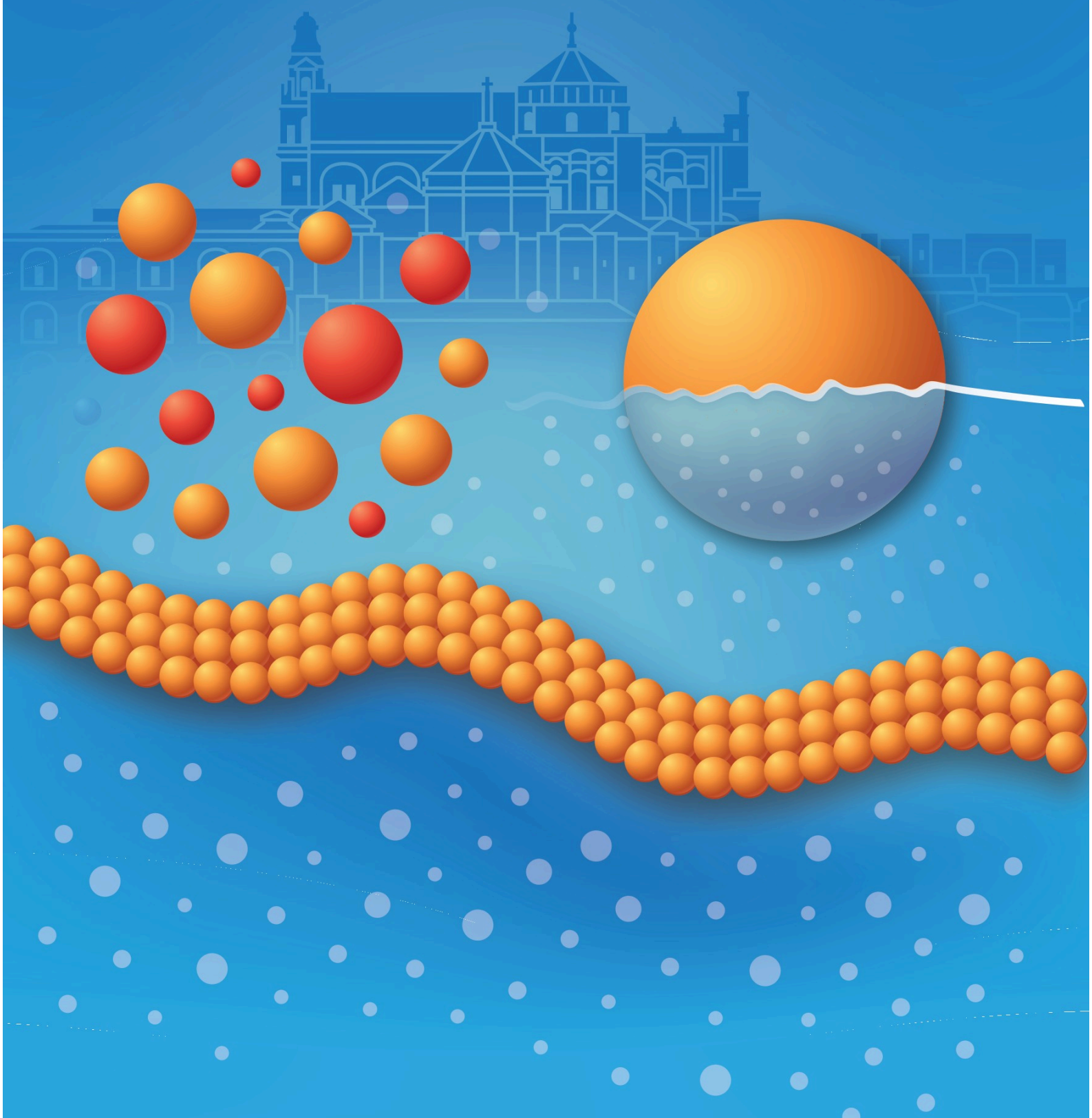


RICI XI

JUNE | 22, 23 AND 24 | 2026 | CÓRDOBA | SPAIN



RICI XI – The 11th Iberian Meeting on Colloids and Interfaces

COMMITTEES

Organizing Committee:

Dra. María Teresa Martín Romero

Dr. Juan José Giner Casares

Local Committee:

Dra. Eulogia Muñoz Gutiérrez

Dra. Marta Pérez Morales

Dr. Antonio J. Fernández Romero

Dr. Gustavo de Miguel Rojas

Dr. Manuel Cano Luna

Dr. Pablo Gómez Argudo

Dr. Valentín Gómez Caballero

PhD Student Eulogio Vargas García

Student Domingo Salazar Ordóñez

Student Miguel González Luque

Student Antonija Starcevic

Scientific Committee — Spain:

Dra. Julia Maldonado Valderrama

Dr. Rafael Muñoz-Espí

Dra. Isabel Pastoriza Santos

Dr. Jesús Martínez de la Fuente

Dr. Marek Grzelczak

Dra. María Teresa Martín Romero

Dr. Pablo Taboada Antelo

Scientific Committee — Portugal:

Dra. Marlene Lúcio

Dr. Eduardo Marques

Dr. Tito Trindade

Dr. Alberto Pais

Dr. José Paulo Farinha

Dr. Nuno Basílio

WELCOME

We are delighted to host the upcoming 11th edition of the Iberian Meeting on Colloids and Interfaces (RICI XI), taking place from June 22 to June 24, 2026, at the historical city of Córdoba, Spain.

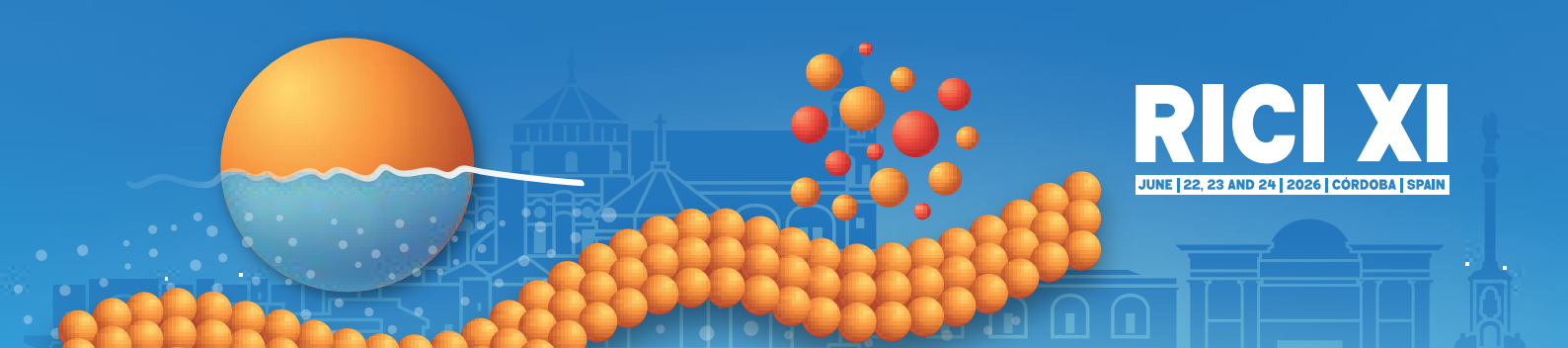
RICI is a well-respected and community-oriented international conference named after Reunión Ibérica de Coloides e Interfases / Reunião Ibérica de Colóides e Interfaces. RICI is a joint venture between the Grupo Especializado de Coloides e Interfases (GECI) of the Real Sociedad Española de Química (RSEQ) and the Real Sociedad Española de Física (RSEF), together with the Grupo de Colóides, Polímeros e Interfaces of the Sociedade Portuguesa de Química (SPQ).

RICI is a friendly and open conference populated with researchers from Spain, Portugal, and around the world to come together, share ideas, and explore the latest research in colloidal science.

RICI XI will feature an engaging program with relevant topics within the multidisciplinary domain of colloids and interfaces with plenary and invited sessions, as well as opportunities for scientific communications through oral and poster presentations. Topics include:

- Colloids, Biocolloids, Nanoparticles, and Colloidal Nanoscience
- Surfaces, Interfaces, and Films
- Polymers, Foams, Emulsions, Liquid Crystals, and Gels
- Surfactant Science and Technology
- Advanced Materials and their Characterization
- Theory and Modeling Applied to Soft Matter
- Colloidal Biotechnology, Medical, Pharmaceutical, and Food Applications
- Experimental Methods in Colloidal and Interface Science
- Colloids and Surfaces in Energy and Environmental Technologies

We are looking forward to welcoming you to RICI XI in Córdoba. Córdoba is one of the cities with the highest number of World Heritage Sites worldwide, with four sites included in the UNESCO World List: the historic centre of Córdoba, the Caliphate city of Medina Azahara, the festival of the Patios Cordobeses and, first and foremost, the Mosque-Cathedral of Córdoba, which was included in the prestigious list in 1984. Córdoba has one of the largest historic centres in Europe, covering 246.73 hectares with monuments dating back to Roman times. Thus, be prepared for a highly enriching experience at a both scientific and non-scientific level at RICI XI in Córdoba!



