS

The **Sixth Edition** of the research contest *Brain Wars: The future is in your hands* is organized by

Madrid UCM Student Chapter

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semana de la ciencia y la innovación
Del 3 al 16 de noviembre de 2025

JÓVENES INVESTIGADORES QUÍMICOS

MINISTERIO DE CIENCIA E INNOVACIÓN

Financiado por la Unión Europea NextGenerationEU

Plan de Recuperación, Transformación y Resiliencia

AGENCIA ESTATAL DE INVESTIGACIÓN

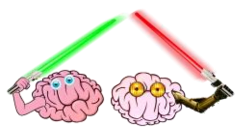
VI Brain Wars: The Future is in your Hands

Programme Schedule

Salón de Actos "Prof. M. A. Alario", Facultad de CC Químicas, UCM
7th November, 2025

9:30	**Opening Ceremony**		
9:45	*Invited talk*: **Elena Montejano Nares (UNED)** *Transformation of Methane and CO_2: From Pollutants to Resources*		
10:05	O1	Marta Santos Rodríguez	Operando NMR insights into ion transport through fluorine-free membranes in redox flow battery systems
10:20	O2	Víctor M. Amador Luna	Plate-Ready from the Dumpster? The Science That Makes It Possible
10:35	O3	Madelín Pérez Armas	Tagatose Consumption Provokes Metabolic Syndrome Features in
10:50	O4	Andrea Sánchez Elvira	Redefining Mycotoxin Monitoring: A Dual BRET Biosensing Approach for Rapid, Multiplex, and Wash-Free Detection
11:05	O5	Antonio Canoyra Calero	Anti-inflammatory potential of chalcones present in Corema album berries juice
11:20	O6	Kevin Gutierrez	Ir(III) complexes for CO_2 conversion to formic acid
11:35	**Coffee break**		
12:05	**Flash session 1 (F1-F6)**		
12:45	O7	José Ignacio Guerrero Blanco	Sustainable analytical innovations for obtaining bioactive extracts from agri-food waste

13:00	O8	Víctor Pastor Marcos	Molecular Nanographenes: Discovering the Antiaromaticity
13:15	O9	Jaime Jurado Sánchez	In the not-too-distant future... Chiral zeolites could be the stars of the pharmaceutical revolution
13:30	O10	Miriam Vos Gracia	Defects as Design Tools: Boosting Photocatalytic Hydrogen Production in Titanium MOFs
13:45	O11	Iván Madrazo Palou	Aromatic amides and diimides for their application as organic electrodes in potassium-ion batteries
14:00	**Lunch time**		
15:45	**Flash session 2 (F7-F13)**		
16:25	O12	Víctor Martín Jiménez	Study of cannabidiol synthesis for its application in the development of chemical probes for the identification of novel therapeutic targets
16:40	O13	Luis Fernández Gallego	Low-dimensional magnetocalorics for efficient refrigeration
16:55	**Flash session 3 (F14-F20)**		
17:40	**KEYNOTE LECTURE** **Prof. Antonio Rey Gayo (UCM)** *Demystifying AI: A primer on the algorithms behind the tools we use in our research*		
18:30	**Awards ceremony and closing remarks**		



Flash session		
F1	Teresa Moreno	Janus nanoparticles for targeted drug delivery
F2	Irene De La Rosa Sánchez	Mix & Measure: fast immunoassays for food safety evaluation
F3	Julia Díaz Magdaleno	Lighting Up Cancer Therapy: Designing Photoactivatable Metal Complexes
F4	Lucía Espejo	Tiny Materials, Big Solutions: Nanotechnology for CO_2 and N_2 valorization
F5	Alba Fernández-Rodríguez	New Advanced Polymers with High Ionic Conductivity and Selectivity for Sustainable Energy Storage
F6	Victoria García Almodóvar	Fighting Breast Cancer with Nanoparticles: A Triple Strategy for More Selective Therapies
F7	Nagore Grasa-Gude	Tiny particles crossing big barriers: Nanomedicine for ALS
F8	Irene Gutiérrez Cabello	Chitosan–streptomycin hydrogels with lysozyme-responsive behavior for biofilm treatment
F9	Lucía Jiménez Gómez	Crossing the Blood-Brain Barrier: Mesoporous silica nanoparticles for Advanced Parkinson’s Treatment
F10	Sara Seoane	Construction of novel MoS_2/BiOX (X = Cl, Br, I) heterojunctions with an enhanced photocatalytic activity for pollutants degradation
F11	José Antonio Carralero	The hidden power of heat: Tin Sulfide advances thermoelectric energy conversion

F12	Daniel García Fernández	Future Paths for Autism Spectrum Disorder Diagnosis Through Biomarker Detection
F13	Jorge Parrón Ballesteros	Yeast surface display: an improved alternative for allergy diagnosis
F14	Laura Pretel Fernández	CO_2 capture and conversion cycles via hydrogenation using bifunctional materials and magnetic induction heating
F15	Cristina García Belchí	Avocado peel waste as a sustainable source of bioactive extracts with neuroprotective and antioxidant activity
F16	Silvia Gil Granja	A new hope of Platinum-based complexes to fight cancer
F17	Marina Iglesias	Tetrahedral nanographenes: Synthesis and Aggregation-Induced Emission
F18	Omar Santiago Mayorga	Unravelling Corrosion Mechanisms of Alloys in Mars: CHIMERA
F19	Ismael Picazo Arijón	Chemical degradation of biogenic amines in fermented and non-fermented foods
F20	Estela Soraya Castromil Benito	Predatory mite, Cheyletus eruditus, as a new allergenic source: Identification and cross-reactivity of its allergens


INVITED
TALKS

Transformation of Methane and CO_2: From Pollutants to Resources

Elena Montejano Nares[1], Esther Asedegbega Nieto[1], Francisco Ivars Barceló[1]

[1] *Dept. Química Inorgánica y Química Técnica, Facultad de Ciencias, UNED; Av. Esparta s/n, Las Rozas, 28232 Madrid (Spain).*

Climate change is one of the most pressing global challenges of our time, driven primarily by the continuous rise in greenhouse gas concentrations. Since the beginning of the Industrial Revolution, the extensive use of fossil fuels, together with deforestation and other human activities, has drastically accelerated these emissions. Methane (CH_4) and carbon dioxide (CO_2) account for more than 90% of the total anthropogenic emissions of primary greenhouse gases released annually into the atmosphere and are directly involved in the relentless global warming and its devastating consequences. Converting CO_2 and CH_4 into valuable and industrially relevant products would provide a strong incentive to mitigate these emissions, aligning environmental responsibility with technological innovation and economic opportunity (Fig.1). Our research group has designed catalytic materials capable of simultaneously activating CO_2 and CH_4 under mild temperature and pressure conditions. These nanocomposite materials, based mainly on mixed iron oxides doped with noble metals, have been thoroughly characterized using a range of complementary techniques including transmission electron microscopy (TEM), X-ray photoelectron spectroscopy (XPS), X-ray absorption spectroscopy (XAS), and grazing incidence X-ray diffraction (GI-XRD) among others. This comprehensive analysis has allowed us to correlate the structural and electronic properties of the catalysts with their reactivity. The catalytic results, recently patented, show productivities significantly higher than those previously reported for the coupled conversion of CO_2 and CH_4 via heterogeneous thermocatalysis, offering a promising pathway toward the sustainable utilization of greenhouse gases.

Keywords: Global warming, Carbon dioxide, Methane, Heterogeneous Catalysis.

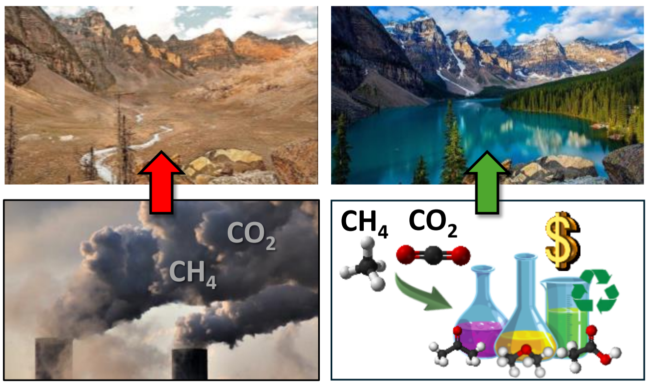


Fig 1. Possible future consequences of uncontrolled CH_4 and CO_2 emissions into the atmosphere, contrasted with their valorization into high-value industrial products.

Demystifying AI: A primer on the algorithms behind the tools we use in our research

Antonio Rey[1]

[1]*Dept. Química Física; Fac. CC. Químicas; Universidad Complutense de Madrid. areygayo@ucm.es*

The term Artificial Intelligence (AI) has rapidly entered our everyday vocabulary over the past few years. From general-purpose tools such as chatbots to specialized applications tailored to specific research areas, AI technologies are becoming an integral part of how we work and think, sometimes even without us realizing it.

Yet, despite this recent explosion of interest, many of the core ideas behind AI are not as new or mysterious as they might seem. In fact, several concepts that underpin today's AI methods have their roots in the data analysis and numerical modelling techniques long used by scientists. What we now call machine learning and algorithms, often perceived as opaque "black boxes" controlled by the *dark side*, are, in many cases, sophisticated extensions of the statistical and computational tools familiar from our university training.

In this talk, I will present an informal overview of how these traditional ideas evolve into the foundations of modern AI. Using simple and intuitive examples, we will explore how basic data-fitting and pattern-recognition concepts lead naturally to the architecture of neural networks, and how these networks form the basis of deep learning. Finally, we will connect these ideas to the large language models (LLMs) that power today's conversational AI systems, such as chatbots.

The goal of the presentation is not to provide a technical course, but rather to demystify the principles behind current AI tools and to show how their logic connects with methods already familiar to young researchers in chemistry and related sciences.

Keywords: Machine learning; algorithms; neural networks; chatbots

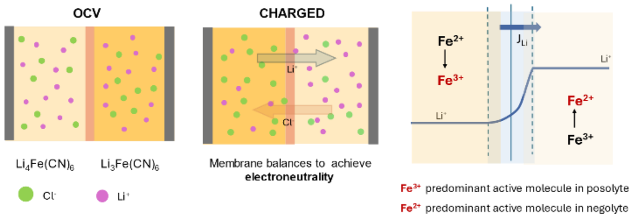

ORAL
PRESENTATIONS

Operando NMR insights into ion transport through fluorine-free membranes in redox flow battery systems.

Marta Santos Rodríguez[1*], Giu A. Silva Testa[2], Juan Carlos Martínez López[1] Ángel E. Lozano[1], Cristina Álvarez[1], Javier Carretero-González[1], Evan Wenbo Zhao[2]

[1] *Institute of Polymer Science and Technology, ICTP, CSIC, C/Juan de la Cierva, 3, Madrid 28006, Spain*

[2] *Magnetic Resonance Research Center, Institute for Molecules and Materials, Radboud University, 6525 AJ Nijmegen, The Netherlands*



KEYWORDS: membranes, permeability, energy, capacity

Ion exchange membranes (IEM) play a key role in redox flow batteries (RFB), where they regulate ion transport and contribute to overall battery performance. For that purpose, they need to ensure high ion conductivity and selectivity while effectively minimizing crossover of redox species. However, commercial perfluorinated membranes, such as Nafion®, face low selectivity and high costs, compromising both performance and economic feasibility. To overcome these limitations, our current research focuses on the development of byphenyl-isatin based polymers, that provide excellent charge balance and high-capacity retention rates in the battery [1]. In this context, sulfonated linear polymeric membranes have been proposed as suitable cation exchange membranes [2], where the hydrophilic groups (SO_3H) promote the formation of water channels improving ion transport through the membrane. In parallel we have implemented an operando benchtop NMR method to identify charge-balancing ions through the membrane in a redox flow battery cell.

Sulfonated polymers were synthesized from a precursor polymer made from the isatin monomer and several aromatic nucleophilic monomers via a superacid-catalyzed polyhydroxylakylation reaction [3], followed by a post-modification reaction of the NH lactam ring, present in the precursor polymer, with 1,3-propanesultone. Permeability and ionic conductivity were assessed through ion diffusion experiments demonstrating high permeability to small cations (e.g. Li+: $1.4\cdot10^{-7}$ cm^2/s), and reduced crossover to active molecules (e.g. $K_4Fe(CN)_6$: $8\cdot10^{-12}$ cm^2/s). Electrochemical impedance spectroscopy reflected an enhancement of membrane's conductivity with sulfonic content. The assessment of the polymer membranes by galvanostatic cycling limited potential (GCLP) was also performed in symmetric redox flow cells. The best performing membrane was ensambled in a symmetric ferro/ferricyanide-based RFB, showing a high capacity retention over 100 cycles of galvanostatic charge and discharge cycling.

References

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[3] L. Matesanz-Niño et al., "Polymer materials derived from the SEAr reaction for gas separation applications," Polymer (Guildf), vol. 267, p. 125647, Feb. 2023, doi: 10.1016/J.POLYMER.2022.125647.

Plate-Ready from the Dumpster? The Science That Makes It Possible

Victor M. Amador-Luna[1*]; Miguel Herrero[1], Lidia Montero[1]

[1] *Laboratory of Foodomics, Institute of Food Science Research, CIAL, CSIC Nicolas Cabrera 9, 28049 Madrid, Spain*

Madrid generates large amounts of **organic food waste-peels, seeds and leaves** that are rich in **carotenoids, terpenes and polyphenols** we rarely use. Our project shows how to turn this "trash" into brain-friendly ingredients by following a simple path:

EXTRACT ⟶ ENCAPSULATE ⟶ DIGEST ⟶ NEW FOODS.