RICI XI

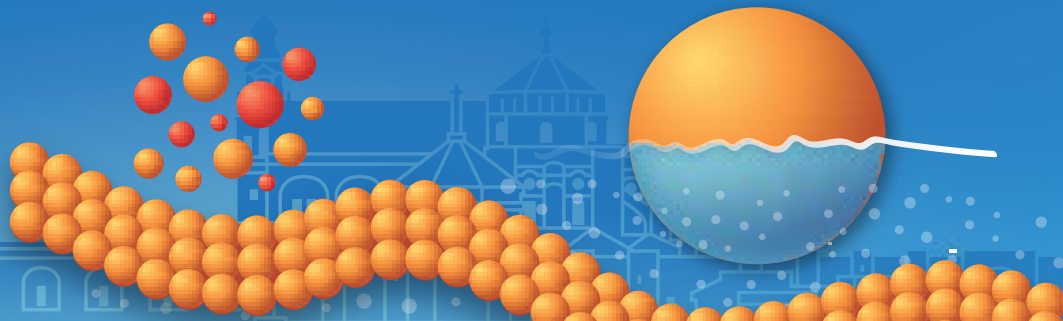
JUNE | 22, 23 AND 24 | 2026 | CÓRDOBA | SPAIN

Sunday, 21 June 2026

18:00 – 20:00	Registration and welcome — Rectorado de la Universidad de Córdoba
21:00	Welcome Cocktail — Caballerizas Reales

Monday, 22 June 2026 · Day 1

08:30 – 09:00	Registration and opening
09:00 – 09:45	Plenary 1 · Assembly Hall Session Chair: Dr. Tito Trindade Surface Forces of Polymers and Surfactants for the Cosmetic substrate. Transition to eco design of sustainable formulations <i>Gustavo Luengo. L'OREAL Research and Innovation.</i>
09:45 – 10:15	Invited 1 · Assembly Hall Session Chair: Dr. Tito Trindade Adaptive nanocapsules for targeted drug delivery and as artificial nanoorganelles <i>Katharina Landfester. Max Planck Institute for Polymer Research, Mainz, Germany.</i>
10:15 – 11:00	Oral parallel sessions <u>Assembly Hall</u> Session Chair: Dra. Isabel Pastoriza Santos Topic. Polymers, Foams, Emulsions, Liquid Crystals and Gels: O.01, O.02, O.03 <u>Mudéjar Hall</u> Session Chair: Dr. Alberto Pais Topic. Surfaces, Interfaces and Films: O.04, O.05, O.06
11:00 – 11:30	Coffee break



11:30 – 12:45

Oral parallel sessions

Assembly Hall

Session Chair: Dra. Isabel Pastoriza Santos

Topic. Polymers, Foams, Emulsions, Liquid Crystals and Gels:

O.07, O.08, O.09

Topic. Advanced Materials and their Characterization: **O.13, O.14**

Mudéjar Hall

Session Chair: Dr. Alberto Pais

Topic. Surfaces, Interfaces and Films: **O.10, O.11**

Topic. Surfactant Science and Technology: **O.12**

Topic. Experimental Methods in Colloidal and Interface Science: **O.15, O.16**

12:45 – 14:30

Lunch

14:30 – 15:00

Invited 2 · Assembly Hall

Session Chair: Dra. Marlene Lúcio

Advancing RNA Therapeutics Through Next-Generation Nanomedicines

*Cristina Fornaguera. Institut Químic de Sarrià (IQS),
Universitat Ramon Llull (URL).*

15:00 – 16:15

Oral parallel sessions

Assembly Hall

Session Chair: Dra. Marlene Lúcio

Topic. Colloidal Biotechnology, Medical, Pharmaceutical and Food Applications: **O.17, O.19, O.20, O.21**

Mudéjar Hall

Session Chair: Dr. Marek Grzelczak

Topic. Advanced Materials and their Characterization: **O.22, O.24, O.25, O.26**

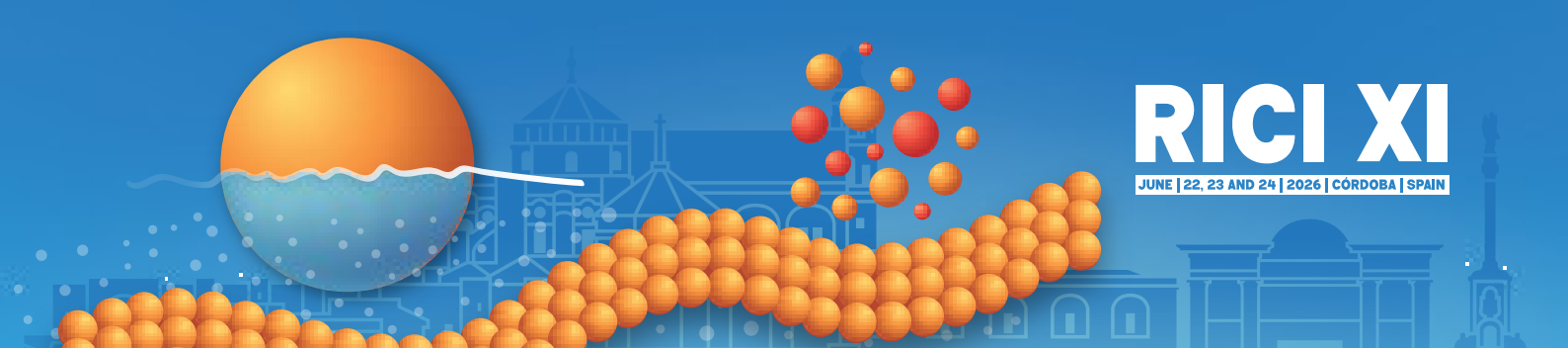
Topic. Experimental Methods in Colloidal and Interface Science: **O.62**

16:15 – 18:00

Poster session

19:00

Guided tour — Mosque-Cathedral of Córdoba



RICI XI

JUNE | 22, 23 AND 24 | 2026 | CORDOBA | SPAIN

Tuesday, 23 June 2026 · Day 2

09:00 – 09:45

Plenary 2 · Assembly Hall

Session Chair: Dr. Pablo Taboada Antelo

Nanoparticles for the next generation of implants

Daniel Jaque. nanoBIG, Faculty of Sciences, Department of Materials Physics.

09:45 – 10:15

Invited 3 · Assembly Hall

Session Chair: Dr. Pablo Taboada Antelo

Cyclodextrin-based nanosponges: from water remediation to sensing

Artur Valente. CQC-IMS, Department of Chemistry, University of Coimbra.

10:15 – 11:00

Oral parallel sessions

Assembly Hall

Session Chair: Dr. Rafael Muñoz-Espí

Topic. Colloidal Biotechnology, Medical, Pharmaceutical and Food Applications: **O.27, O.28, O.29**

Mudéjar Hall

Session Chair: Dr. José Paulo Farinha

Topic. Colloids and Surfaces in Energy and Environmental Technologies: **O.30, O.31, O.32**

11:00 – 11:30

Coffee break

11:30 – 12:45

Oral parallel sessions

Assembly Hall

Session Chair: Dr. Rafael Muñoz-Espí

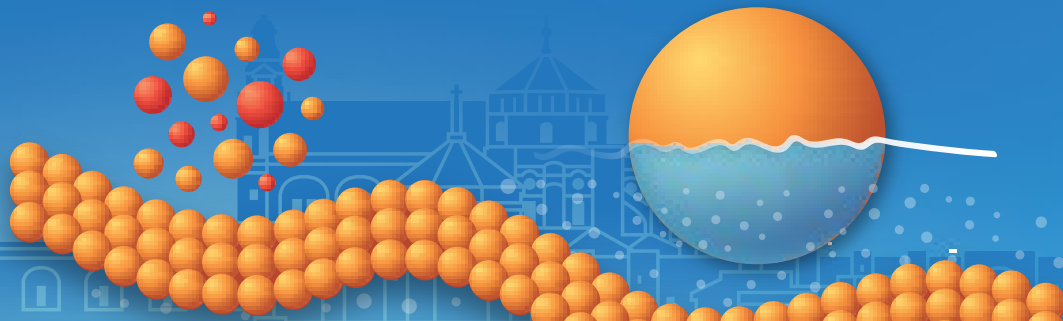
Topic. Colloidal Biotechnology, Medical, Pharmaceutical and Food Applications: **O.33, O.34, O.35, O.36, O.37**

Mudéjar Hall

Session Chair: Dr. José Paulo Farinha

Topic. Colloids and Surfaces in Energy and Environmental Technologies: **O.38, O.39, O.40**

Topic. Advanced Materials and their Characterization: **O.41, O.42**



12:45 – 14:30

Lunch

14:30 – 15:00

Invited 4 · Assembly Hall

Session Chair: Dr. Eduardo Marques

Crystals at the Interface: Steering Lipid Crystallisation Through Emulsifier Choice

Marta Krasowska. Professor of Physical Chemistry and Academic Lead | Future Industries Institute.

15:00 – 16:15

Oral parallel sessions

Assembly Hall

Session Chair: Dr. Eduardo Marques

Topic. Advanced Materials and their Characterization: **O.43, O.44, O.45, O.46**

Mudéjar Hall

Session Chair: Dr. Andrés Guerrero Martínez

Topic. Theory and Modelling Applied to Soft Matter: **O.48, O.49**

Topic. Experimental Methods in Colloidal and Interface Science: **O.50, O.51, O.52**

21:00

Dinner — Hotel Hesperia

Wednesday, 24 June 2026 · Day 3

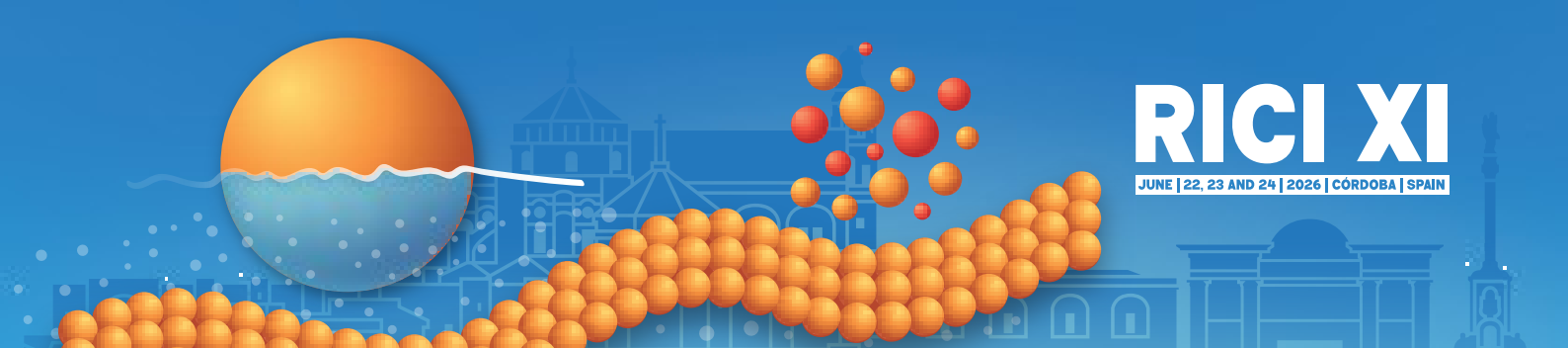
09:00 – 09:45

Plenary 3 · Assembly Hall

Session Chair: Dra. Julia Maldonado Valderrama

Design of Peptide Coacervates for Compartmentalized Enzymatic Catalysis

Ana Pina. António Xavier Institute of Chemical and Biological Technology, NOVA University of Lisbon.



RICI XI

JUNE | 22, 23 AND 24 | 2026 | CORDOBA | SPAIN

09:45 – 10:30

Oral parallel sessions

Assembly Hall

Session Chair: Dra. Julia Maldonado Valderrama

Topic. Advanced Materials and their Characterization: **O.53, O.54, O.55**

Mudéjar Hall

Session Chair: Dr. Nuno Basílio

Topic. Experimental Methods in Colloidal and Interface Science: **O.56, O.57, O.58**

10:30 – 11:15

Oral parallel sessions

Assembly Hall

Session Chair: Dra. María Teresa Martín Romero

Topic. Experimental Methods in Colloidal and Interface Science: **O.59, O.60**

Topic. Colloidal Biotechnology, Medical, Pharmaceutical and Food Applications: **O.66**

Mudéjar Hall

Session Chair: Dr. Nuno Basílio

Topic. Theory and Modelling Applied to Soft Matter: **O.63, O.64, O.65**

11:15 – 11:45

Coffee break

11:45 – 12:30

Awards + Ceremony

12:30 – 12:45

Farewell

12:45 – 14:30

Lunch

Oral Presentations

62 oral presentations · O.1–O.66

O.1: Multi-responsive microgels crosslinked with chitosan: a biocompatible and amphoteric colloidal system

C. Cara-Galdeano¹, J. Maldonado-Valderrama^{1,2}, N. Ballard^{3,4}, A. Martín-Molina^{1,5}

¹ Department of Applied Physics, University of Granada, Granada, Spain

² Modelling Nature Scientific Research Unit. University of Granada, Granada, Spain

³ POLYMAT, Kimika Aplikatua Saila, Kimika Fakultatea, University of the Basque Country, San Sebastián, Spain

⁴ Basque Foundation for Science, Ikerbasque, Bilbao, Spain

⁵ Carlos I Institute of Theoretical and Computational Physics, Granada, Spain

Stimuli-responsive microgels have attracted considerable attention as versatile colloidal systems for biomedical applications, particularly in controlled drug delivery, owing to their ability to undergo reversible volume transitions in response to external stimuli such as temperature and pH. Among these, oligo(ethylene glycol) (OEG)-based microgels have emerged as a biocompatible alternative to the widely studied poly(*N*-isopropylacrylamide) (pNIPAM)-based ones. Their biocompatibility can be further enhanced by incorporating methacrylated chitosan (ChiMA), a naturally derived, biodegradable polymer¹.

The colloidal properties of OEG microgels have been thoroughly characterized in a previous study². In the present work, a novel amphoteric OEG-MAA-ChiMA microgel is synthesized by precipitation polymerization using di(ethylene glycol) methyl ether methacrylate and oligo(ethylene glycol) methyl ether methacrylate as the main monomers, methacrylic acid (MAA) as the anionic comonomer, and ChiMA simultaneously acting as crosslinker and source of cationic character. The resulting system combines the thermoresponsiveness of the OEG network and a complex amphoteric pH-responsiveness driven by the protonation of the amine groups of chitosan at acidic pH and the deprotonation of the carboxylic groups of MAA at neutral-to-basic pH. Dynamic light scattering (DLS) and electrophoretic measurements across the pH range 3–8 confirmed this behaviour, with a charge inversion observed between pH 4 and pH 6 and a size minimum near the isoelectric point (see Fig. 1). DLS measurements further revealed a reversible collapse upon heating, consistent with the behavior expected for OEG networks.

The combination of biocompatibility, multi-responsiveness and amphoteric character makes these microgels promising candidates for drug delivery applications. In particular, the pH-switchable charge enables selective interactions with both positively and negatively charged drug molecules, and the interplay between pH and temperature could be exploited to achieve targeted encapsulation and controlled release.

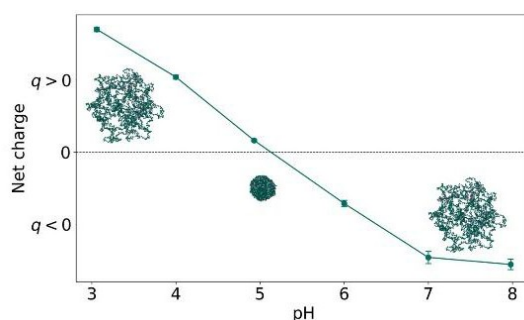


Figure 1: Representation of the pH-dependent swelling behaviour of amphoteric OEG-MAA-ChiMA microgels.

Acknowledgements This activity was funded by grants PID2023-149387OB-I00 —awarded by MICIU/AEI/10.13039/501100011033 and FSE+— and C-EXP-187-UGR23 —awarded by Consejería de Universidad, Investigación e Innovación and by ERDF Andalusia Program 2021-2027.

References

1. G. Aguirre, L. Billon, Water-borne synthesis of multi-responsive and biodegradable chitosan-crosslinked microgels: Towards self-assembled films with adaptable properties. *Carbohydrate Polymers* 2023, 318, 121099.
2. G. Aguirre, J. Quirosa-Mancilla, C. Cara-Galdeano, I. Navarro-Arrebola, A. Rubio-Andrés, M. A. Fernández-Rodríguez, L. Billon, A. Martín-Molina, J. Maldonado-Valderrama, Surface characterisation of thermoresponsive microgels based on oligo(ethylene glycol): Adsorption kinetics, dilatational rheology and monolayers. *Journal of Colloid and Interface Science* 2026, 705, 139522.

O.2: Sustainable Lignin Nanocapsules Incorporated into Textile Fabrics for Latent Heat Storage

L. F. Jiménez-Hernández, A. Martínez-Quimbiulco, C. Gómez, M. Culebras, R. Muñoz-Espí

Institut de Ciència dels Materials (ICMUV), Universitat de València. C/Catedrático José Beltrán 2, 46980, Valencia, Spain.

Lignin is one of the most abundant biopolymers derived from lignocellulosic biomass and represents an attractive renewable feedstock for the development of sustainable functional materials. Its aromatic structure and broad availability as an industrial byproduct a promising alternative to petroleum-derived shell materials for the encapsulation of phase change materials (PCMs).^{1,2} The confinement of solid-liquid PCMs within lignin shells not only prevents leakage during phase transitions but also contributes to the valorization of biomass residues through the generation of high-added-value thermoregulating materials. In this context, the preparation of lignin-based encapsulated PCMs (ePCMs) requires precise control over capsule morphology, encapsulation efficiency, colloidal stability, and processability during coating formation.¹⁻³ Moreover, reducing capsule size to the nanoscale facilitates their homogeneous incorporation into coatings while tailoring heat storage dynamics and passive thermoregulating performance.

The choice of solvent strongly affected the structure of the lignin fractions involved in capsule formation. ³Chloroform promoted the formation of smaller and more compact nanocapsules with higher PCM loadings, whereas ethyl acetate yielded larger and more polar particles due to the preferential dissolution of more oxygenated lignin fractions. Despite these differences, both systems successfully encapsulated hexadecane and preserved its melting and crystallization behavior over repeated thermal cycles. Differential scanning calorimetry confirmed the latent heat storage capacity of the capsules, while thermogravimetric analysis revealed solvent-dependent differences in thermal degradation and encapsulation behavior.

Finally, the thermoregulating performance of the lignin nanocapsules was assessed after their incorporation into textile substrates. The encapsulated PCM delayed heat transfer and reduced temperature fluctuations during heating and cooling cycles, demonstrating their potential for passive thermal management. These results highlight the importance of solvent-lignin interactions in determining capsule morphology, encapsulation efficiency, and thermal buffering performance, while also supporting the use of ethyl acetate as a more sustainable alternative for lignin-based PCM encapsulation.

Acknowledgements This research was supported by the Generalitat Valenciana through a Consolidated Group Grant (grant no. CIAICO/2023/172), as well as by the Spanish Ministry of Science, Innovation, and Universities (PID2023-152347OB-I00, funded by MCIN/AEI/10.13039/501100011033). The authors also acknowledge the Generalitat Valenciana for the funding provided to L. F. J.-H. through a pre-doctoral Santiago Grisolia fellowship (CIGRIS/2021/061).

References

1. Jiménez-Hernández, L. F.; Martínez-Quimbiulco, A.; Gómez, C. M.; Culebras, M.; Muñoz-Espí, R. (2026) Thermoregulating Lignin-Based Sustainable Nanocapsules Prepared by Miniemulsion-Solvent Evaporation. Submitted.
2. Adam-Cervera, I.; Huerta-Recasens, J.; Gómez, C. M.; Culebras, M.; Muñoz-Espí, R. (2024) Nanoencapsulation of Organic Phase Change Materials in Poly(3,4-Ethylenedioxythiophene) for Energy Storage and Conversion. *Polymers*, 16(1), 100–111. DOI:10.3390/POLYM16010100/S1.
3. Álvarez-Bermúdez, O.; Adam-Cervera, I.; Aguado-Hernández, A.; Landfester, K.; Muñoz-Espí, R. (2020) Magnetic Polyurethane Microcarriers from Nanoparticle-Stabilized Emulsions for Thermal Energy Storage. *ACS Sustain Chem Eng*, 8(49), 17956–17966. DOI: 10.1021/acssuschemeng.0c05525.

O.3: Chromophore-Functionalized Polymer Nanoparticles for Photocatalysis

Inés Adam-Cervera¹, Christian Rodríguez-Boscà^{1,2}, María González-Béjar², Rafael Muñoz-Espí¹

¹ Institut de Ciència dels Materials (ICMUV), Universitat de València, c/ Catedràtic José Beltrán 2, 46980 Paterna, Valencia, Spain

² Institut de Ciència Molecular (ICMol), Universitat de València, c/ Catedràtic José Beltrán 2, 46980 Paterna, Valencia, Spain

The development of heterogeneous photocatalysts has attracted significant attention in recent years for light-driven chemical transformations. A widely explored strategy relies on the use of transition metal complexes or organometallic species immobilized on polymeric supports for catalytic applications; however, the development of metal-free heterogeneous photocatalysts has emerged as a promising alternative. In this context, polymeric nanoparticles represent versatile platforms for the immobilization of organic photoactive molecules, combining structural stability, tunable surface chemistry, and easy recovery and reuse.¹

In this work, we present different synthetic strategies for the preparation and functionalization of polymer nanoparticles for photocatalytic applications. Polymeric nanoparticles were synthesized via miniemulsion radical polymerization of styrene and divinylbenzene (DVB). This methodology allows the preparation of particles with well-defined size distribution, spherical morphology, and high surface area, which are key parameters to maximize catalytic efficiency by enhancing the accessibility of active sites and the structural stability of the catalytic system.²

The resulting nanoparticles were characterized by dynamic light scattering (DLS), ζ-potential measurements, and transmission electron microscopy (TEM), confirming well-defined particle size distributions and good colloidal stability.