First, we apply green extraction (supercritical CO_2, pressurized liquids, NADES) to concentrate the most valuable molecules from **citrus by-products, bitter-orange leaves, tomato skins and microalgae**. Then we protect them using food-grade carriers: liposomes, Pickering particles and alginate hydrogels. *Pickering* systems are physically robust and *hydrogels* are easy to handle, but across storage and digestion tests *liposomes* preserved more bioactivity and delivered more payload to the intestine. [1,2]. That matters because as our population ages, chronic degenerative diseases are rising; if we want food to help, the molecules must actually reach the body [2,3].

And the final step, the real challenge, and most delicius: **weaving these encapsulated extracts into everyday products (sauces, drinks, bakery) so health travels straight from the plate to the body**. In short, Madrid's "waste" isn't a problem to hide; it's a pantry for the future. And the data are clear: liposomes performed best overall and are the platform we're taking forward to build the foods of the future.

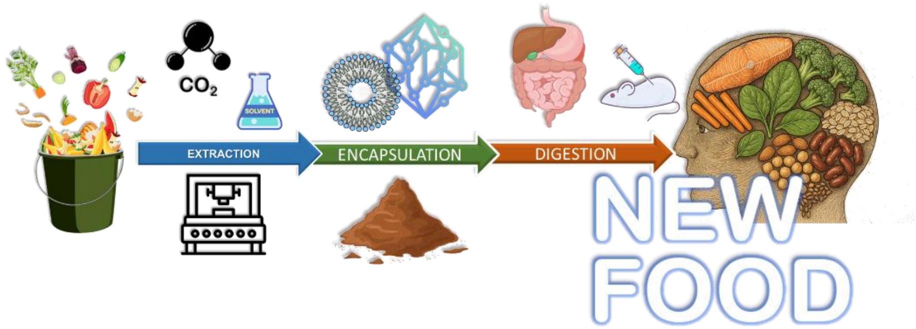

Fig 1. Graphical abstract

Keywords: food-waste valorization; extraction; encapsulation; neuroprotection

References

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Tagatose Consumption Provokes Metabolic Syndrome Features in Rat Males from Mothers That Consumed Fructose During Their Pregnancy

Madelín Pérez-Armas[1*]; Elena Fauste[1]; Cristina Donis[1]; Paola Otero[1]; Mª Isabel Panadero[1], Carlos Bocos[1]

[1] *San Pablo CEU University, Pharmacy Faculty, Urbanización Montepríncipe 28925 Alcorcón, Madrid. m.perez170@usp.ceu.es*

Maternal nutrition strongly influences offspring metabolic health. We have previously shown that fructose intake during pregnancy negatively programs offspring metabolism. This study investigates whether tagatose, a low-calorie sweetener, affects lipid metabolism differently than fructose in male offspring of fructose-supplemented mothers. To achieve this objective, three-month-old males from control or fructose-fed dams received a 10% fructose or tagatose solution for 21 days. Biochemical and molecular markers were analysed in plasma and tissues. Both sugars induced hypertriglyceridemia in offspring of fructose-fed mothers, with fructose promoting hepatic lipogenesis and tagatose enhancing bile acid recirculation, intestinal lipid absorption, and increasing plasma Ang II and FGF21 levels. However, FGF21 does not counteract Ang II effects in the hearts of offspring of fructose fed mothers. Overall, maternal fructose intake predisposes offspring to tagatose-induced steatosis, glycogen accumulation, and oxidative stress, highlighting the critical role of maternal diet and supporting WHO recommendations to limit simple sugar intake to under 10% of daily calories.This work was supported by the Ministerio de Ciencia e Innovación (MCIN): PID2020-118054RB-100/AEI/10.13039/501100011033 and PID2023-152756OB-I00/AEI/10.13039/501100011033. Elena Fauste was, and Madelín Pérez-Armas is supported with FPU fellowships from MCIN.

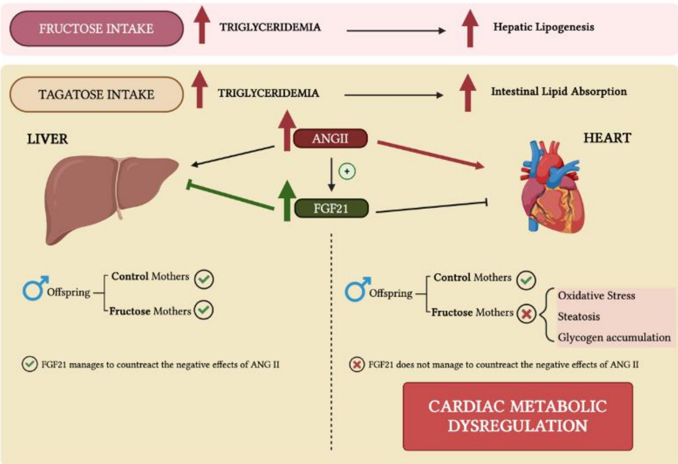

Fig 1. Effects of fructose and tagatose consumption in progeny of fructose and control mothers.

Keywords: Fructose, Tagatose, Fetal programming, Metabolic Syndrome.

References

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Redefining Mycotoxin Monitoring: A Dual BRET Biosensing Approach for Rapid, Multiplex, and Wash-Free Detection

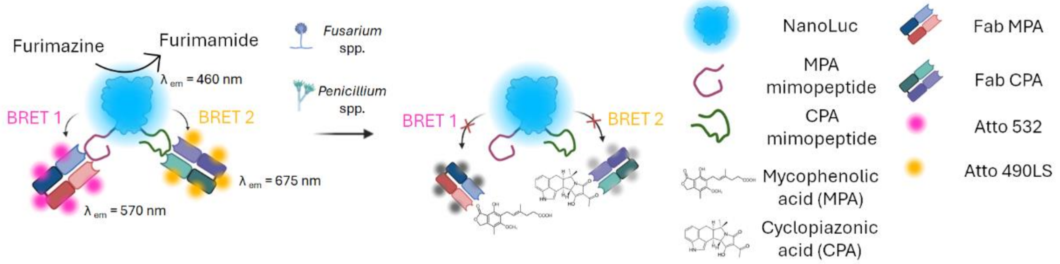
Andrea Sánchez-Elvira*; Marta García-Cortés; Melisa del Barrio; Elena Benito-Peña

Department of Analytical Chemistry, Universidad Complutense de Madrid, 28040 Madrid, Spain, andsan45@ucm.es

This study addresses the urgent need for fast and reliable methods to detect multiple mycotoxins—low molecular weight fungal secondary metabolites that pose significant risks to human and animal health. Mycotoxins are common in crops and food products, and their co-occurrence can cause synergistic toxic effects [1, 2, 3]. Current detection methods are often complicated, time-consuming, or require chemical labeling of toxins, which limits their use in routine and field testing. This work presents a quick, sensitive, and multiplexed analytical approach for detecting multiple mycotoxins at once, using a new bioluminescence resonance energy transfer (BRET)-based immunoassay.

The proposed bi-BRET immunoassay combines mycotoxin-specific mimetic peptides (mimotopes) with NanoLuc luciferase as the energy donor and fluorescently labeled antibody fragments (Fab MPA-Atto532 and Fab CPA-Atto490LS) as energy acceptors. This design allows for the simultaneous detection of two target mycotoxins: mycophenolic acid (MPA) and cyclopiazonic acid (CPA). To address spectral overlap between fluorophores, a mathematical correction matrix was applied, ensuring signal discrimination and accurate quantification. The assay was optimized for quick results, taking only five minutes. It demonstrated high sensitivity with IC_{50} values of 22.2 ± 0.6 ng/mL for MPA and 2.6 ± 0.2 ng/mL for CPA, along with detection limits of 2.5 and 0.8 ng/mL, respectively. The method was validated using spiked maize extracts to evaluate matrix effects and recovery. Results were compared to those obtained by HPLC-DAD, showing excellent agreement, with recoveries ranging from 93–111% for MPA and 72–115% for CPA.

This work makes a significant step forward in real-time, field-based mycotoxin monitoring. The developed wash-free multiplexed BRET system improves analytical throughput, portability, and usability in food and feed safety surveillance.



Keywords: Mycotoxins, immunoassay, BRET, NanoLuc

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Anti-inflammatory potential of chalcones present in *Corema album* berries juice

Antonio Canoyra Calero[1*], Dolores Muñoz-Mingarro Martínez[2], Antonio José León-González[3], Carmen Martín-Cordero[3], Marina Sánchez-Hidalgo[3], Nuria Acero[1].

[1] Departamento de CC Farmacéuticas y de la Salud, Facultad de Farmacia, Universidad San Pablo-CEU, CEU Universities, Urbanización Montepríncipe, 28660 Boadilla del Monte, Madrid, Spain. a.canoyra@ceu.es.

[2] Departamento de Química y Bioquímica, Facultad de Farmacia, Universidad San Pablo-CEU, CEU Universities, Urbanización Montepríncipe, 28660 Boadilla del Monte, Madrid, Spain

[3] Departamento de Farmacología, Facultad de Farmacia, Universidad de Sevilla, C/P. García González, 2, 41012 Seville, Spain.

Corema album berries, endemic from the Atlantic coast of the Iberian Peninsula, produce a juice rich in phenolic compounds, notably chalcones and their derivatives. This study investigated the antioxidant and anti-inflammatory potential of three chalcones identified in the berry juice: 2',4'-dihydroxychalcone, 2',4'-dihydroxydihydrochalcone, and 2'-methoxy-4'-hydroxydihydrochalcone. Structural characterization was performed using ^{1}H-NMR and ^{13}C-NMR, and quantification was achieved via UHPLC/HRMS.

The inhibitory effect on COX-2 activity was assessed *in vitro* using ELISA. In RAW 264.7 macrophages stimulated with LPS, chalcones significantly reduced nitric oxide (NO) production (Griess reaction) and downregulated the expression of iNOS, NF-κB, and IL-1β, as measured by the Protein-Simple (JESS) system. In parallel, THP-1 monocytes differentiated into macrophages were exposed to LPS-induced stress. Chalcones effectively decreased reactive oxygen species (ROS) levels (DCFH assay) and suppressed the release of pro-inflammatory cytokines IL-6 and TNF-α (ELISA).

In summary, the chalcones present in *C. album* berry juice demonstrated significant antioxidant and anti-inflammatory properties through multiple and potentially complementary mechanisms, highlighting their promise as therapeutic agents for inflammation-related disorders.

Keywords: *Corema album*, chalcones, anti-inflammatory, antioxidant, cytokines, COX-2.

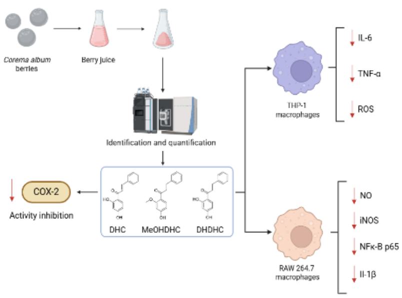

Fig 1. Isolation, identification and of DHC; DHDHC; and MeOHDHC in the juice of *Corema album* berries using UHPLC-MS. Anti-inflammatory potential of chalcones were tested *in vitro* and in macrophages cell culture (THP-1 and RAW 264.7).

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Ir(III) complexes for CO_2 conversion to formic acid.

Kevin Gutiérrez[1*]; Alejandro Torres,[1] José Alemán,[2,3] Alba Collado[1,3]

[1] *Inorganic Chemistry Department, Universidad Autónoma de Madrid (UAM), 28049 Madrid, Spain.*
[2] *Organic Chemistry Department, Universidad Autónoma de Madrid (UAM), 28049 Madrid, Spain*
[3] *Institute for Advanced Research in Chemical Sciences (IAdChem), UAM, 28049 Madrid, Spain*
kevin.gutierrez@uam.es

One of today´s major adversities is the continuous increase in anthropogenic CO_2 emissions due to the high energy demand and fossil fuel consumption. Atmospheric CO_2 concentration has increased from about 280 ppm pre-industrially to 427 ppm today, becoming the main responsible for climate change.[1] The only way to reverse the situation is by reducing emissions, but this is a slow process. Additionally, CO_2 can be used as raw material for the synthesis of fine chemicals such as formic acid, though it is not a straightforward transformation due to the high molecular stability of the CO_2 molecule.
In this context, catalytic transfer hydrogenation (TH) has emerged as an alternative method to the hydrogenation of substrates without using pressurized H_2 (g). Iridium complexes are known to be the most active, but achieving efficient CO_2 reduction under mild conditions remains challenging.[2] Photo- and electrocatalysis offer alternative approaches, yet only a few examples of CO_2 reduction to formic acid exist.[3,4] Despite significant progress, developing more robust and efficient catalysts remains crucial for large-scale applications.

Herein, we present the catalytic activity of a series of [IrClCp*(8-QO)] complexes with 8-hidroxyquinoline-derived ligands (8-QO) for CO_2 reduction to formic acid in TH, photo- and electrocatalysis, demonstrating their high versatility in CO_2 reduction under mild conditions (Figure 1).