In a first system, a rhodamine-based monomer was synthesized via Steglich esterification between Rhodamine B and 2-hydroxyethyl methacrylate (HEMA), enabling its covalent incorporation into the polymer network. These nanoparticles were successfully applied as heterogeneous photocatalysts for the dehalogenation of meso-1,2-dibromo-1,2-diphenylethane under visible light irradiation and mild conditions, highlighting the advantages of metal-free photoredox systems in terms of sustainability and operational simplicity.

In a second system, nanoparticles based on styrene, DVB, and acrylic acid were prepared and further functionalized through post-polymerization modification. The introduction of azide groups allowed subsequent conjugation with phenalenone derivatives via copper-catalyzed azide-alkyne cycloaddition (CuAAC), a well-known click chemistry approach, yielding hybrid photoactive materials. These systems were applied to the oxidation of benzaldehyde to benzoic acid under visible light, showing high catalytic efficiency.

Overall, this work highlights the versatility of polymeric nanoparticles as sustainable and reusable platforms for the design of efficient heterogeneous photocatalysts, combining controlled colloidal synthesis with modular surface functionalization for light-driven chemical transformations under environmentally benign conditions.

Acknowledgements We thank the Advanced Materials Program (grant no. MFA/2022/064), supported by the Spanish Ministry of Science and Innovation, with funding from the European Union (Next GenerationEU, PRTR-C17.11), and supported by the Generalitat Valenciana. I. A.-C. thanks the Universitat de València for a predoctoral position within the “Atracció de Talent” Program.

References

- [1] O. Álvarez-Bermúdez, I. Adam-Cervera, K. Landfester, R. Muñoz-Espí, *Polymers*. 2024, 16, 2997.
- [2] P. Froimowicz, R. Muñoz-Espí, K. Landfester, A. Musyanovych, D. Crespy, *Curr. Org. Chem.* 2013, 17, 900–912.

O.4: Templated Self-Assembly Engineering of Tunable Colloidal Metasurfaces on Sb_2S_3

Nineli Abramidze Kublashvili¹, Yael Gutiérrez Vela², Leonardo Scarabelli¹

¹ Department of Chemistry & Process and Resources Engineering, ETSIT, University of Cantabria, Av. de los Castros, 39005 Santander, Spain

² Department of Applied Physics, University of Cantabria, Av. de los Castros, 39005 Santander, Spain

Surface Lattice Resonances (SLRs) are a phenomenon arising when the Localized Surface Plasmon Resonances (LSPRs) of individual nanoparticles arranged in a two-dimensional periodic array couple with the associated diffractive modes near the Rayleigh anomaly. The outcome is a collective response of these nanoparticles observed as sharp dips in the transmittance spectra. Colloidal metasurfaces obtained *via* templated self-assembly are characterized by high wavelength tunability, promising quality factors and reduced optical losses, making them highly promising for several applications such as biosensing, photonics, optoelectronics and so on.¹ In particular, the high level of control expressed on crystallography and surface chemistry of the assembled colloids makes these systems especially promising as dynamic and responsive metasurfaces, exploiting addressable variations in the dielectric environment surrounding the nanoparticles. In this work, we propose a tunable colloidal metasurface fabricated by the self-assembly of gold nanoparticles over antimony trisulfide (Sb_2S_3), a Phase-Change Material (PCM) compound semiconductor.³

In particular, Sb_2S_3 is a thermal PCM that can switch between an amorphous and a crystalline phase characterized by significantly different refractive index (n) and extinction coefficient (k).² This transition was exploited for post-assembly tuning of the dielectric environment, thereby altering the plasmonic response of our gold metasurface and paving the way for reprogrammable nanophotonic platforms.^{2,3}

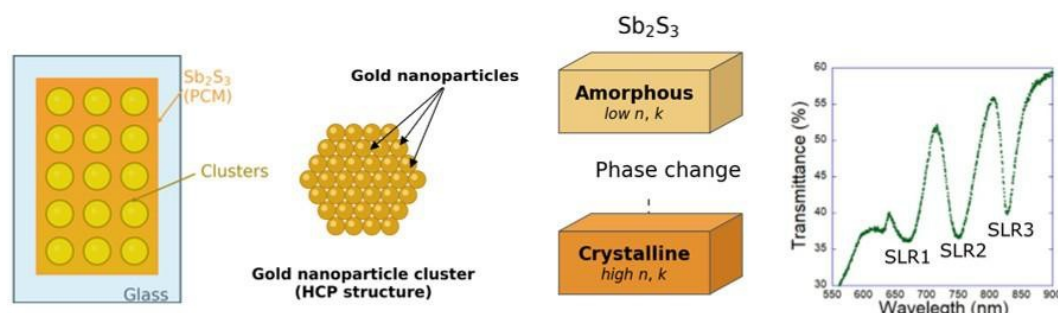


Figure 1: Representation of a tunable colloidal metasurface with gold nanoparticles assembled on a Sb_2S_3 thin film, allowing to change the dielectric environment and shift the optical response.

Acknowledgements

We thank the European Research Council (ERC Starting Grant 101115164, NANOGROWDIRECT). L.S. acknowledges support from the Spanish Ministerio de Ciencia e Innovación y Universidades through fellowship RYC2022-037894-I.

References

- [1] V. G. Kravets, A. V. Kabashin, W. L. Barnes, A. N. Grigorenko, *Chem. Rev.* 2018, 118, 5912–5951.
- [2] A. Bieganski, M. Perestjuk, R. Armand, et al., *Opt. Mater. Express* 2024, 14, 862–870.
- [3] M. Mayer, M. J. Schnepf, T. A. F. König, A. Fery, *Adv. Opt. Mater.* 2019, 7, 1800564.

O.5: Nanoarchitectonic Tools for Interfacial Control in Large-Area [Electrode-Organic Monolayer-Electrode] Junctions

P. Cea¹, S. Martín, E. Escorihuela, A. Gómez-González, D. Riaño, Y. Falconi

Institute of Nanoscience and Materials of Aragón (INMA)

C/Mariano Esquilor s/n. 50018 Zaragoza, Spain

The transition from isolated functional molecules to integrated large-area molecular electronics requires precise and reproducible control over molecular orientation and spatial arrangement across macroscopic scales. This presentation discusses the implementation of nanoarchitectonics as a holistic framework to bridge the gap between synthetic molecular design and the fabrication of functional electrode-organic monolayer-electrode junctions. By integrating bottom-up strategies such as Langmuir–Blodgett deposition, self-assembly, and electrografting, we demonstrate the construction of organized molecular architectures with emergent electronic properties.

The discussion, illustrated with examples of some recent publications,^{1–8} will be structured around the three critical pillars of junction engineering (see Figure 1):

- (1) **Electrode Surface Patterning:** Advanced functionalization of the underlying substrate to ensure robust molecular anchoring and optimized charge transfer over large surface areas.^{1–2}
- (2) **Interfacial Organization:** Use of nanoarchitectonic tools to fabricate well-ordered organic monolayers, exploiting non-covalent interactions (π – π stacking, H-bonding, host-guest complexes) to dictate the internal order, density, and electrical performance of the active layer.^{1,3–4}
- (3) **Top-Contact Deposition:** Scalable strategies, e.g. cryo-FEBID (focused electron beam induced deposition) for the integration of the top-contact electrode while preserving the structural integrity and the specific orientation of the underlying molecular assembly.^{5–8}

This systematic approach highlights how nanoarchitectonics provides a versatile toolkit to translate molecular concepts into tangible technological solutions, addressing the current challenges of stability and scalability in next-generation molecular electronic devices.

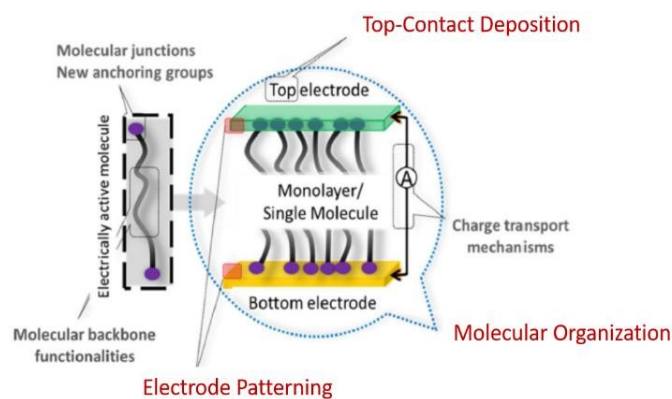


Figure 1. Nanoarchitectonic roadmap for the fabrication of large-area electrode-organic monolayer-electrode junctions through controlled interfacial assembly.

References

- (1) E. Escorihuela et al., *Mater. Today Chem.* **2022**, 26, 101067; (2) E. Escorihuela et al., *Adv. Mater. Interfaces* **2024**, 11, 2470045; (3) L. Herrero et al., *Adv. Mater. Interfaces* **2023**, 10, 2300133; (4) A. García-Serrano et al., *ACS Appl. Electron. Mater.* **2025**, 7, 9470; (5) E. Gorenskaia et al., *Nanoscale* **2021**, 13, 9055; (6) A. Salvador-Porroche et al., *ACS Appl. Mater. Interfaces* **2022**, 14, 28211; (7) S. Sangiao et al., *Small* **2017**, 13, 1603207; (8) A. Salvador-Porroche et al., *Microsyst. Nanoeng.* **2026**, in press.

Acknowledgements Authors are grateful for funding from DGA and fondos FEDER (E31_23) and Ministerio de Economía y Competitividad from Spain in the framework of project PID2022-141433OB-I00 funded by MCIN/AEI/10.13039/501100011033/FEDER, UE. and financial support from the Spanish Ministry of Science and Innovation and the Spanish State Research Agency (AEI) through the Severo Ochoa Programme of Excellence for Research Units, with grant CEX2023-001286-S funded by MICIU/AEI/10.13039/501100011033.