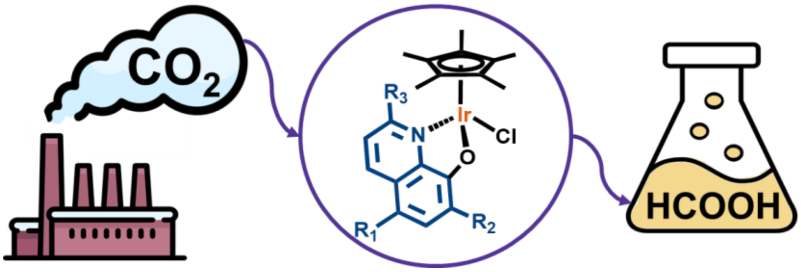

Figure 1. Catalytic CO_2 reduction to formic acid

Keywords: CO_2, iridium, homogeneous catalysis.

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SUSTAINABLE ANALYTICAL INNOVATIONS FOR OBTAINING BIOACTIVE EXTRACTS FROM AGRI-FOOD WASTE

José Ignacio Guerrero Blanco[1*]; Esther Gómez-Mejía,[1] Noelia Rosales Conrado,[1]

[1] *Department of Analytical Chemistry, Faculty of Chemical Sciences, Complutense University of Madrid, Avda. Complutense S/N, 28040 Madrid, Spain.*

* *E-mail: josgue02@ucm.es*

Soybean residues, discarded despite their rich nutritional and bioactive content, cause both economic and environmental drawbacks. This research seeks to valorise these by-products into sustainable, high-value ingredients within a circular economy framework [1].

The approach begins with a comprehensive characterisation of the residues, assessing physicochemical properties and stability under preservation treatments to understand their influence on bioactive recovery. Eco-friendly extraction methodologies are developed, combining benign solvents with non-conventional techniques such as cold-pressing for lipid fractions and matrix solid-phase dispersion for hydrophilic extracts. The environmental performance of these processes is quantitatively assessed using sustainability metrics.

Extracts are profiled through advanced analytical platforms—GC-MS for fatty acids, HPLC-DAD/MS for tocopherols, polyphenols and peptides, complemented by spectrophotometric assays for phenolic, flavonoid, and protein contents. Their biological potential is evaluated through in vitro antioxidant, neuroprotective, antimicrobial, and antihypertensive assays. Multivariate chemometric tools provide a robust framework to correlate bioactivity with composition, enabling data-driven optimisation of valorisation pathways [2].

Ultimately, this research demonstrates how agro-industrial waste can be reimagined as a renewable resource for nutraceuticals, natural additives, cosmetics, and fortified foods. By bridging analytical chemistry, and industrial innovation, it contributes to resource efficiency, and healthier societies—embodying the essence of “from waste to value”.

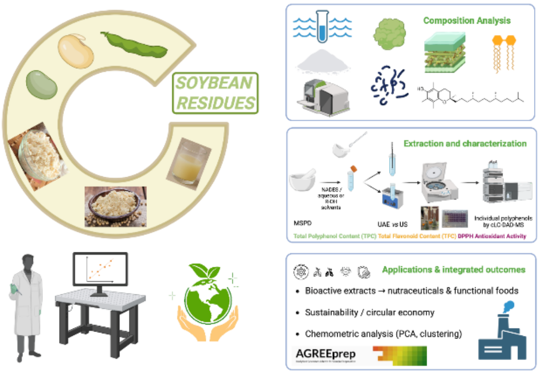

Fig 1. Valorisation of bioactive-rich extracts from soybean residues for nutraceuticals and functional foods

Keywords: *Soybean residues, Bioactive compounds, Green extraction, Sustainable valorisation.*

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Molecular Nanographenes: Discovering the Antiaromaticity

V. Pastor-Marcos,[1*] P. Izquierdo-García,[1] N. Martín[1,2]

[1] *Departamento de Química Orgánica I, Facultad de Ciencias Químicas, Universidad Complutense, 28040 Madrid, Spain. E-mail: victpast@ucm.es*
[2] *IMDEA-Nanociencia, C/Faraday, 9, Campus de Cantoblanco, 28049 Madrid, Spain.*

Molecular nanographenes are atomically precise graphene fragments whose dimensions and topology can be finely tuned through bottom-up organic synthesis. This atomic-level control enables the rational design of structures with tailored electronic and optical properties. Key strategies to modulate these properties include controlled π-extension and the incorporation of non-hexagonal rings into the carbon framework.[1]
In this work, we explore an alternative approach that involves integrating antiaromatic motifs into nanographenes. These structural elements are expected to markedly influence the electronic structure by narrowing the energy gap between the conduction and valence bands, thereby modulating their overall optoelectronic behaviour.[2]
We report the synthesis of molecular nanographene **1** (Figure 1), which contains a central pentalene-based antiaromatic core (highlighted in yellow) fused to two hexa-*peri*-hexabenzocoronene (HBC) units (in green). The synthetic route comprises four main steps. Initially, nucleophilic addition of methylmagnesium bromide to diketone precursor **2** affords the antiaromatic intermediate **3**, a dibromodimethyldibenzopentalene. Subsequent twofold Sonogashira coupling of **3** with 4-*tert*-butylphenylacetylene yields the bis(arylethynyl) derivative **4**. This compound then undergoes a double Diels–Alder cycloaddition with tetraarylcyclopentadienone **5**, forming the bis(pentaryl)dibenzopentalene framework **6** upon CO extrusion. Finally, a Scholl cyclodehydrogenation step establishes 12 new C–C bonds around the antiaromatic core, completing the graphitization process. The optoelectronic properties of nanographene **1** are currently being investigated through UV–vis absorption, fluorescence spectroscopy, and cyclic voltammetry.

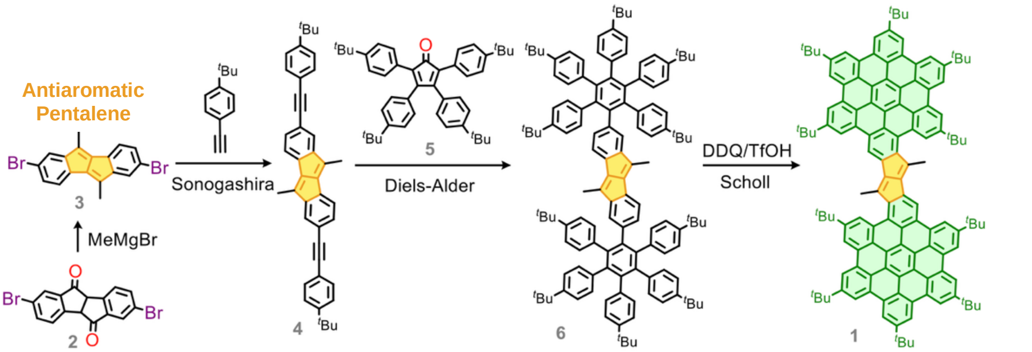

Figure 1. Stepwise synthesis of nanographene **1** incorporating a central antiaromatic pentalene unit.

Keywords: nanographene, antiaromaticity, Sholl reaction.

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In the not-too-distant future... Chiral zeolites could be the stars of the pharmaceutical revolution.

Jaime Jurado-Sánchez[1]; Joaquín Pérez-Pariente,[1] Luis Gómez-Hortigüela,[1]

[1] *Instituto de Catálisis y Petroleoquímica (ICP-CSIC), Calle Marie Curie, 2, 28049, Madrid, Madrid. jaime.jurado@csic.es*

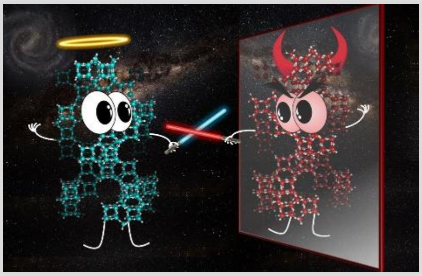

Fig 1. The two enantiomers of the GTM-4 material battling it out Star Wars style.

Chirality is the property of an object of not being superimposable on its mirror image, with each of these mirror images being referred to as enantiomers. In the pharmaceutical industry, most drugs are chiral, and in most cases, one enantiomer exhibits a greater therapeutic effect on the human body than its mirror image. These differences in activity can even be lethal to humans, which is why the development of chiral heterogeneous catalysts that promote the synthesis of one enantiomer over the other represents one of the most challenging and fascinating goals in current scientific research, where zeolites may be ideal candidates. Zeolites are crystalline materials with a perfectly ordered three-dimensional structure, featuring channels and cavities of molecular dimensions, which provide interesting confinement properties for use as heterogeneous catalysts.

For this purpose, the Molecular Sieves Group discovered two materials named GTM-3 and GTM-4.[1][2] Both materials are enriched in one of the two polymorphs of the -ITV zeolite structure, where the GTM-4 material is enantiopure, achieving enantiomeric excesses in catalytic reactions that approach 90%.[3][4] This work will show not only the potential of these zeolite materials, but also how 3D electron diffraction is the key not only to resolving structures, but also to determining the chirality of each single crystal.

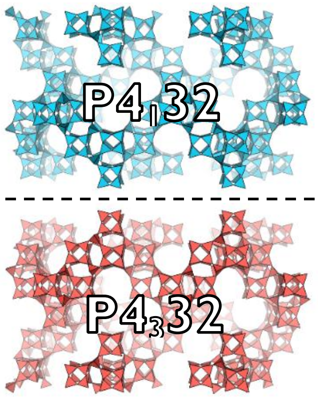

Fig 2. Polymorphs that compose the -ITV type of GTM-3 and GTM-4 materials.

Keywords: Chirality, Zeolites.

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Defects as Design Tools: Boosting Photocatalytic Hydrogen Production in Titanium MOFs

M. Vos Gracia,[1] J. Ferrando,[1] M. González-Fernández,[2] H. García Baldoví,[2] H. García,[2] S. Navalón,[2] S. Carrasco,[1] P. Horcajada[1]

[1] Adv. Porous Materials Unit, IMDEA Energy. Avda. Ramón de la Sagra 3, 28935, Móstoles;
[2] Departamento de Química and Instituto de Tecnología Química (CSIC-UPV), Universitat Politècnica de València, C/Camino de Vera, s/n, 46022 Valencia, Spain

Climate change and environmental pollution are critical global challenges that urge the development of cleaner and more sustainable energy sources[1]. One of the main bottlenecks is the inefficiency of the photocatalyst. In this contest, metal-organic frameworks emerged as a prime candidate due to chemical versatility, high surface-to-volume ratio[2], and catalytic efficiency[3]. In 2021, we reported IEF-11(Ti)[4] (from *IMDEA Energy Frameworks*), the first MOF based on the photo/redox-active Ti(IV) cation and the squarate ligand. This material achieved record-breaking H_2 production via photocatalytic water splitting in the absence of co-catalysts.
To enhance hydrogen production, isostructural IEF-11(Ti) derivatives were synthesized via defect engineering. Partial replacement of squarate with 5% squaramide significantly improved photocatalytic performance. This enhancement results from band gap tuning and increased mesoporosity, which improves light absorption and access to active Ti(IV) sites.

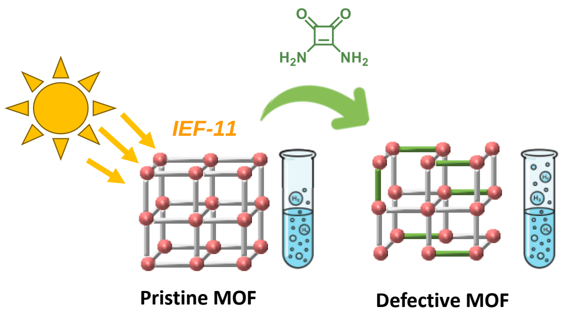

Fig 1. Defective (Ti)IEF-11 to enhance hydrogen production.

Keywords: MOF, defects, water splitting, green H_2

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Aromatic amides and diimides for their application as organic electrodes in potassium-ion batteries.

Iván Madrazo Palou[1], Irene Gómez-Berenguer[1,2], Elizabeth Castillo-Martínez[2], Bernardo Herradón[1]

[1]Instituto de Química Orgánica General, (IQOG-CSIC), C. Juan de la Cierva, 3, Madrid, 28006, info@iqog.csic.es
[2]Inorganic chemistry department, Universidad Complutense de Madrid (UCM), 28040, quinorga@ucm.es

Potassium-ion batteries and **sodium-ion batteries** are a promising alternative to lithium-ion batteries. Both alkali metals presents several advantages, such as more abundance in earth's crust, lower cost and reduced environmental impact, while having similar electrochemical properties to lithium. Additionally, current day batteries components contain toxic and highly polluting elements such as cobalt and nickel. The substitution of these inorganic electrodes for organic molecules, ideally made from abundant compounds with low price, low toxicity and zero environmental impact is highly important for the future development of sustainable energy storage devices[1,2]. In this landscape we present the synthesis, structural and compositional characterization, as well as the electrochemical performance for potassium and sodium insertion of a series of **arene-amino acid hybrids**.

These compounds have been prepared via the **peptidic coupling** of an aromatic scaffold (**naphthalene tetracarboxylic dianhydride**, **9-oxo-9*H*-fluorene** and **9,10-anthraquinone derivates**) with a variety of amino acids. Two different synthetic routes have been followed: Naphthalene diimides were prepared by the nucleophilic attack of glycine to naphthalene tetracarboxylic dianhydride, while fluorene and anthraquinone derivatives were obtained via the peptidic coupling of glycine, L-tryptophan, L-tyrosine and L-aspartic acid using HOBt**/**EDC**/**DMAP as the coupling reagents.

After that, potassium and sodium salts of the synthesized hybrids were prepared via reaction with the corresponding carbonate, as the carboxylate group is reported to enhance the electrochemical capacities.[3]

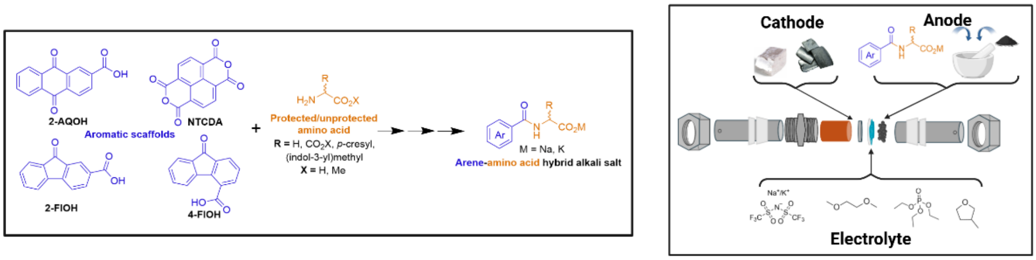

Fig. 1. Synthetic procedure and half-cell preparation for galvanostatic cycling.

Keywords: Electrochemistry, metal-ion batteries, arene-amino acid hybrids

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Study of cannabidiol synthesis for its application in the development of chemical probes for the identification of novel therapeutic targets.

Víctor Martín Jiménez[1*]; Silvia Ortega Gutiérrez[1], María del Henar Vázquez Villa[1]

[1] *Medicinal Chemistry and Chemical Biology Research Group (MedChemLab), Department of Organic Chemistry, School of Chemical Sciences, Complutense University of Madrid, 28040 Madrid, Spain. Victma12@ucm.es*

(-)-Cannabidiol ((-)-CBD) is a phytocannabinoid of great biomedical interest due to its anti-inflammatory, antitumor, and neuroprotective properties, combined with its low toxicity and lack of psychotropic effects [1]. Despite its therapeutic potential, the molecular mechanisms through which (-)-CBD exerts its effects remain largely unknown [2]. The specific objective of this project is the optimization of a robust and scalable synthetic route to access (-)-CBD, allowing its subsequent modification with an appropriate spacer for the incorporation of labeling subunits at different positions of the molecule. In this work, the synthetic route leading to (-)-CBD was optimized, with special emphasis on the Friedel-Crafts reaction to minimize the formation of Δ^9-tetrahydrocannabinol (Δ^9-THC) and other by-products. The structural characterization of the final product and all the intermediates of the route was performed. As a step toward identifying its molecular targets, the (-)-CBD molecule was successfully coupled to a polyethylene glycol (PEG)-based spacer, enabling the subsequent incorporation of labeling subunits for the development of chemical probes. This work lays the foundation for the creation of molecular probes capable of revealing the protein targets with which (-)-CBD interacts, contributing to a deeper understanding of its therapeutic actions and paving the way for the development of more effective and specific pharmacological treatments.

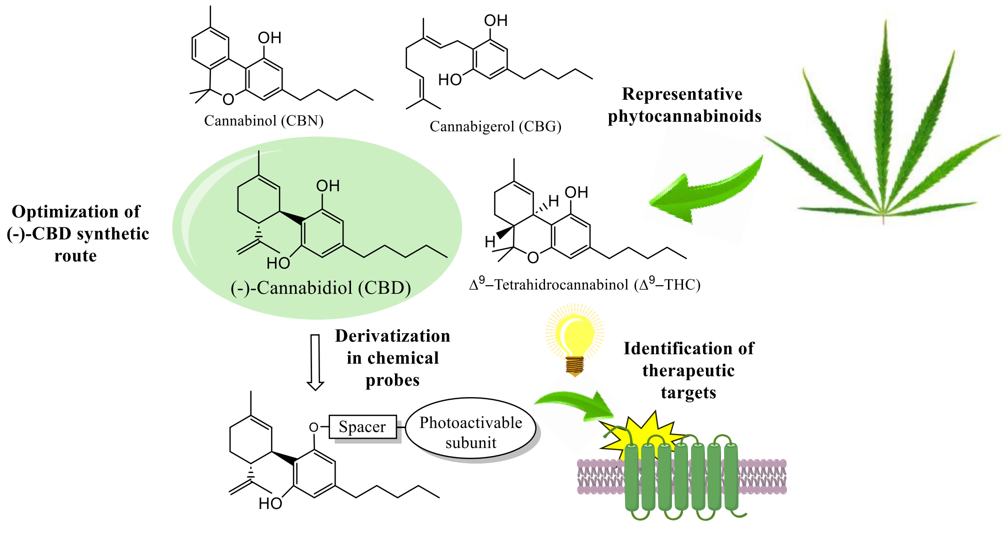

Figure 1. Graphic abstract.

Keywords: cannabinoids, chemical probes, therapeutic target, (-)-CBD

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Low-dimensional magnetocalorics for efficient refrigeration

Luis Fernández-Gallego,[1*] Elena Solana-Madruga[1]

[1] *Dpto. Química Inorgánica, Universidad Complutense de Madrid, Pl. Ciencias 2. 28040, Madrid, *luisfe14@ucm.es*

Cryogenic cooling (below −150°C) underpins a wide range of strategic technologies in the modern economy, from hydrogen liquefaction for clean energy storage and transport to emerging quantum technologies. Low-temperature refrigeration (from −150 °C to ambient temperature) is also indispensable for food preservation and pharmaceutical logistics, for instance. Current refrigeration systems rely on gas-compression cycles that use either scarce helium or environmentally harmful halocarbons, which account for ~ 20% of global electricity consumption and 8% of greenhouse-gas emissions. The increasing global demand for refrigeration motivates an urgent development of alternative, energy-efficient and sustainable cooling technologies. Magnetic refrigeration, based on the magnetocaloric effect (MCE), represents a promising solid-state alternative.[1] The MCE arises from a strong coupling between magnetic and structural features, allowing entropy to be reversibly stored/released by applying/removing a magnetic field, and thus to cool/store thermal energy.

Most known magnetocaloric materials contain rare-earths (scarce and expensive) and exhibit large entropy changes but require strong magnetic fields (> 5 T) and operate at very low temperatures (< 25 K). We aim to overcome these limitations focusing on low-dimensional and metamagnetic systems, where moderate magnetic fields (~ 2 T) can induce magnetic transitions with large entropy changes and promoting an efficient refrigeration.[2]

Here, we will present some preliminary materials to tackle this challenge in the cryogenic temperature range. The selected materials, transition metal oxides with predicted strong MCE, are prepared using both conventional and high-pressure synthesis methods. A comprehensive study of their compositional modification and structural features will explain their related magnetic properties.

Fig 1. Magnetocaloric materials for advanced solid-state refrigeration technologies.

Keywords: Magnetocaloric effect, energy-efficient cooling, low dimensional systems, high-pressure synthesis.

References

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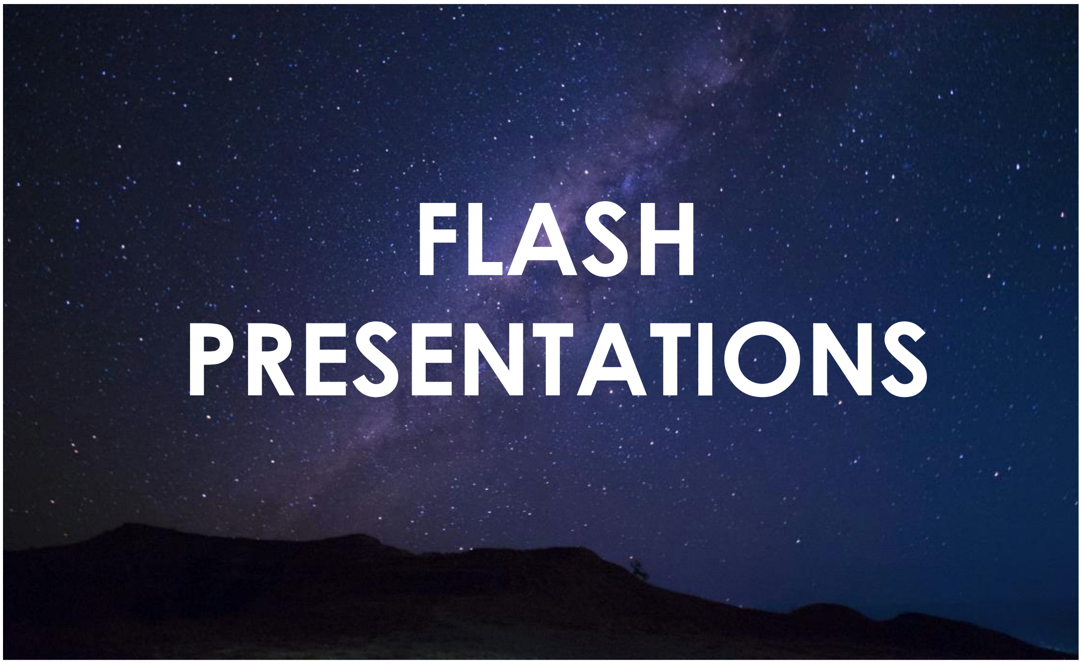
FLASH
PRESENTATIONS

Janus nanoparticles for targeted drug delivery

Teresa Moreno[1*]; Marta González-Jimenez,[2] Beatriz Mayol,[2] Anabel Villalonga,[2] Natalia Melones,[2] Paloma Martínez-Ruiz,[1] Diana Vilela,[2] Narcisa Martínez-Quiles,[3] Reynaldo Villalonga.[2]

[1] *Department of Organic Chemistry, Faculty of Chemistry, UCM, Spain, teremo01@ucm.es*
[2] *Department of Analytical Chemistry, Faculty of Chemistry, UCM, Spain.*
[3] *Department of Immunology, Ophthalmology and Otorhinolaryngology, Faculty of Medicine, UCM, Spain.*

Compared to conventional drugs, nanoparticle-based drug delivery has specific advantages, such as improved stability and biocompatibility, enhanced and precise targeting. Janus nanoparticles (JNs) have emerged as promising nanomaterials due to their anisotropic structure, which enables the combination of multiple functionalities within a single nanoparticle. In this study, we report the synthesis and characterization of a Janus gold nanoparticle designed for controlled drug delivery on cancer cells [1].

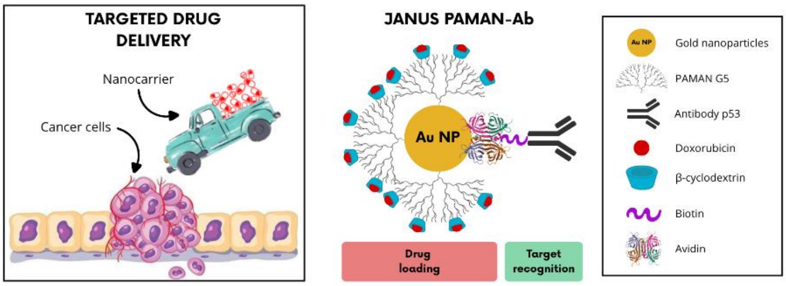

Fig 1. Schematic representation of Janus PAMAN-Ab nanoparticles

The synthesis was based on a mask-protecting assisted site-selective modification strategy employing positive-charged $Fe_3O_4@SiO_2$ core-shell nanoparticles as a masking element to protect one face of the AuNP [2]. The AuNP were asymmetrically functionalized, with one side caped with β-cyclodextrin (*β*-CD)-modified poly(amidoamine) (PAMAM) dendrimers, as the *β*-CD cavity was used for the supramolecular encapsulation of model drugs, like doxorubicin [3]. The other one was conjugated with a biotinylated anti-p53 antibody linked through avidin-biotin interactions, providing a highly selective recognition, ensuring targeted drug delivery in tumoral cells and minimizing side-effects [4]. Both the nanoparticle and their precursor materials were characterised by different techniques, demonstrating the proper assembly of the device, and the loading capacity of the nanoparticle was evaluated with UV-Vis spectroscopy. In order to evaluate the performance of the Janus nanodevices as target drug release systems, *in vitro* assays using HeLa cells were conducted.

Keywords: Janus nanoparticles, drug delivery, *β*-cyclodextrin, gold nanoparticles

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Mix & Measure: fast immunoassays for food safety evaluation

Irene De La Rosa Sánchez; Fernando Pradanas González, Marta García Cortés, Pablo Purohit Pacheco, Elena Benito Peña

Dpto. Química Analítica, Facultad CC Químicas, Universidad Complutense de Madrid, Avda. Complutense s/n, 28040, Madrid, e-mail: idelar03@ucm.es

The ubiquity of mycotoxins has granted them a relevant spot among closely monitored foodborne hazards. Aflatoxin M1 (AFM_1) represents the hydroxylated derivative of the highly carcinogenic Aflatoxin B1 and is commonly targeted to assess the presence of the latter. The threat posed by aflatoxins implies that the detection limits of the strategies used to inspect samples at various stages of the production chain must be exceptionally low. Bioluminescent sensors are leading-edge analytical tools combining high selectivity (provided by the antibody) and high sensitivity owing to the enhanced brightness of the transducer, resulting in high signal-to-noise ratios. Moreover, these sensors provide fast results over a wide variety of analytical scenarios. In the present work, we present a mix-and-measure competitive bioassay able to quantify AFM_1 in approximately 5 minutes. Competition was established between AFM_1 and a mimopeptide linked to nanoluciferase (NLuc) for binding to an anti-AFM_1 IgG conjugated to a long Stokes shift dye (Atto490LS) that absorbs at the NLuc peak emission wavelength (λ = ca. 450 nm). Therefore, in absence of the toxin, the NLuc was close enough to the dye to ensure resonant energy transference (BRET) between both entities, resulting in measurable emission at ca. 650 nm. The strong distance dependence of the BRET phenomenon ($1/r^6$) ensures that dye excitation and emission occur only upon mimotope binding. The assay developed herein constitutes a simple and time-efficient strategy for screening AFM_1 in different matrices.