O.6: Diketopyrrolopyrrole Thin Films for High-Performance Molecular Electronics: A Surface and Interface Perspective

Santiago Martín^{1,2,4}, José María Bonastre^{1,2}, Maria Elisabetta Giglio³, Marta Mas-Torrent³, Pilar Cea^{1,2,4}, Núria Crivillers³

¹ Instituto de Nanociencia y Materiales de Aragón (INMA), CSIC-Universidad de Zaragoza, 50009 Zaragoza, Spain

² Departamento de Química Física, Facultad de Ciencias, Universidad de Zaragoza, 50009 Zaragoza, Spain

³ Institute of Materials Science of Barcelona (ICMAB-CSIC), Campus de la UAB, 08193 Bellaterra, Spain

⁴ Laboratorio de Microscopías Avanzadas (LMA), Universidad de Zaragoza, 50018 Zaragoza, Spain

Large-area molecular junctions offer a promising pathway toward the scalable implementation of molecular electronic devices, where charge transport is strongly governed by molecular structure and supramolecular organization.^{1,2} In this work, two diketopyrrolopyrrole (DPP) derivatives featuring tailored alkyl chain lengths designed to isolate the DPP moiety from the anchor groups, are used to form well-ordered Langmuir-Blodgett (LB) films. By bridging the gap between single-molecule behavior and collective transport in large-area devices, molecular junctions were first characterized using the ‘scanning tunneling microscopy (STM) touch-to-contact’ method. These junctions exhibit higher conductance than conventional single molecule *I*(*s*) measurements, attributed to intermolecular charge-transfer processes enabled by the ordered LB assemblies. Consistent with this enhanced conductance, low transition voltages (V_{trans}) indicate favorable alignment between the metal electrode Fermi level and the frontier molecular orbitals. To assess device-relevant performance, large-area molecular junctions were fabricated using Eutectic Gallium-Indium (EGaIn) as a soft top electrode. These junctions exhibit high yield and reproducibility, confirming the formation of robust and high-quality junctions that mirror the transport behavior observed at the single-molecule scale. Together, these results establish a consistent transport picture across both small- and large-area junctions identifying the DPP moiety as a highly effective molecular wire (Fig. 1).

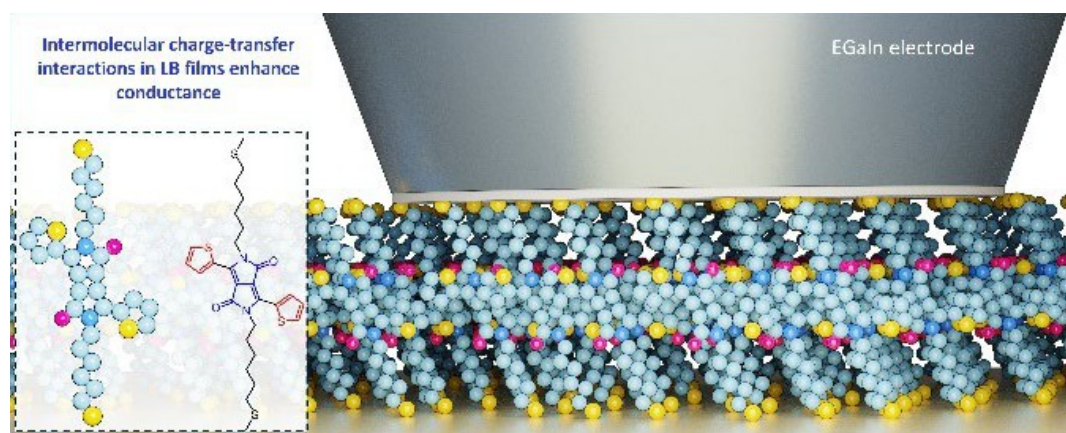


Figure 1: Langmuir-Blodgett films of DPP derivatives as highly effective backbone in large-area molecular devices.

Acknowledgements Authors acknowledge PID2019-105881RB-I00 (PhD grant PRE2020-093409), PID2022-141433OB-I00 and PID2022-141393OB-I00 as well as Severo Ochoa Programme of Excellence for Research Units, with Grants CEX2023-001286-S and CEX2023-001263-S by MICIU/AEI//10.13039/501100011033 and by FEDER, UE. DGA/Fondos FEDER (Construyendo Europa desde Aragón) Platón (E31_23R)) and Generalitat de Catalunya (2021-SGR-00443).

References

1. E. Gorenskaia, K. L. Turner, S. Martín, P. Cea and P. J. Low, *Nanoscale*, **13** (2021), 9055-9074.
2. A. Vilan, D. Aswal and D. Cahen, *Chem. Rev.*, **117** (2017), 4248-4286.

O.7: Passive Thermoregulation in Polymer Films with Nanoencapsulated Phase Change Materials

Rafael Muñoz-Espí, Luis F. Jiménez-Hernández, Inés Adam-Cervera, Clara M. Gómez, Mario Culebras

Institut de Ciència dels Materials (ICMUV), Universitat de València, c/ Catedràtic José Beltrán 2, 46980 Paterna, Spain

Passive thermoregulating materials are attracting increasing interest as energy-efficient solutions for thermal management in applications where active cooling or heating is not desirable. In this context, phase change materials (PCMs) are particularly promising because they can absorb and release large amounts of thermal energy in the form of latent heat during reversible phase transitions, thereby enabling passive regulation of heat flows. For the practical implementation of solid-liquid PCMs, however, encapsulation is generally required to prevent leakage during phase transition, preserve structural integrity, and ensure reliable thermal cycling.^{1,2} Different emulsion-based strategies have been developed for PCM encapsulation, thus broadening the range of accessible encapsulation routes and material combinations. Direct (oil-in-water) approaches are commonly used for hydrophobic PCMs,² while inverse (water-in-oil) emulsions are applicable to the encapsulation of hydrophilic PCMs.^{1,3}

Reducing the capsule size to the nanoscale is particularly advantageous for their incorporation into polymer coatings and films, since it facilitates homogeneous dispersion within the matrix while preserving the heat-storage capability of the encapsulated core. In this work, we focus mainly on the encapsulation of alkanes as model solid-liquid PCMs in synthetic polymer shells, including poly(styrene-co-acrylic acid), poly(methyl methacrylate), and polyurethane. Current efforts are also directed toward the use of biopolymers such as lignin. These miniemulsion-based approaches provide access to a high degree of control over capsule size, shell formation, colloidal stability, and encapsulation efficiency, all of which are key parameters for the successful fabrication of passive thermoregulating coatings. The resulting colloidal dispersions are particularly well suited for wet-processing methods and can be readily incorporated into polymer matrices. In the present case, poly(vinyl alcohol) and carboxymethylcellulose are used as film-forming matrices to obtain homogeneous composite films with functional thermal properties.

The resulting nanocomposite films were evaluated in terms of morphology, thermal stability, and latent heat storage performance. Special attention was paid to verifying that the encapsulated PCM remained effectively confined after film formation and that the thermal storage function was preserved within the polymer coating. Thermal analysis confirmed successful PCM confinement and showed that the nanoencapsulated systems retained a significant latent heat storage capacity in the final films. The thermoregulating behavior of the coatings was further assessed through heat-transfer experiments, which revealed a measurable temperature-damping effect associated with the absorption and release of latent heat during the phase transition of the encapsulated PCM. This behavior demonstrates that the incorporation of nanoencapsulated PCMs can effectively modulate heat flow across the material and delay temperature fluctuations. Overall, these results show that polymer films containing nanoencapsulated PCMs constitute a promising platform for passive thermal regulation and open new opportunities for the development of advanced functional coatings for thermal energy management.

Acknowledgements We acknowledge financial support from the Generalitat Valenciana (Consolidated Group Grant No. CIAICO/2023/172 and MFA/2022/064) and from the Ministry of Science and Innovation of Spain (Grant No. PID2023-152347OB-I00).

References

- [1] Álvarez-Bermúdez, O.; Adam-Cervera, I.; Aguado-Hernández, A.; Landfester, K.; Muñoz-Espí, R. *ACS Sustainable Chem. Eng.* 2020, 8, 17956–17966. DOI: 10.1021/acssuschemeng.0c05525
- [2] Adam-Cervera, I.; Huerta-Recasens, J.; Gómez, C. M.; Culebras, M.; Muñoz-Espí, R. *Polymers* 2024, 16 (1), 100. DOI: 10.3390/polym16010100
- [3] Muñoz-Espí, R.; Adam-Cervera, I.; Jiménez-Hernández, L. F. *Curr. Opin. Colloid Interface Sci.* 2025, 79, 101951. DOI: 10.1016/j.cocis.2025.101951

O.8: Colloidal rubber solution from recycled tyres: redrawing the tyre crumb applications

T. Silva¹, J.P. Ruivo¹, G. Clare¹, P. Santos², P. Barros³, J. Tavares⁴, C. Mota⁴, L. Durães¹

¹ University of Coimbra, CERES, Dept. Chemical Engineering, Rua Sílvio Lima, 3030-790 Coimbra, Portugal

² University of Coimbra, ISE, Dept. Civil Engineering, Rua Luís Reis Santos, 3030-788 Coimbra, Portugal

³ Biogoma, Covão do Brejo, 2025-552 Tremez – Santarém, Portugal

⁴ PneuGreen, Zona Industrial de Óbidos, 2510-752 Gaeiras – Óbidos, Portugal

End-of-Life tyres (ELTs) may be recycled through several conventional strategies, namely by i) mechanical shredding followed by granulation to obtain crumbs with size normally from 0.5 to 4-5 mm, ii) thermochemical processing including energy recovery, pyrolysis (400-700 °C) and gasification (>800 °C) to obtain oils/fuels, syngas, char and recovered constituents as carbon black and steel fibres, and iii) devulcanization and blending of devulcanized rubber in virgin rubber for new tyres production or other rubber products (footwear, automotive parts, flooring).¹ Regarding the first approach, two main routes are applied for grinding, at environmental or cryogenic temperatures (below the glass transition temperature of rubber), with the cryogrinding providing more spherical and small crumbs, with less fibres and metal contamination. These crumbs are used for several purposes, such as pavement composites, rubberized asphalt, concrete additives, sound barrier composites, artificial sports pitches among other. All the above recycling approaches require intensive energy for the reprocessing of rubber for reuse, and frequently present issues concerning the release of microplastics to the environment. Otherwise, in this work, we present a room temperature chemical route to transform rubber crumbs into a colloidal rubber solution^{2,3,4}, which was primarily upcycled for the preparation of rubber-silica aerogel insulator panels (project Tyre4BulDns)^{2,3}, then tested in several substrates as impermeable and enhanced-grip coating (project RubLiq)⁴, and is currently being investigated in the project GreenCoat for multifunctional coating of rubber flooring panels produced by the company PneuGreen (Portugal). The colloidal rubber solution is prepared from the Biogoma's rubber crumbs, with size up to 0.5 mm, which are dissolved in a solution of 2.5% peracetic acid in ethanol, at environmental temperature. The coatings are then produced by simple blade coating of the solution on the substrates followed by evaporation of the solvent, taking advantage of its high volatility. The produced rubber film efficiently impermeabilizes the porous flooring panels (substrates) aiming their easy cleaning. Additional functionalities are being developed related to aesthetical and sensorial features by the introduction of specific additives.

Acknowledgements This work was supported by the GreenCoat project, Ref. COMPETE2030-FEDER-01466600, cofunded by the European Union and National funds through COMPETE2030 and PORTUGAL2030 programs. The work developed at CERES research unit was supported by FCT (Portugal) and the European Union - NextGenerationEU, through PRR and Equipar+2, under the scope of projects: <https://doi.org/10.54499/UID/00102/2025>, <https://doi.org/10.54499/UID/PRR/00102/2025>, <https://doi.org/10.54499/UID/PRR2/00102/2025>.

References

- [1] W.A. Laftah and W.A.A. Rahman, "A comprehensive review of tire recycling technologies and applications", *Materials Advances*, 6 (2025): 4992-5010, <https://doi.org/10.1039/d5ma00463b>.
- [2] University of Coimbra (Inventors: L.M. Durães, A.C. Lamy Mendes, A.D.R. Pontinha, P.F.A. Santos), "Fibre-reinforced Aerogel Composites from Mixed Silica and Rubber Sols and a Method to Produce the Rubber-Silica Aerogel Composites", International Bureau of WIPO, PCT/IB2022/050094, filed 06.Jan.2022,, WO 2022/259044 A1, published 15.Dec.2022.
- [3] A. Lamy-Mendes, A.D.R. Pontinha, P. Santos, L. Durães, "Aerogel Composites Produced from Silica and Recycled Rubber Sols for Thermal Insulation", *Materials*, 15 (2022): 7897, <https://doi.org/10.3390/ma15227897>.
- [4] University of Coimbra (Inventors: L.M.R. Durães, G.C.C.A. Santos, P.C.F. Silva, A.C. Lamy-Mendes, A.D.R. Pontinha, P.F.A. Santos), "Rubber Coating Composition for Application as a Coating to a Substrate and a Rubber Solution", International Bureau of WIPO, PCT/IB2024/058839, filed 11.Sep.2024.

O.9: Pluronic-Stabilized Emulsions Based on a Hydrophobic Deep Eutectic Solvent

Eduardo Guzmán^{1,2}, Belén Arcos¹, Edwin Doughty-Domínguez¹, Alejandro Lucia³, Ramón G. Rubio¹, Francisco Ortega^{1,2}

¹ *Departamento de Química Física, Universidad Complutense de Madrid, Plaza de las Ciencias s/n, Madrid, Spain*

² *Instituto Pluridisciplinar, Universidad Complutense de Madrid, Paseo Juan XXIII 1, Madrid, Spain*

³ *Instituto de Ecología y Desarrollo Sustentable, Luján, Buenos Aires, Argentina*

Essential oil components (EOCs) such as eugenol and thymol exhibit potent antimicrobial and antioxidant activities, yet their practical implementation in aqueous environments is hindered by low water solubility, volatility, and chemical instability. In this work, we investigate pseudo-ternary water/oil/Pluronic F-127 systems in which the oil phase is not a simple hydrophobic liquid, but a hydrophobic Deep Eutectic Solvent (hDES) formed by eugenol and thymol. The strong hydrogen-bonding interactions and π - π stacking between these phenolic molecules generate a eutectic-like liquid at room temperature, providing a structured hydrophobic domain with enhanced solubilization capacity and physicochemical properties distinct from those of the individual components. This hDES nature plays a central role in enabling low-energy emulsification and in modulating the microenvironment experienced by the encapsulated bioactive molecules.

By systematically varying the total oil fraction, the thymol/eugenol ratio, and the concentration of Pluronic F-127, we construct detailed phase diagrams that delineate the compositional regions leading to transparent emulsions, turbid emulsions, gel-like structures, or phase separation. Stable oil-in-water emulsions exhibit nanodroplets with hydrodynamic diameters of ≈ 15 – 25 nm, whose size, polydispersity, and interfacial organization depend sensitively on the hDES composition and polymer/oil ratio. Dynamic light scattering, ionic conductivity, and fluorescence spectroscopy reveal that the hDES core promotes efficient solubilization of thymol within eugenol and generates two distinct microenvironments, a hydrophobic core and an interfacial region, whose relative contributions evolve with droplet swelling and composition. These findings are consistent with the heterogeneous nanostructure typically observed in DES-based formulations.

The resulting emulsions spread effectively on surfaces of different wettability and retain high antioxidant activity, with radical scavenging efficiencies exceeding 80% and tunable through the thymol/eugenol ratio. Overall, this study positions eugenol-thymol hDES-based emulsions as robust, scalable, and environmentally friendly carriers for essential oil components. Their combination of low-energy preparation, structural versatility, and functional performance highlights their potential for applications in cosmetics, food preservation, biomedicine, and agrochemical formulations.

Acknowledgements We thank to the the grant PID2023-147156NB-I00 funded by MCIN/AEI/10.13039/501100011033 (Spain).

O.10: Advancing anticancer drug-membrane interaction studies with real cell membranes and combining experiments and simulations

María Pedrosa^{1,2}, Pablo Graván^{2,3}, Jesús Peña-Martín^{2,4}, Aixa Aguilera-Garrido⁵, Matej Kanduč⁶, Julia Maldonado-Valderrama^{1,2}, Francisco Galisteo-González^{1,2}, Arturo Moncho-Jordá^{1,6}, María José Gálvez-Ruiz^{1,2}

¹ Dept. of Applied Physics, Faculty of Science, University of Granada, Campus Fuente Nueva, s/n, 18071, Spain

² Excellent Research Unit “Modeling Nature” (MNaT). Cuesta del Hospicio, s/n, 18071, Granada, Spain

³ Centre for BioNano Interactions, School of Chemistry, University College Dublin, Belfield, Dublin 4, Ireland

⁴ Centre for Biomedical Research (CIBM), University of Granada, Spain.

⁵ Centre de Recherche en Automatique de Nancy (CRAN). Institut de Cancérologie de Lorraine (ICL), 6 Av. de Bourgogne, 54519 Vandœuvre-lès-Nancy, France

⁶ Jožef Stefan Institute, Jamova 39, 1000, Ljubljana, Slovenia

⁷ Carlos I Institute of Theoretical and Computational Physics. University of Granada, Campus Fuente Nueva, s/n, 18071, Granada, Spain

The plasma membrane is the first barrier encountered by anticancer agents, and its interactions critically determine drug selectivity and cellular uptake. However, their characterization through *in vivo* and *in vitro* studies remains challenging. This work presents a multiscale approach centered on the Langmuir film technique and computational simulations. Two key advancements over classical approaches are introduced: the use of Langmuir films based on isolated natural membranes, preserving their native complexity, and the integration of the Langmuir technique with complementary methods, including Brewster angle microscopy and atomic force microscopy for morphological analysis, and atomistic Molecular Dynamics simulations, which provide atomic-level insight not accessible through Langmuir experiments alone. Langmuir films were prepared from natural membranes of MCF-7 breast cancer cells and healthy fibroblasts to study their interaction with anticancer agents such as doxorubicin, maslinic acid nanoparticles and curcumin. Results were compared with mixed lipid monolayers to assess how well classical models reproduce real membrane behavior. Clear differences in interaction mechanisms were observed depending on membrane composition, highlighting cholesterol as a key factor modulating membrane structure and mechanical properties.

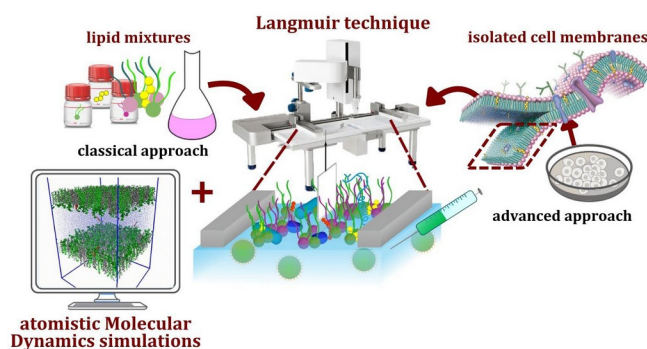


Figure 1: Schematic of the anticancer agent-cell membrane model interaction studies using Langmuir films from isolated membranes or lipid mixtures, combined with atomistic Molecular Dynamics simulations.

References

- Pedrosa, M., Graván, P., et al. (2026). Langmuir film approach with breast cancer and fibroblast cell membranes to explore their interaction with doxorubicin. *J. Colloid Interface Sci.* 703: 139020.
- Pedrosa, M., Moncho-Jordá, A., et al. (2024). Impact of cholesterol on the structure and phase separation of DPPC Langmuir monolayers: Experiments and simulations. *Surf. Interfaces* 51: 104757.
- Pedrosa, M., Maldonado-Valderrama, J., José Gálvez-Ruiz, M.J. (2022). Interactions between curcumin and cell membrane models by Langmuir monolayers. *Colloids Surf. B Biointerfaces* 217: 126636.

O.11: Rapid Piezo-Driven Decoration of ZnO with Noble Metals nanoparticles for Advanced Hydrogen-Generating Interfaces

G. Manca^{1,2}, S. Bettini^{2,3}, M. Cano Luna⁴, J.J Giner-Casares⁴, V. García Caballero⁴, G. Giancane^{2,5}, L. Valli^{2,3}

¹ Department of Chemistry, Biology and Biotechnology, Centro di Eccellenza per I Materiali Innovativi Nanostrutturati (CEMIN), University of Perugia, via Elce di Sotto 8, Perugia, 06123, Italy

² Dipartimento di Scienze e tecnologie Biologiche e Ambientali, Università del Salento, Via Monteroni, Lecce, I-73100, Italy

³ Consorzio Interuniversitario Nazionale per la Scienza e la tecnologia dei Materiali, INSTM, Via G. Giusti, Firenze, I-50121, Italy

⁴ University of Córdoba, Department of Physical Chemistry and applied Thermodynamics, Campus de Rabanales, Edificio Marie Curie, Córdoba, Spain E- 14014

⁵ Department of Cultural Heritage, University of Salento, Via D. Birago 64, Lecce, 73100, Italy

Hybrid semiconductor/metal nanostructures are attracting growing interest due to their enhanced optical, electronic, and catalytic properties arising from metal–semiconductor synergy^{1,2}. Decorating semiconductor photocatalysts with metal nanoparticles is a well-established strategy to promote charge separation and interfacial charge transfer, thereby boosting their catalytic performance. In this contribution, a rapid (one-minute) and sustainable piezo-assisted route is presented for the synthesis of metal-decorated ZnO nanostructures under ultrasonic excitation³. The approach exploits the intrinsic piezoelectric response of ZnO to drive in situ reduction of metal precursors at the semiconductor surface, enabling nanoparticle nucleation without any impactful reducing agents or thermal treatments. By tuning the precursor concentration, the size and surface density of metal nanoparticles can be finely controlled; TEM analysis (Fig. 1) confirms successful nucleation and size tunability. A major outcome of this work is the demonstration of the method's versatility toward different metals, with particular focus on Pt, leading to ZnO@Pt hybrids that display highly efficient electrocatalytic hydrogen evolution in aqueous media. The H₂ production rates achieved by ZnO@Pt are comparable with, or superior to, state-of-the-art ZnO-based electrocatalysts, while relying on a markedly simpler, faster, and greener synthetic protocol. Structural and spectroscopic analyses (TEM, XRD, XPS) clarify the metal– semiconductor interfacial structure and its impact on charge separation and catalytic activity, and additional photo-assisted tests highlight the potential of these hybrids for combined electro- and photocatalytic operation. Overall, piezo-assisted interfacial engineering emerges as a powerful and broadly applicable strategy for the rapid fabrication of metal–semiconductor hybrid catalysts for sustainable hydrogen production and environmental remediation.