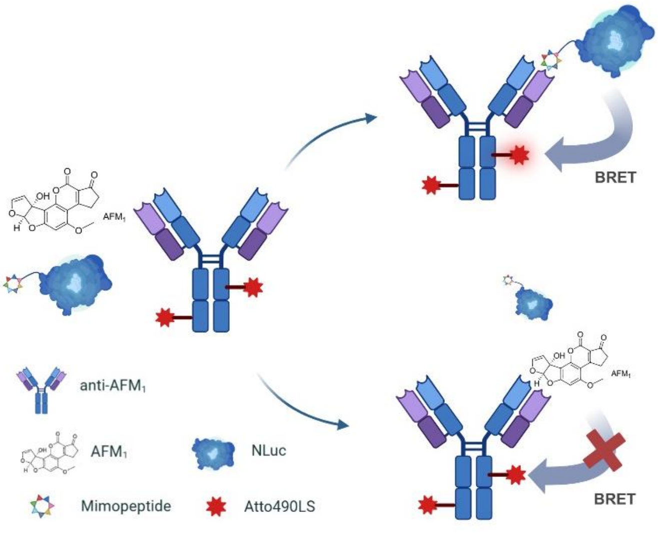

Fig 1. Homogenous BRET immunoassay for AFM_1

Keywords: aflatoxin M_1, mix and measure, bioluminescence

References

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Lighting Up Cancer Therapy: Designing Photoactivatable Metal Complexes

Julia D. Magdaleno,[1*] Santiago Gómez-Ruíz, [1] María Jesús Morán-Plata[1]

[1] COMET-NANO Group, Departamento de Biología y Geología, Física y Química Inorgánica, ESCET, Universidad Rey Juan Carlos, C/Tulipán s/n, 28933, Móstoles, Madrid, Spain, julia.magdaleno@urjc.es

By 2013, cancer had become the second leading cause of death worldwide,[1] and by 2022, nearly 20 million new cases were reported, according to the World Cancer Research Fund. Despite major scientific and clinical advances, conventional treatments such as surgery, chemotherapy, and radiotherapy are the most used in terms of cancer therapy. However, their limitations including systemic toxicity, resistance, and poor selectivity, continue to drive the search for more precise and less invasive alternatives.

In this context, light-based therapies have gained increasing attention as promising tools for next-generation cancer treatments. Among them, Photodynamic Therapy (PDT), Photothermal Therapy (PTT), Photoimmunotherapy (PIT), and Photoactivated Chemotherapy (PACT) have emerged as versatile strategies that exploit the spatial and temporal control provided by light. Upon irradiation with specific wavelengths, photoactive compounds can trigger diverse biological responses, Figure 1, such as localized heat generation, drug release, or the production of reactive oxygen species (ROS).[2] These processes enable targeted action at the tumor site, reducing side effects and improving therapeutic outcomes.

Nevertheless, the underlying mechanisms of photoresponsive compounds are often complex and not fully understood. This challenge has inspired the design of hybrid molecular systems capable of combining multiple activation pathways and selective targeting strategies, aiming to enhance both efficacy and control over the therapeutic response.

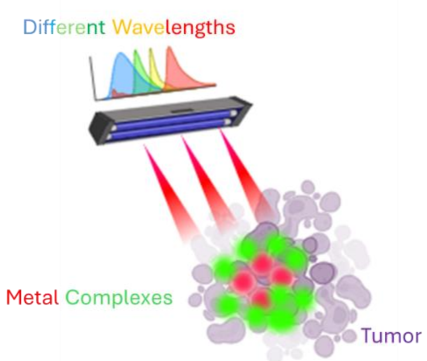

Figure 2. Light-activated metallocomplex

Our project focuses on the design, synthesis, and characterization of a series of bimetallic complexes built around an organic core functionalized with different substituents to promote synergistic anticancer activity. By integrating distinct light-triggered mechanisms into a single molecular platform, these compounds seek to maximize therapeutic efficiency while minimizing collateral damage. Ultimately, this approach could open new avenues toward smarter, more selective, and minimally invasive cancer treatments based on the precision of light-activated chemistry.

Keywords: metal complexes, photoactivated therapy, photodynamic therapy, cancer.

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Tiny Materials, Big Solutions: Nanotechnology for CO_2 and N_2 valorization

Lucía Espejo[1*], Santiago Gómez-Ruiz[1], Sanjiv Prashar[1],

[1] *COMET-NANO Group, Departamento de Biología y Geología, Física y Química Inorgánica, Universidad Rey Juan Carlos, C/ Tulipan s/n 28933 Móstoles (Madrid) lucia.espejo@urjc.es*

The increasing concentration of greenhouse gases in the atmosphere represents one of the greatest environmental challenges of our time. Carbon dioxide and nitrogen-based compounds are major contributors to global warming and air pollution, and finding efficient ways to capture and transform these molecules is a key step towards a more sustainable future. Nanotechnology offers a unique toolbox to address this issue by designing materials capable of interacting with gases at the molecular level, promoting both their capture and their conversion into valuable products[1,2].

Our research focuses on the development of advanced nanosystems aimed at the mitigation and valorization of greenhouse gases. Specifically, we are exploring molecular strategies for the coordination and activation of small molecules such as CO_2 and N_2. The current stage of our work centres on the design and synthesis of organic ligands with tailored electronic and structural properties, capable of binding to transition metals and forming well-defined coordination complexes. These systems are envisioned as potential candidates for catalytic processes that could either convert CO_2 into useful chemicals or enable nitrogen fixation under mild conditions, processes that are traditionally energy-intensive.

This project highlights how nanostructured and molecular materials can foster innovation in environmental chemistry. By combining inorganic synthesis, molecular design, and catalysis, we aim to create sustainable strategies for greenhouse gas management. It also underscores the importance of collaboration and the key role of chemistry in tackling global challenges.

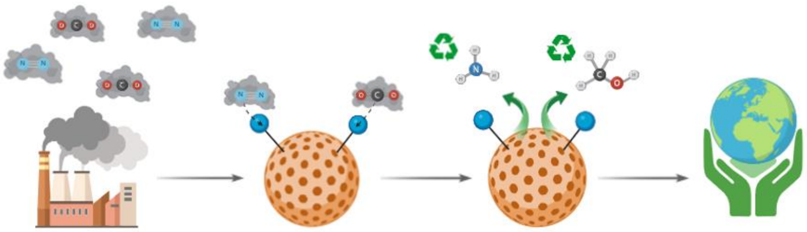

Fig 1. Nanotechnology for CO_2 and N_2 valorization.

Keywords: CO_2 and N_2 valorization, greenhouse gases, sustainability, nanomaterials.

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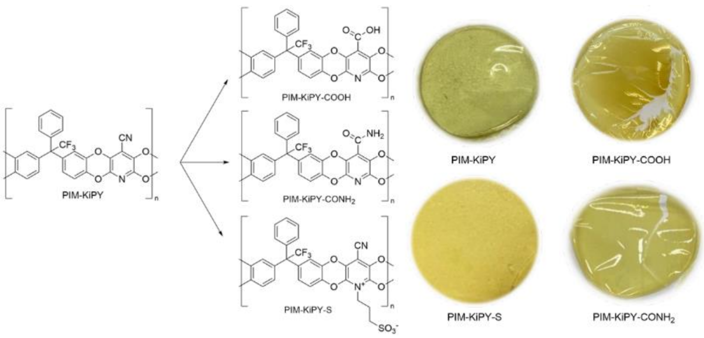
New Advanced Polymers with High Ionic Conductivity and Selectivity for Sustainable Energy Storage.

Alba Fernández-Rodríguez[1], Juan Carlos Martínez-López[1], Cristina Álvarez-Sancho[1], Javier Carretero-González[1]

[1]Institute of Polymer Science and Technology (ICTP-CSIC), Madrid, Spain



Keywords: Polymers of Intrinsic Microporosity (PIMs), functionalization.

Polymers of Intrinsic Microporosity (PIMs) are emerging materials that combine rigid and contorted structures, generating large free volumes that enable efficient ion transport. In this context, we present the synthesis and functionalization of PIM-KiPy derivatives bearing carboxylic acid and amide groups to improve hydrophilicity and ionic conductivity. Structural and thermal analyses (FTIR, TGA) confirm the successful incorporation of these functionalities, while electrochemical measurements demonstrate enhanced Li^+ diffusion and reduced crossover in aqueous media. The degree of functionalization directly influences water channel formation and overall membrane performance. These results highlight functionalized PIMs as promising, sustainable alternatives to conventional perfluorinated membranes for next-generation redox flow batteries and other energy storage technologies.

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Fighting Breast Cancer with Nanoparticles: A Triple Strategy for More Selective Therapies

Victoria García-Almodóvar,[1*] Julia D. Magdaleno,[1] Diana Díaz-García,[1] Sanjiv Prashar,[1] Santiago Gómez-Ruiz[1]

[1] *COMET-NANO Group, Departamento de Biología y Geología, Física y Química Inorgánica, ESCET, Universidad Rey Juan Carlos, C/Tulipán s/n, 28933, Móstoles, Madrid, Spain.* victoria.galmodovar@urjc.es

Cancer remains one of the most serious public health challenges, currently ranking as the second leading cause of death worldwide. Among its various forms, breast cancer is the most frequently diagnosed malignancy in women, accounting for nearly 685,000 deaths annually.[1] Despite the significant progress made in early detection and treatment, the lack of selectivity and systemic toxicity associated with conventional chemotherapeutic agents continue to limit their clinical success. In this context, nanotechnology offers a powerful platform to design targeted delivery systems capable of improving the efficacy and safety of anticancer therapies.

COMET-NANO research group focuses on the development of innovative nanomaterials for biomedical applications. In this work, we report the synthesis and characterization of mesoporous silica nanoparticles (MSN) functionalized with an organotin(IV) compound (Sn) exhibiting antitumor activity, and with folic acid (FA) to promote selective internalization in tumor cells that overexpress the folate receptor. Furthermore, different proportions of covalently bound polyethylene glycol (PEG) were incorporated to enhance nanoparticle stability and dispersion in aqueous and biologically relevant media (Figure 1).[2]

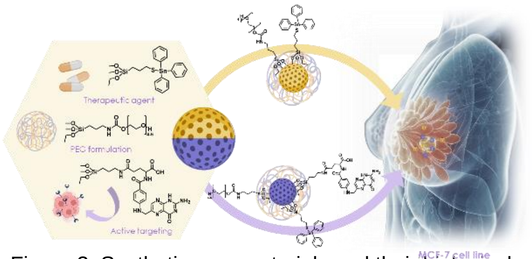

Figure 3. Synthetic nanomaterials and their biological application

Comprehensive physicochemical characterization confirmed the successful functionalization and stability of the obtained materials. Their biological performance was evaluated *in vitro* against MCF-7 (breast cancer) and Hek 293T (healthy) cell lines. The results demonstrated that FA improved the selectivity of the nanoplatform, significantly reducing cytotoxic effects in non-cancerous cells. In addition, formulations containing 5% PEG showed the most favorable behavior, achieving a balance between good colloidal stability and strong antitumor activity. In conclusion, the combination of Sn, FA, and PEG within MSN represents a promising and versatile strategy for the development of multifunctional nanomaterials with potential applications in oncology. These findings provide a solid foundation for future studies aimed at optimizing the formulation and performing *in vivo* validation. Ultimately, this approach could contribute to the design of more selective, efficient, and less toxic therapeutic alternatives for breast cancer treatment.

Keywords: nanomedicine, breast cancer, drug delivery, metal complex.

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Tiny particles crossing big barriers: Nanomedicine for ALS

Nagore Grasa-Gude,[1*] Diana Díaz-García,[1] Santiago Gómez-Ruiz[1].

[1] *COMET-NANO Group, Departamento de Biología y Geología, Física y Química Inorgánica, E.S.C.E.T., Universidad Rey Juan Carlos, E-28933 Móstoles, Madrid, Spain; nagore.grasa@urjc.es.*

Amyotrophic Lateral Sclerosis (ALS) is an irreversible neurodegenerative disease characterized by the progressive loss of motor neurons, leading to severe muscle weakness and ultimately to the death of the patient. Currently, there is no cure, and the approved drugs, riluzole and tofersen, provide only limited benefits, extending survival by approximately 3 to 6 months.[1]

One of the main challenges in the treatment of ALS is the blood–brain barrier (BBB), a highly selective system that protects the brain from potentially harmful substances but also restricts the passage of therapeutic compounds into the central nervous system. This represents a major limitation for the development of effective treatments for neurodegenerative diseases. In this context, nanotechnology emerges as a promising tool for designing drug delivery systems capable of crossing the BBB and acting directly on the pathological mechanisms of the disease.

Among these mechanisms, oxidative stress plays a crucial role. The accumulation of reactive oxygen species (ROS) causes damage to proteins, lipids, and nucleic acids, contributing to neuronal degeneration observed in ALS patients. Modulating these processes, together with improving drug delivery to the nervous system, constitutes one of the key strategies in the search for more effective therapies.

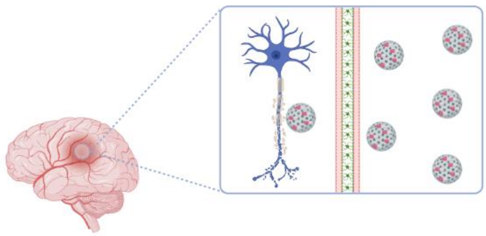

Figure 4..Crossing the BBB for smarter ALS therapy.

Mesoporous silica nanoparticles have attracted increasing attention in nanomedicine as a suitable platform to address these challenges. These materials exhibit excellent biocompatibility, stability, and tunable porosity, as well as a large surface area and versatile functionalization capacity. Such characteristics enable the controlled loading and release of therapeutic molecules, enhancing their bioavailability and improving their ability to cross biological barriers such as the BBB.

The use of mesoporous silica-based systems for the delivery of approved drugs in ALS represents an innovative strategy to optimize their therapeutic efficacy and improve access to the central nervous system.[2] This approach offers a promising path toward the development of more efficient and selective treatments, potentially applicable not only to ALS but also to other neurodegenerative disorders that remain difficult to treat.

Keywords: Amyotrophic Lateral Sclerosis, Blood-Brain Barrier, Drug Delivery, Nanotechnology.

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Chitosan–streptomycin hydrogels with lysozyme-responsive behavior for biofilm treatment

Irene Gutiérrez-Cabello[1*], Julia Revuelta[2].

[1] COMET-NANO Group, Department of Biology and Geology, Physics and Inorganic Chemistry, ESCET, Rey Juan Carlos University, C/Tulipán s/n, 28933 Móstoles, Spain. irene.gutierrezc@urjc.es

[2] Biological Glycochemistry Group, Department of Bioorganic Chemistry, IQOG, CSIC, C/Juan de la Cierva, 3, Madrid, Spain.

Biofilms are communities of microorganisms adhered to surfaces and protected by a matrix that provides resistance to antimicrobial treatments, complicating the management of infections, particularly those occurring in the oral cavity and on medical devices. Various strategies are being developed to prevent and treat biofilms, including the use of enzymes that promote their dispersion.[1] Chitosan is a biocompatible and antibacterial material widely used in dentistry due to its ability to form protective films on teeth and to act as a carrier for antibiotics, although its oral effectiveness is limited by rapid salivary clearance.[2] Hydrogels capable of controlled release of antibiofilm agents represent a promising alternative for the treatment of oral infections.[3] In this work, a chitosan–streptomycin (QS) hydrogel was developed to combat bacterial biofilms, particularly those triggered by lysozyme overexpression, an enzyme present in saliva at physiological concentrations (1 µg/mL) that increases significantly during oral infections (up to 10 µg/mL). When applied to simulated oral *S. aureus* biofilms, lysozyme interacts with the hydrogel, releasing chitosan–streptomycin oligosaccharides that effectively eliminate biofilm structures. This process resulted in a significant reduction in biofilm biomass and a substantial decrease in the bacterial population. Furthermore, hydrogels loaded with biofilm-disrupting enzymes, such as Dispersin B and/or DNase I, exhibited remarkable efficacy in the eradication of *S. aureus* biofilms. These enzymes degrade the biofilm matrix and promote cell dispersion, thereby enhancing bacterial susceptibility to antibiotic treatments. The combination of enzymatic degradation and antibiotic release produced a synergistic effect, significantly improving biofilm removal. Overall, the developed lysozyme-responsive QS hydrogel represents a promising and versatile approach for the prevention and treatment of oral biofilm-associated infections, with potential applications in dental materials and medical devices to reduce microbial colonization and improve therapeutic outcomes.

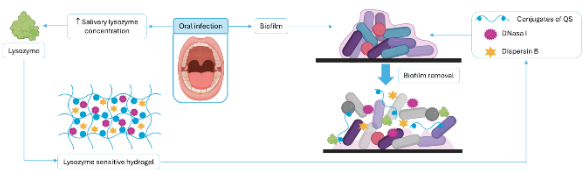

Fig 1. Graphic representation of the QS hydrogel and its role in biofilm prevention.

Keywords: Chitosan, hydrogels, lysozyme, biofilm.

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Crossing the Blood-Brain Barrier: Mesoporous silica nanoparticles for Advanced Parkinson's Treatment

Lucía Jiménez-Gómez[1]*, Santiago Gómez-Ruiz[1], Sanjiv Prashar[1]

[1]COMET-NANO Group, Departamento de Biología y Geología, Física y Química Inorgánica, Universidad Rey Juan Carlos, C/ Tulipán s/n 28933 Móstoles (Madrid) lucia.jimenezg@urjc.es

Delivering therapeutic molecules to the brain remains a major challenge in treating neurodegenerative diseases such as Parkinson's disease. The blood–brain barrier (BBB) protects the central nervous system from harmful agents but also prevents most drugs from reaching their targets. Developing strategies to overcome this barrier safely and effectively is therefore a central goal in modern nanomedicine [1].

This research explores the use of mesoporous silica nanoparticles (MSNs) as potential nanocarriers for brain-targeted therapies. MSNs possesses a highly porous structure and a versatile surface that allows them to encapsulate therapeutic compounds and interact with biological environments in a controlled manner. These properties enable the protection of fragile molecules, improve their bioavailability, and allow their gradual release at the desired site of action [2].

In this work, MSNs are designed as smart and multifunctional nanoparticles to carry neuroactive molecules with potential therapeutic effects. They feature a bioinspired surface modification that enhances stability and biocompatibility, promoting favourable interactions with the BBB and facilitating selective delivery of therapeutic agents to affected brain regions. Although still in an exploratory stage, this design highlights the potential of combining mesoporous structures with adaptable surface chemistry to create next-generation nanomedicines.

Keywords: Parkinson, Blood-brain barrier, Nanoparticles, Drug delivery.

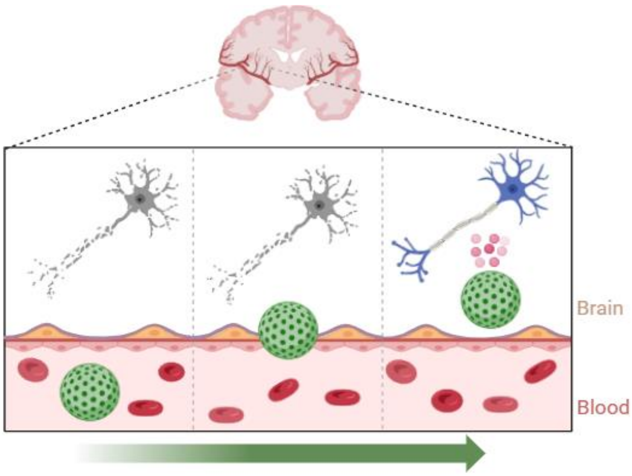

Fig 5. Nanoparticle crossing the blood-brain barrier and releasing drugs.

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Construction of novel MoS2/BiOX (X = Cl, Br, I) heterojunctions with an enhanced photocatalytic activity for pollutants degradation

S. Seoane[1], L.O. Amaral[2], A.L. Daniel-da-Silva[2], S. Gómez-Ruiz[1,3], I. del Hierro[1,3], J. Ortiz-Bustosa[1]

[1] COMET-NANO Group, Departamento de Biología y Geología, Física y Química Inorgánica, Universidad Rey Juan Carlos, C/ Tulipan s/n 28935 Móstoles (Madrid) sara.seoane@urjc.es
[2]CICECO-Aveiro Institute of Materials, Department of Chemistry, University of Aveiro, 3810-193 Aveiro, Portugal.
[3]Instituto de Investigación de Tecnologías para la Sostenibilidad (ITPS), Universidad Rey Juan Carlos, C/ Tulipan s/n 28935 Móstoles (Madrid)

For decades, environmental pollution and energy shortages have been major global concerns, driving the development of efficient semiconductor photocatalysts. Among them, MoS_2 has shown high photocatalytic activity for hydrogen production, but its efficiency under visible light is limited due to the rapid recombination of photogenerated electrons and holes. In contrast, bismuth-based semiconductors BiOX (X = Cl, Br, I) have recently attracted great attention thanks to their high stability, activity, low cost, and non-toxicity. Their layered structure enables various modification strategies to enhance photocatalytic performance, such as ion doping, heterojunction formation, morphology control, and the creation of oxygen vacancies. In particular, forming heterojunctions between semiconductors has proven to be an effective way to promote charge separation and strengthen the internal electrostatic field, thereby improving photocatalytic efficiency[1][2].
In this work, MoS_2/BiOX (X = Cl, Br, I) composites were synthesized through a simple one-step hydrothermal method. The resulting materials exhibited enhanced electron–hole separation across the MoS_2/BiOX heterojunction, leading to improved photocatalytic degradation efficiency for pollutants such as dyes (Rhodamine B) and herbicides (Acetamiprid).

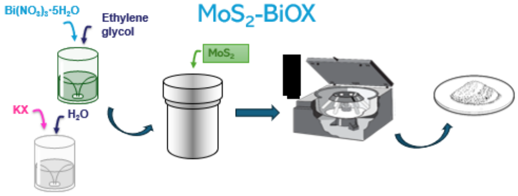

Fig 1. Synthesis of MoS2/BiOX composites.

Keywords: Semiconductor photocatalyst, heterojunction, pollutant degradation

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The hidden power of heat: Tin Sulfide advances thermoelectric energy conversion

J.A. Carralero González[1*]; M.M. González Barrios[1], O.J. Dura[2], J. Prado Gonjal[1]

[1] *Departamento de Química Inorgánica, Universidad Complutense de Madrid, E-28040 Madrid, España, e-mail: jcarrale@ucm.es*

[2] *Departamento de Física Aplicada, Universidad de Castilla-La Mancha, E-13071 Ciudad Real, España.*

The direct conversion of heat into electricity through thermoelectric materials provides a sustainable route for waste heat recovery. Since nearly 60% of global energy is lost as heat in industrial and transport processes, capturing part of it could enhance efficiency and reduce emissions. [1]

Conventional thermoelectric materials like Bi_2Te_3 are efficient but contain scarce and toxic elements, limiting large-scale use. Current research focuses on sustainable alternatives using abundant and nontoxic components. Tin sulfide (SnS), similar to high-performance SnSe, stands out for its abundance and low toxicity, though its low electrical conductivity still limits efficiency. [2-3]

Thermoelectric performance is described by the figure of merit (zT), which combines the Seebeck coefficient (voltage from a temperature difference), electrical conductivity (charge transport), and thermal conductivity (heat flow). The higher zT, the better the performance.

In this study, p-type SnS was doped with Ge and Zn to enhance electrical conductivity. Synthesized via microwave-assisted hydrothermal-solvothermal methods and consolidated by SPS, the 3% Ge-doped sample achieved zT_{max} = 0.51 at 720 K, confirming compositional engineering as a promising route for sustainable thermoelectrics.

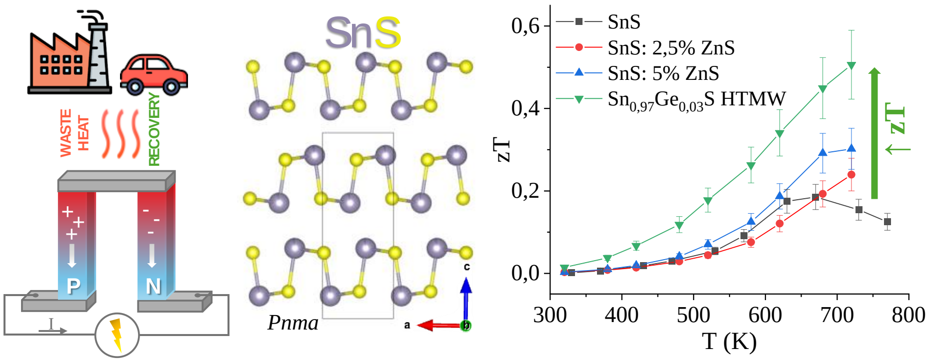

Fig 1. The thermoelectric effect, crystal structure of SnS and zT of SnS-based compounds.

Keywords: Thermoelectricity, Figure of merit, Tin sulfide, Composicional Engineering.

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Future Paths for Autism Spectrum Disorder Diagnosis Through Biomarker Detection

Daniel García-Fernández*[1], Mónica Revenga-Parra,[1,2] Tania García-Mendiola,[1,2]

[1] *Department of Analytical Chemistry and Instrumental Analysis, UAM, 28049 Madrid, Spain.*
[2] *Institute for Advanced Research in Chemical Sciences (IAdChem), UAM, 28049 Madrid, Spain*

Autism Spectrum Disorder (ASD) affects over 168 million people globally, with its prevalence increasing significantly in recent years. Although no cure exists, early detection, ideally between 6 months and 3 years of age, can substantially improve developmental outcomes. However, current diagnostic methods often fail to provide timely and objective identification, limiting the potential for early intervention. This delay can lead to behavioural challenges that contribute to social isolation and economic strain for patients. The **World Health Organization (WHO)**, through its *Comprehensive Mental Health Action Plan 2013–2030*, highlights the importance of mental health and the urgent need for innovative strategies to improve diagnosis of neurodevelopmental conditions such as ASD. Traditionally, ASD diagnosis has relied on behavioural observation, which are subjective and vary widely across individuals. The complexity and heterogeneity of ASD symptoms demand more accurate, sensitive, and scalable diagnostic tools. In response to this need, our research proposes a **multidisciplinary approach** based on **precision medicine**, aiming to develop **multiplex smart electrochemical biosensors** for the early detection of ASD. These biosensors are designed to identify emerging molecular biomarkers, which are associated with autism-related pathways. By integrating nanotechnology, molecular biology, and analytical chemistry, we seek to create a platform that enables objective, rapid, and cost-effective diagnosis. This strategy not only addresses the limitations of current diagnostic practices but also opens new pathways for personalized intervention and monitoring. The development of such biosensors represents a significant step toward improving early diagnosis and ultimately enhancing the quality of life for individuals with ASD and their families.