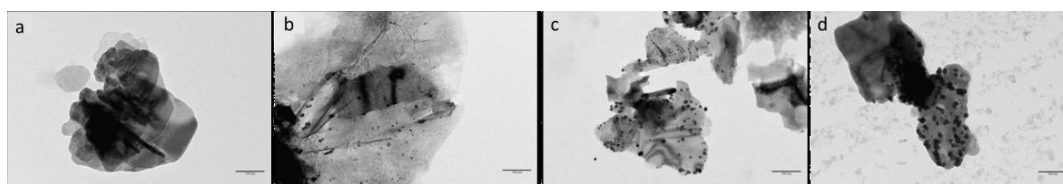


Figure 1 TEM images acquired for ZnO pristine (a) and ZnO with increasing concentration of Au nanoparticles (b-d)

References

- 1 Amirav L, Wächtler M. Nano Schottky? Nano Letters 2022, 22, 9783-9785; <https://doi.org/10.1021/acs.nanolett.2c04150>
- 2 Ben-Shahar Y, Stone D, Banin U. Rich Landscape of Colloidal Semiconductor–Metal Hybrid Nanostructures: Synthesis, Synergetic Characteristics, and Emerging Applications. Chemical Reviews 2023, 123, 3790-3851; [10.1021/acs.chemrev.2c00770](https://doi.org/10.1021/acs.chemrev.2c00770)
- 3 Bettini S, Manca G, Pagano R, Ingrosso C, Valli D, Hofkens J, Maarten R, Valli L, Giancane G. Piezo-Triggered Formation of Functional ZnO@Au Interfaces: Toward Instant and Sustainable Interface Engineering. Surfaces and Interfaces 2025, 73, 107611; <https://doi.org/10.1016/j.surfin.2025.107611>

O.12: Micellization and gelling features of mixed direct and reverse Pluronics (P104 and 17R4) for antineoplastic drug delivery

A. Aguilar-Ramírez^{1,2}, B. Velasco-Rodríguez³, E. R. Macías-Balleza¹, G. Landázuri-Gómez¹, J. F. A. Soltero-Martínez¹, S. Barbosa², P. Taboada²

¹ Departamento de Ingeniería Química, CUCEI, Universidad de Guadalajara, 44430 Guadalajara, Mexico.

² Grupo de Física de Coloides y Polímeros, Departamento de Física de Partículas, Universidade de Santiago de Compostela, 15782 Santiago de Compostela, Spain.

³ Centro Singular de Investigación en Química Biolóxica e Materiais Moleculares (CiQUS), Departamento de Química Inorgánica, Universidade de Santiago de Compostela, 15782 Santiago de Compostela, Spain

Pluronics (or poloxamers) have been widely explored for drug delivery systems due to their ability to enhance therapeutic efficacy at target site. These are commercially available, low-toxicity, and non-ionic copolymers extensively studied as nanocarriers of poorly-aqueous soluble drugs. Pluronics enhance the solubilization of hydrophobic drugs and allow sustained release, a critical aspect in several biomedical applications, such as cancer and antimicrobial therapy. Structurally, direct Pluronics are represented as $(\text{PEO})_x-(\text{PPO})_y-(\text{PEO})_x$, or in its reverse form as $(\text{PPO})_y-(\text{PEO})_x-(\text{PPO})_y$, where x and y denote the lengths of the hydrophilic poly(ethylene oxide) (PEO) and hydrophobic poly(propylene oxide) (PPO) blocks, respectively¹.

Although direct Pluronics are the most commonly used for bioapplication¹, several studies have demonstrated that the addition of reverse Pluronics improves the solubilization of hydrophobic drugs compared to using only direct Pluronics². In addition, SAXS and rheological measurements have confirmed that reverse Pluronics can form combined micelles or even enhance gelation owing to their ability to interconnect micelles, leading to greater micellar stability and lower foam formation³.

In this sense, this study aimed to characterize the physical and thermodynamic properties of two Pluronics systems (P104 and 17R4) in binary solution both with the same PPO/PEO ratio and to confirm that 17R4 is incorporated into the P104 micelle without forming an independent flower-like micelle. This analysis was carried out over the concentration range of 1-30 wt.% and at different molar ratios of 17R4 to P104 using density, sound velocity, viscosity, DLS, microDSC, and rheology measurements. Based on the previous results, encapsulation efficiency of docetaxel was evaluated at a 5 wt.% copolymer concentration through a HPLC analysis. This antineoplastic drug is used to treat various types of cancer, including prostate, breast, lung, and cervical cancer, and has a water solubility of approximately 5 µg/mL⁴.

The drug loading and entrapment efficiency demonstrated that a significantly greater amount of drug is solubilized when 17R4 is present in the solution, due to the increased hydrophobicity conferred by this copolymer within the micelle crown (Fig. 1), thereby increasing the total solubility of docetaxel by a factor of 176.

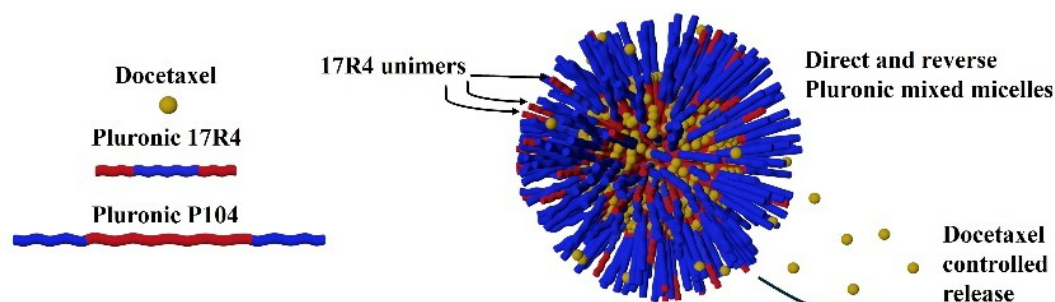


Figure 1: Schematic representation of the micelle formed by P104 and 17R4 encapsulating docetaxel.

Acknowledgements The authors thank financial support from grant PID2022-142682OB-I00 funded by MICIU/AEI/10.13039/501100011033 and by the European Union NextGenerationEU/PRTR. The authors also thank support from grants PID2023-152062OA-I00 funded by MICIU/AEI/10.13039/501100011033 and ED431F2025/14 funded by Xunta de Galicia. A.A.-R. acknowledges the scholarship granted by SECIHTI from Mexico (CVU 1243505).

References

1. Naharros-Molinero, M. Á. Caballo-González, F. J. De La Mata, and S. García-Gallego, *Pharmaceutics*, 14, no. 12 (2022): 2628, 10.3390/pharmaceutics14122628.
2. S. Garg, M. Peeters, R. K. Mahajan, and P. Singla, *J Drug Deliv Sci Technol* 75, no. 1 (2022): 103699, 10.1016/j.jddst.2022.103699.
3. J. M. White and M. A. Calabrese, *Colloids Surf A Physicochem Eng Asp* 638, no. 1 (2022): 128246, 10.1016/j.colsurfa.2021.128246.
4. Y.-M. Yin et al., *J. Controlled Release* 140, no. 2 (2009): 86–94, 10.1016/j.jconrel.2009.08.015.

O.13: Water-Triggered Disassembly of Graphene-Stabilized Metallic Magnesium Nanoplatelets and Transformation to MgO

Anupong Nuekaew¹, Alexandre Piton¹, Cécile Rizzi¹, Nicolas Menguy², Ali Abou-Hassan^{1,3}

¹ *PHysicochimie des Électrolytes et Nanosystèmes Interfaciaux (PHENIX) Sorbonne Université, CNRS, 75005 Paris, France*

² *Institut de Minéralogie, de Physique des Matériaux et de Cosmochimie, MNHN, IRD, Sorbonne Université, CNRS, 75005 Paris, France*

³ *Institut Universitaire de France (IUF), 75231 Paris, France*

The applications of metallic magnesium nanoparticles (MgNPs) in plasmonics, photocatalysis, and energy conversion critically depend on precise control over their size and shape, which in turn requires a fundamental understanding of their formation mechanisms. Here, we report the synthesis of hexagonal metallic Mg (Mg⁰) nanoplatelets via a reductive lithium naphthalenide (LiNapht) route¹⁻³, both in the absence and presence of graphene oxide (GO)^{4,5}, and elucidate their growth and transformation pathways. Transmission electron microscopy analysis (Fig. 1) at different reaction time reveals that Mg⁰ nanoplatelets, in addition to dissolution and oxidative etching, may form through a non-classical crystallization mechanism involving oriented attachment⁶ of primary nanocrystals into thin hexagonal sheets, followed by out-of-plane thickening into mesocrystalline platelets. In aqueous environments, bare Mg⁰ nanoplatelets undergo rapid, uncontrolled and complete degradation into brucite Mg(OH)₂, resulting in the loss of both morphology and plasmonic response. In contrast, in water, graphene-stabilized Mg⁰ structures exhibit a disassembly process, where the large hexagonal platelets (~800 nm) transform into ~70 nm faceted hexagonal nanobricks while retaining metallic cores and broadband optical extinction. Strikingly with time, these nanobricks transform into MgO instead of Mg(OH)₂ as evidenced by electron diffraction studies from TEM. Spectroscopic, microscopic, and zeta potential analyses reveal a dual role of GO in directing nucleation at carboxylic acid edges and controlling oxidation kinetics via interfacial interactions. These findings provide mechanistic insight into the growth and aqueous transformation of Mg nanostructures, opening new routes for controlling particle size, shape, and stability in both laboratory-scale synthesis and scalable platforms such as microfluidic systems.