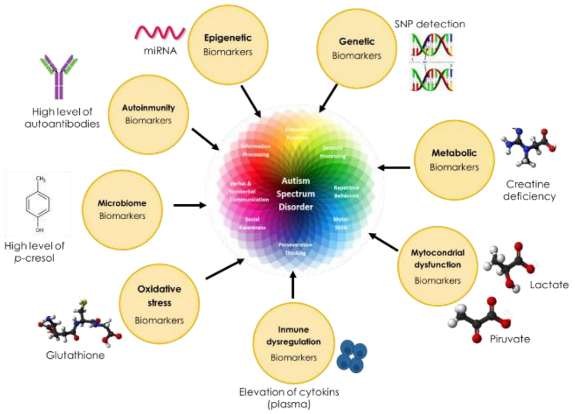


Fig 1. Scheme of the different biomarkers associated with risk of autism disorder.

Keywords: Autism Spectrum Disorder, precision medicine, electrochemical biosensor, diagnostic techniques

Yeast surface display: an improved alternative for allergy diagnosis

Jorge Parrón-Ballesteros[1]; Estela Soraya Castromil-Benito[1]; Javier Turnay[1]; Mayte Villalba[1]; Esperanza Rivera-de-Torre[3]

[1]Department of Biochemistry and Molecular Biology, Faculty of Chemistry, Complutense University of Madrid, Madrid, Spain (jparron@ucm.es)

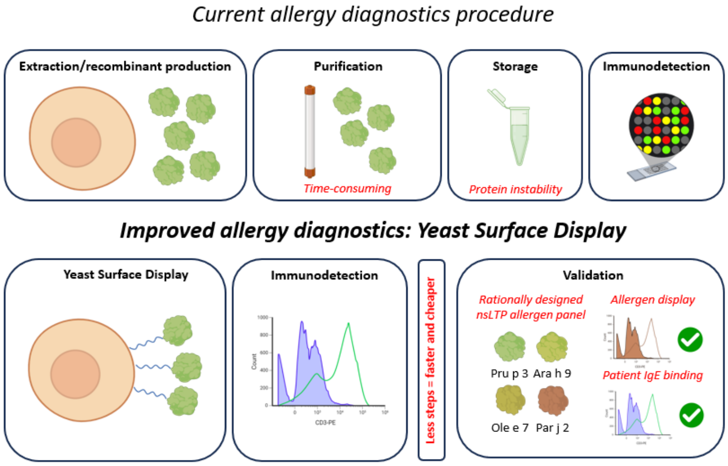
[2]Allergy Department, University Hospital Fundación Jiménez Díaz, Madrid, Spain.

[3]Department of Biotechnology and Biomedicine, Technical University of Denmark, Kongens Lyngby, Denmark

Food allergies are a global health problem whose clinical relevance has increased significantly over the last two decades. Environmental and food contamination predispose individuals to develop allergies, increasing their prevalence and the severity of symptoms, putting the lives of more people at risk. The proper management of food allergies requires accurate diagnosis. This diagnosis is limited by current technologies, which require the production and/or isolation of high-quality proteins (with the added costs of recombinant production and purification). In addition, purified proteins often lose biological activity over time, potentially risking the diagnosis of allergic patients.

As an alternative, we have developed for the first time a platform for the expression of an allergen panel on the surface of *Saccharomyces cerevisiae* (**Yeast Surface Display**), taking the nsLTP family as a model due to its clinical relevance in Mediterranean Countries (representing the main cause of anaphylaxis in Spain) and its complex protein folding. Yeast Surface Display allows the identification of allergens *in situ* with two key advantages: it does not require the costly purification step and there is no risk of degradation.

We used four allergens to set up the platform: Pru p 3, from peach skin (the prototypical member and the main allergen of the nsLTP family); Ara h 9, from peanuts (similar in its amino acid sequence to Pru p 3); Ole e 7, from olive pollen; and Par j 2, from pellitory pollen (highly dissimilar to Pru p 3 regarding amino acid sequences). Despite the low sequence similarity between the allergens, all were recognized by the individual sera of 9 nsLTP allergic patients, with a greater sensitivity than the current methods used in clinical practice for screening. These results validate Yeast Surface Display panels as a more cost-effective and efficient technology for the molecular diagnosis of food allergies.



Graphical abstract of the oral communication

Keywords: Allergy, Diagnostics, Biotechnology

CO_2 capture and conversion cycles via hydrogenation using bifunctional materials and magnetic induction heating

Laura Pretel Fernández[1], E. Castillejos-López[2], Ana Belén Dongil de Pedro[1].

[1]Instituto de Catálisis y Petroleoquímica, CSIC, Marie Curie, 2, Madrid. *laura.pretel@ipc.csic.es* [2] *Dpt. Inorganic and Technical Chemistry, Faculty of Sciences, UNE, Av. de Esparta s/n. 28232. Madrid*

Objectives: Carbon Capture and Utilization (CCU) is a process that can be carried out in two separate units: one for capture and another for conversion. However, it can also be implemented in a single unit using Dual Function Materials (DFMs),[1] Moreover, the application of magnetic induction heating (MIH) offers additional advantages due to its rapid heating, efficiency, and selectivity.[2]

Methodoloy: Ru/CeO_2 and $Ru(Ba)/CeO_2$ (doped with 1 mmol Ba/g of catalyst) with 1 wt.% Ru were synthesized. Magnetic heating agents, Fe_3O_4 and lab-synthesized FeCo@C nanoparticles, were compared. Catalysts were characterized by XRD, H_2-TPR, and CO_2-TPD, and FeCo@C were analyzed by XRD, vibrating sample magnetometry, TEM, and STEM.

Results: Both catalysts were tested under steady-state conditions. The Ba-doped sample showed higher CO_2 conversion (18%) than the non-doped one (14%) due to increased basicity and CO_2 activation ability. Catalytic performance was assessed under conventional heating and MIH; at all temperatures, MIH achieved superior conversion (30%), evidencing localized heating effects such as hot spots and hot electron generation. The presence of Fe_3O_4 reduced conversion and selectivity owing to phase changes and side reactions, whereas FeCo@C remained stable thanks to its protective carbon shell. Using the Ba-doped catalyst with FeCo@C, MIH produced up to 50% more methane than conventional heating, with minimal variation between cycles, suggesting catalyst and nanoparticle stability.

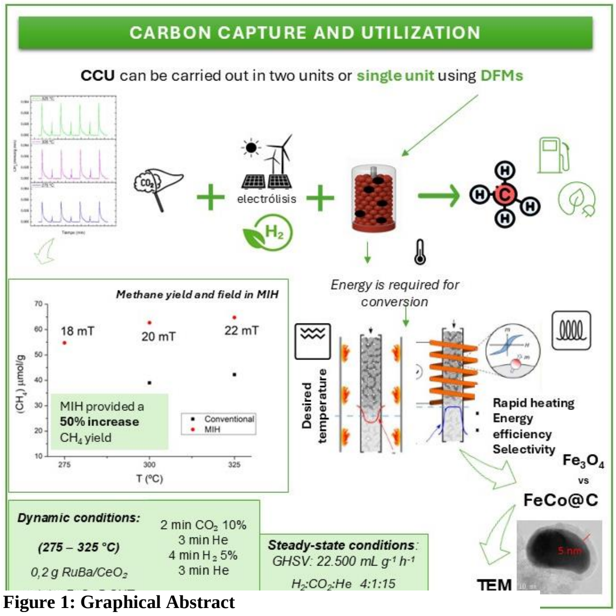


Figure 1: Graphical Abstract

Conclusion: The combination of Ba-doped catalysts with FeCo@C under MIH demonstrates a promising strategy for enhancing CCU methanation efficiency, highlighting the potential of integrating doped-DFMs and advanced heating techniques.

Keywords: methanation, dual function materials, magnetic induction heating, CCU.

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Avocado peel waste as a sustainable source of bioactive extracts with neuroprotective and antioxidant activity

Cristina García-Belchí[1*]; Esther Gómez-Mejía[1], Noelia Rosales-Conrado[1]

[1] Dpt. Analytical Chemistry, Faculty of Chemistry, Complutense University of Madrid, crisga32@ucm.es

Alzheimer's disease is the most prevalent neurodegenerative disorder worldwide, characterized by progressive neuronal loss, oxidative stress, and β-amyloid aggregation. Current pharmacological treatments only provide symptomatic relief, highlighting the need for novel therapeutic strategies [1]. In this context, polyphenols have attracted great attention for their antioxidant properties. Agri-food waste such as avocado peels represents an abundant and low-cost source of these compounds, offering a sustainable alternative for their recovery within the circular economy framework [2].
This study aimed to characterize the phenolic profile and bioactive properties of aqueous extracts obtained from avocado peel using a solid-liquid extraction (SLE) method with water as the only solvent, in line with the principles of Green Chemistry.
The sustainability of the extraction procedure was evaluated using the AGREEprep tool [3]. The total phenolic and flavonoid contents and the antioxidant activity of the extracts were assessed spectrophotometrically. Individual phenolic compounds were identified by capillary liquid chromatography coupled to a diode-array detector (cLC-DAD). Their neuroprotective potential was evaluated via inhibition of acetylcholinesterase (AChE) and inhibition of β-amyloid peptide ($A\beta_{42}$) aggregation observed by transmission electron microscopy (TEM). Additionally, the antihypertensive potential of the extracts was determined by evaluating their ability to inhibit the angiotensin-converting enzyme (ACE).
The extraction showed a high sustainability score (0.7/1.0), confirming its environmental compatibility. The aqueous extracts exhibited notable phenolic and flavonoid contents with gallic, caffeic, and vanillic acids identified as major components. The extracts displayed significant antioxidant activity and AChE inhibition, comparable to standard inhibitors. TEM analysis revealed a reduction in amyloid fibril formation, indicating inhibition of $A\beta_{42}$ aggregation, showing neuroprotective activity. Moreover, the extracts showed moderate ACE inhibitory activity, suggesting potential cardiovascular benefits.

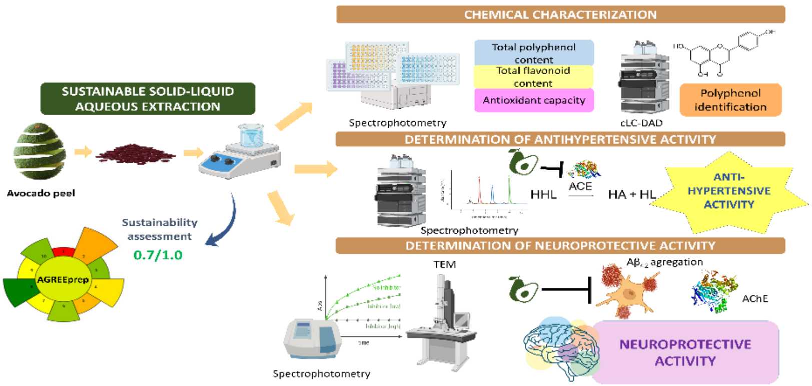

Fig 1. Graphical abstract of the research

Keywords: Agri-food waste, polyphenols, sustainability, neuroprotective activity

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A new hope of Platinum-based complexes to fight cancer

Silvia Gil-Granja[1*]; Diana Díaz-García[2], Leticia Cubo[1], Isabel Sánchez-Pérez[3], Santiago Gómez-Ruiz[2], Adoración G. Quiroga[1]

[1] *Inorganic Chemistry Department, Universidad Autónoma de Madrid, 28049 Madrid, Spain, silvia.gil@uam.es*
[2] *Biology, Geology, Physic, Inorganic Chemistry Department, Universidad Rey Juan Carlos, 28933 Madrid, Spain*
[3] *Biochemistry Department, Universidad Autónoma de Madrid, 28049 Madrid, Spain*

Cancer is a widespread disease among the global population and in European countries it ranks on top ten causes of death. It is a highly heterogeneous disease, and its treatment is usually carried out through chemotherapy. Since the discovery of cisplatin, platinum-based drugs have played a central role in cancer therapy. However, these drugs cause severe side effects due to its lack of selectivity and specificity, and repeated treatment can lead to resistance, reducing its efficacy. The European Commission has identified cancer as one of its highest healt priorities and emphasized the importance of finding new treatments.

Platinum(IV) complexes are developed as new metallodrugs that are considered prodrugs. They require intracellular reduction to exert cytotoxic activity[1], thereby reducing adverse effects and increasing selectivity towards the therapeutic target. Their octahedral geometry allows for additional chemical modifications at axial positions, enhancing pharmacokinetic properties, solubility and stability compared to their Pt(II) analogues.

Pt(IV) complexes are relevant in terms of their potential efficacy and specificity, and they also offer to explore new mechanisms of action in chemotherapy. This work is focused on the synthesis and characterization of non-convectional Pt(IV) complexes which incorporate biological active molecules, such as aminoacids, to improve targeting and improve the pharmacological profiles[2]. Furthermore, we describe the functionalization of the prodrugs with nanoparticles that act as nanocarriers to enhance targeting and specificity[3] and offer controlled drug release and improved biocompatibility.

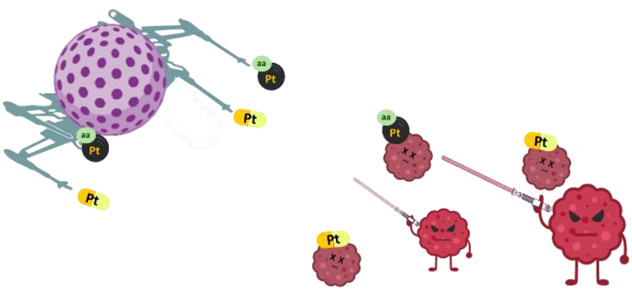

Figure 1. Graphical abstract.

Keywords: Antiproliferative, Platinum(IV), aminoacids, nanoparticles.

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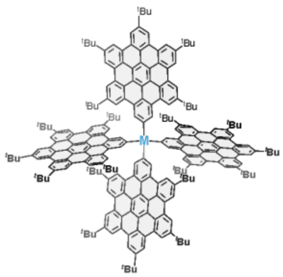
Tetrahedral nanographenes: Synthesis and Aggregation-Induced Emission

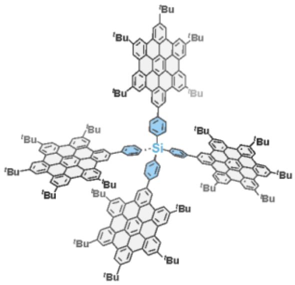
Marina Iglesias,[1] Jesús M. Fernández-García,[1] Nazario Martín,[1,2] ...

[1] *Departamentode Química Orgánica, Facultad de Química, Universidad Complutense de Madrid Avd. Complutense S/N, 28040 Madrid (Spain)*
[2] *IMDEA-Nanociencia C/Faraday, 9. Campus de Cantoblanco,28049 Madrid (Spain)*
marigl06@ucm.es

Graphene, discovered in 2004, is a groundbreaking material with the potential to revolutionize the future of nano-electronics due to its exceptional mechanical strength, flexibility and high carrier mobility. However, its zero bandgap limits its use in conventional transistors. To overcome this, quantum confinement of the electrons in smaller fragments, so called nanographenes, opens a bandgap and turns them into semiconductor materials.
Through bottom-up organic synthesis, molecular nanographenes can be precisely designed in size and shape. Following this approach, our research group has recently developed the synthesis of "tetrahedraphene" **1a** (Figure 1), a molecule composed of a central sp^3 carbon atom linked to four hexa-*peri*-hexabenzocoronenes (HBCs). This molecule showed aggregation-induced emission (AIE), making it a promising candidate for OLED applications. [1].



1a= C



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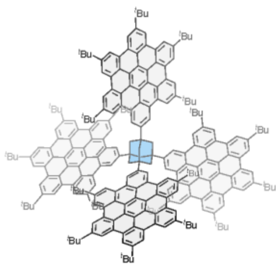

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Figure 1. Tetrahedral nanographenes with a central atom **1** (M= C or Si), with a benzene spacer **2** and with a central adamantane moiety **3**.

Encouraged by this result, we proceeded to synthesize a new series of tetrahedral nanographenes to gain deeper insight into the relationship between molecular structure and photophysical properties. Our efforts focused on three key structural modifications to investigate the change in the AIE. Firstly, by the variation of the central atom to Si, **1b** (Figure 1)**.** Then, by the introduction of rotational and vibrational freedom using a spacer between the HBC fragments and the central atom **2**. Finally, by the modification of the central core employing molecular fragments such as adamantane **3**, instead single atoms.

Keywords: *molecular nanographenes, photophysical properties, aggregation-induced emission.*

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Unravelling Corrosion Mechanisms of Alloys in Mars: CHIMERA

Omar SMayorga[1*] , Noemí Encinas García,[1] Francisco Javier Pérez Trujillo[1]

1 Departamento de Ingeniería Química y de Materiales, Facultad de Ciencias Químicas, Universidad Complutense de Madrid, 28040, Madrid, Spain

This project aims to advance the understanding of corrosion mechanisms affecting metallic materials. Special focus is placed on stainless steels and aluminium alloys, which are widely used in rover structures for Mars exploration missions conducted by NASA, ESA, and CNSA. Previous missions, such as Curiosity (NASA, 2011), Exo-Mars (ESA-Roscosmos, 2016) or Perseverance (NASA, 2020), have shown that several environmental factors on Mars including atmospheric pressure of about 7 mbar, temperature cycles between 0 °C and −30 °C, soil composition, the presence of molten salts, and intense cosmic radiation contribute significantly to material degradation through electrochemical corrosion.

To shed light on the mechanisms governing these degradation processes, and aid to develop improved materials, the CHIMERA project proposes a methodology integrating thermodynamic and kinetic simulations together with experimental studies performed in a Mars simulation chamber. Within this framework, different types and concentrations of brines—such as perchlorates, sulphates, and chlorides—will be introduced to analyse their synergistic effects on corrosion behaviour.

Advanced computational simulation tools (Thermo-Calc, DICTRA, and COMSOL) will be employed to identify the main oxides formed on aluminium and stainless steel alloys, assessing their stability under Martian environmental conditions.

In parallel, the project focuses on developing Furthermore, a ceramic sensor capable of in situ measurement of corrosion-related variables will be developed. The sensor will continuously monitor potential, current, and pH variations to detect oxidation changes in real time under simulated Martian conditions.

The expected outcomes include the validation of theoretical models with experimental data, the identification of critical environmental variables influencing corrosion, and the design and patenting of a new ceramic sensor for future planetary applications. Ultimately, the project envisions the creation of a dedicated research platform on Martian corrosion, which soon will foster scientific and technological progress with direct benefits for the advancement and development of society.

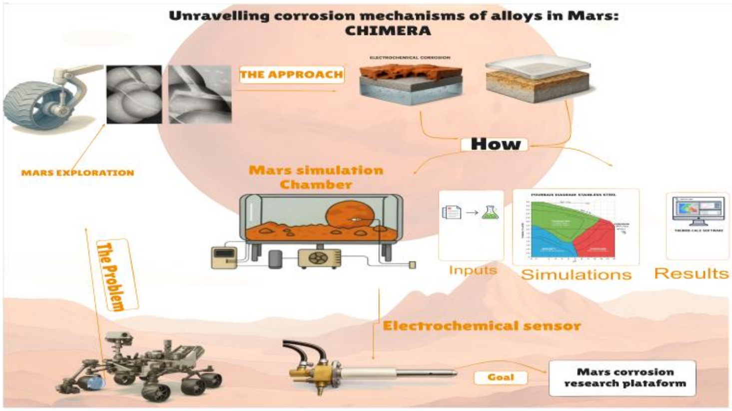

Fig 1. Graphical abstractct

Keywords: Martian environment, molten salt, chemical corrosion, simulation.

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Degradation of biogenic amines in fermented and non-fermented foods

Ismael Picazo-Arijón[1]; Juan José Rodríguez-Bencomo[1]

[1] *Department of Analytical Chemistry, Faculty of Chemistry Sciences, Complutense University of Madrid, 28040 Madrid, Spain, ismapica@ucm.es*

In recent decades, the presence of biogenic amines (BA) (histamine, putrescine, tyramine, etc.) in foods has concerned researchers, producers and consumers and their origin is due to a bacterial enzymatic decarboxylation of the precursor amino acids [1]. When ingested, BA are metabolized by human enzymes, which can become saturated at high BA concentrations, leading to health problems. Nowadays, soy and derivatives are popular products, that tends to contain BA [2]. Thus, an initial study of soy-based products was realized determining its BA content. Additionally, the BA levels variation in non-fermented tofu was evaluated according to the coagulant type used. BA were determined by high-performance liquid chromatography coupled to a diode array detector (HPLC-DAD).

Since BA concentrations are normally higher in fermented foods, our work is focused on mitigating the content of these BA [3]. Although the most usual approach is to prevent BA formation [3], as it is not always possible, an innovative strategy, based on their degradation, is proposed in this ongoing investigation [4]. Therefore, the objective of the project focuses on the chemical degradation of the amines in fermented beverages using common food additives (e.g. ascorbic acid) in an integrated methodology into product processing. This includes the study of the degradation of amines in food and the identification of the degradation products. The methodology will consist of soft thermal treatment to cause the BA degradation in wine and beer. It is expected that the results obtained will generate information about the type of reaction and its viability in food products, establishing a starting point to confront more complex food products, like cheeses (solid matrix). Also, the social and economic impact is foreseeable, as this disruptive approach aligns with the EU regulations using allowed food additives, which can facilitate the future industrial application, even extrapolating it to other food products.

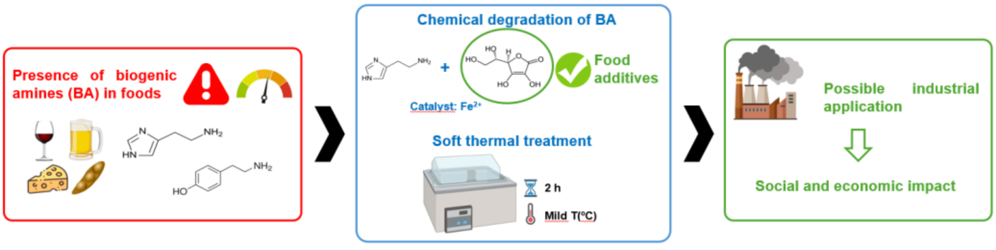

Fig 1. Chemical degradation of biogenic amines in fermented and non-fermented foods.

Keywords: Biogenic amines, Degradation, Fermented foods, Food additives.

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Predatory mite, Cheyletus eruditus, as a new allergenic source: Identification and cross-reactivity of its allergens

Estela Soraya Castromil-Benito[1*]; Jorge Parrón-Ballesteros[1]; Diana Betancor[2]; Víctor Iraola[5]; Mayte Villalba[1]; Carlos Pastor-Vargas[1]

[1*] *Department of Biochemistry and Molecular Biology, Faculty of Chemical Sciences, Complutense University of Madrid, Madrid, Spain, estelasc@ucm.es*
[2] *Allergy Department, University Hospital Fundación Jiménez Díaz, Madrid, Spain*
[5] *I+D+i Department, Inmunotek S.L., Madrid, Spain*

The Western lifestyle involves prolonged indoor stays in homes, offices, gyms, and pubs, leading to increased exposure and allergic symptoms caused by house dust mites. Due to anthropogenic climate change, these mites have improved survival and proliferation. Within this context, we studied *Cheyletus eruditus*, a predatory mite with key adaptive traits, that remains underdiagnosed in clinical practice. Its presence and biotechnological use as a pest biocontrol agent have recently increased in Spanish urban environments, prompting us to identify its allergens and cross-reactivity patterns.

In collaboration with Inmunotek's R&D Department, a *C. eruditus* culture and protein extract were prepared. Allergenic profiles were determined by Western blot using sera from 60 sensitized patients confirmed by skin prick test. Participants came from three regions with distinct climates: Madrid (Continental Mediterranean), the Canary Islands (Subtropical), and La Coruña (Oceanic). IgE-reactive proteins identified by mass spectrometry included a 12 kDa fatty acid-binding protein, a 14 kDa Lep d 2-like protein, a 17 kDa peptidyl-prolyl cis-trans isomerase, a 24 kDa thaumatin-like protein, and a 25 kDa triose-phosphate isomerase. The first was most frequently recognized (50–80% of patients). Recognition patterns varied by region, suggesting sensitization to other mites contributes to *C. eruditus* allergy. Cross-reactivity assays confirmed strong IgE inhibition by *Lepidoglyphus destructor* and *Blomia tropicalis*, and partial inhibition by *Dermatophagoides pteronyssinus* and *D. farinae*.

These results establish the molecular basis of *C. eruditus* allergenicity, demonstrating significant IgE cross-reactivity with related mite species and underscoring its clinical relevance in indoor allergy diagnosis and management.

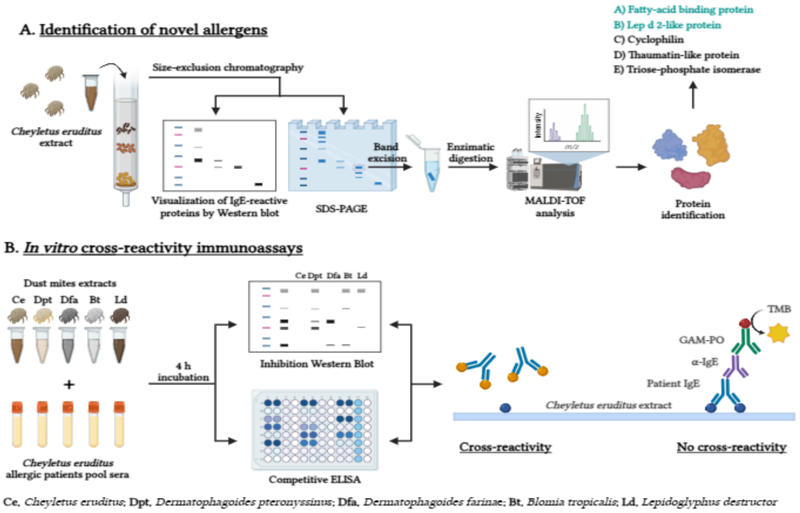

Fig 1. General overview of the methods used for the identification and characterization of the novel allergens from *Cheyletus eruditus* and the evaluation of its *in vitro* cross-reactivity.

Keywords: Allergy, Immunology, Diagnostics, Novel Allergens