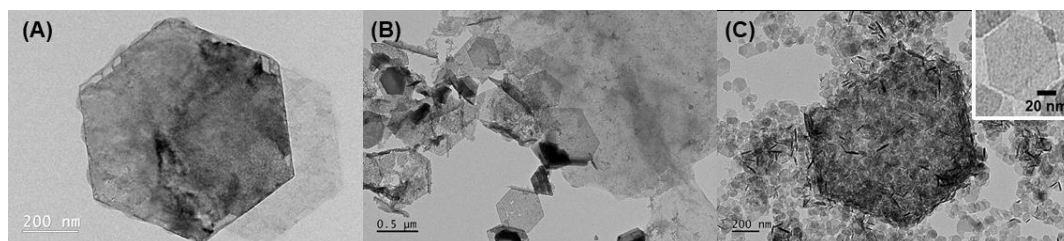


Figure 1: TEM images showing the structural evolution of Mg⁰ nanostructures under different conditions. (A) Bare MgNPs with a well-defined hexagonal morphology. (B) Mg-rGO with hexagonal nanoplatelets (~800 nm) associated with graphene sheets. (C) Mg-rGO after dispersion in water, revealing disassembly into smaller (~70 nm) hexagonal primary nanocrystals while retaining faceted morphology. The inset shows a representative primary nanocrystal, highlighting its faceted hexagonal shape and crystallinity.

Acknowledgements This work was supported by the EMERGENCE 2023-2026 program of the Alliance Sorbonne Université through the project MetalMag, and by the CNRS MITI-80 Prime funding scheme. We gratefully acknowledge these institutions for their financial support.

References

1. A. Nuekaew, D. Talbot and A. Abou-Hassan, *Chem. Eur. J.*, 2026, e03619.
2. J. S. Biggins, S. Yazdi and E. Ringe, *Nano Lett.*, 2018, 18, 3752–3758.
3. E. R. Hopper, T. M. R. Wayman, J. Asselin, B. Pinho, C. Boukouvala, L. Torrente-Murciano and E. Ringe, *J. Phys. Chem. C*, 2021, 126, 563–577.
4. E. S. Cho, A. M. Ruminski, S. Aloni, Y.-S. Liu, J. Guo and J. J. Urban, *Nat. Commun.*, 2016, 7, 10804.
5. H. Jung, S. J. Yang, T. Kim, J. H. Kang and C. R. Park, *Carbon*, 2013, 63, 165–174.
6. R. L. Penn and J. A. Soltis, *CrystEngComm*, 2014, 16, 1409–1418.

O.14: Synthesis of Anisotropic Multimetallic Nanocrystals via Interplay of Reduction and Oxidation Reactions

Sergio Triviño-Sánchez¹, Deema Balalta², Daniel Arenas-Esteban², Eduardo Enciso¹, Andrés Guerrero-Martínez¹, Sara Bals², Guillermo González Rubio¹

¹ Departamento de Química Física, Universidad Complutense de Madrid, Avenida Complutense s/n, 28040 Madrid, Spain.

² EMAT, University of Antwerp, Groenenborgerlaan 171, B-2020 Antwerp, Belgium.

Noble metal-based nanomaterials are of great interest due to their unique physicochemical properties and are particularly well-suited to addressing challenges such as climate change mitigation.^[1,2] For instance, nanocrystals of platinum, palladium, or iridium, as well as many of their alloys, are among the most active materials for the (electro)catalytic production of hydrogen.^[3] Notably, combining two or more metals can lead to synergistic and nonlinear effects, resulting in novel or improved catalytic, optical, magnetic, or electrical properties that are attractive for applications in illumination, sensing, energy harvesting, and catalysis.^[4]

In this work, we propose a bottom-up wet-chemical route to produce multimetallic anisotropic nanocrystals composed of gold, palladium, and platinum, with control over the distribution of the elemental constituents. Specifically, we have developed a multi-step seed-mediated growth strategy in which gold nanorods serve as seeds to impart anisotropy to the final nanocrystals. The multimetallic nature is obtained in two steps, which include the growth of a palladium shell and the subsequent deposition of platinum via: i) direct reduction in the presence of ascorbic acid and ii) through redox reactions between platinum precursor and gold@palladium nanostructure. By carefully controlling the balance between these processes and the geometry of the core@shell gold@palladium nanostructures, we demonstrate the formation of nanocrystals with distinct elemental distributions and unique morphologies, including heterostructured nanoframes and core@alloy-shell structures. The research presented underscores the potential of the interplay between seed-mediated growth routes and redox reactions for the synthesis of anisotropic multielemental nanocrystals with tailored elemental distributions and unusual morphologies.

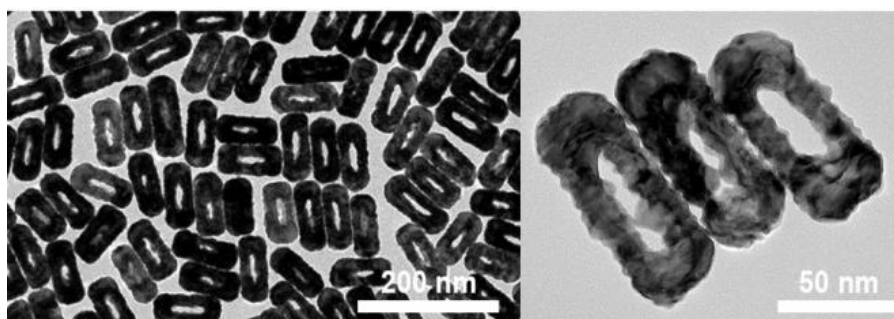


Figure 1: Low (left) and high magnification (right) TEM images of AuPdPt nanoframes

Acknowledgements This work has been supported by the ERC Starting Grant Time4Nano (101164205), the Spanish Ministry of Science, Innovation, and Universities (grants PID2021-123228NB-I00 and PID2024-159196NB-I00), and the International Research Network-IRN Nanoalloys. G.G-R. acknowledges the Atracción de Talento Fellowship from the Madrid Regional Government (Grant 2022-T1/IND-23908).

References

- [1] R. Verma, R. Belgamwar, V. Polshettiwar, "Plasmonic Photocatalysis for CO₂ Conversion to Chemicals and Fuels" *ACS Mater. Lett.* 2021, 3, 574–598.
- [2] P. Losch, W. Huang, E. D. Goodman, C. J. Wrasman, A. Holm, A. R. Riscoe, J. A. Schwalbe, M. Cargnello, "Colloidal nanocrystals for heterogeneous catalysis" *Nano Today* 2019, 24, 15–47.
- [3] H. Kim, T. Y. Yoo, M. S. Bootharaju, J. H. Kim, D. Y. Chung, T. Hyeon, "Noble Metal-Based Multimetallic Nanoparticles for Electrocatalytic Applications" *Adv. Sci.* 2022, 9, 2104054.
- [4] K. D. Gilroy, A. Ruditskiy, H.-C. Peng, D. Qin, Y. Xia, "Bimetallic Nanocrystals: Syntheses, Properties, and Applications" *Chem. Rev.* 2016, 116, 10414–10472.

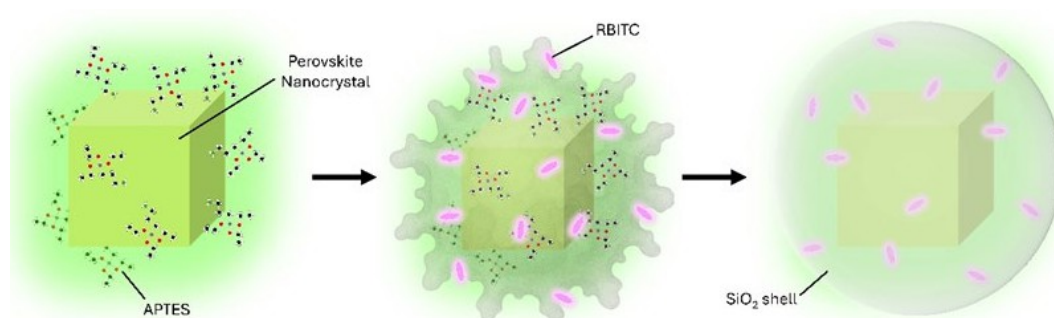
O.15: Using APTES as a bifunctional molecule for silica shell functionalization in perovskite nanocrystals

Iago López-Fernández, Sergio Gómez-Graña, Jorge Pérez-Juste, Lakshminarayana Polavarapu

CINBIO, Universidade de Vigo, Campus As Lagoas-Marcosende Universidade de Vigo, Vigo 36310, Spain

Perovskite nanocrystals have emerged in the last decades in the optoelectronic sector due to their impressive properties, achieving records in the field and becoming materials with promising future¹. However, perovskite possesses two main drawbacks that harden their implementation into daily devices, i.e., their toxicity due to the use of lead and their poor stability along time, which becomes shorter against moisture, water and polar organic solvents². To address these challenges, numerous studies have proposed the development of protective coatings on perovskite surfaces³. This approach results in core-shell nanocomposites, which prevent the perovskite nanocrystals from external reactive molecules. These molecules have the potential to detach ligands and ions from the surface and outer layers, as well as oxidize lead cations. Such actions can decrease perovskite properties and precipitate the degradation process of the nanoparticles⁴.

Following that route, we propose a two-step synthesis of CsPbBr₃@SiO₂ nanoparticles consisting on the synthesis of CsPbBr₃ nanocubes on the first step followed by a ligand exchange of the oleylamine-oleic acid pair by (3-aminopropyl)triethoxysilane (APTES) and the spontaneous silanization on the second step through -Si-O-Si- bonds among APTES molecules. This protocol results in the individual coating of the nanocrystals, as has been proven by HRTEM-EDX, with negligible shift in their optical properties. Furthermore, the use of APTES as silica precursor allows not only the silica growth around the perovskite nanocrystal, but also the functionalization of the composite through the amine terminal group. As an example, we have developed and optimized perovskite functionalization with rhodamine B isothiocyanate (RBITC), which can be linked covalently to APTES and derives in a dual-emission particle (Scheme 1).



Scheme 1: Scheme of the RBITC-functionalization of perovskite@silica nanocomposites by the formation of the RBITC-APTES bond along SiO₂ growth.

Acknowledgements We thank Xunta de Galicia for the fundings through fellowships ED431F 2021/005 and ED481A-2022/441 and also CINBIO for the facilities that allow us to get these results.

References

1. A. Dey, J. Ye, A. De, E. Debroye, S. K. Ha, E. Bladt, A. S. Kshirsagar, Z. Wang, J. Yin, et al., ACS Nano, 2021, 15, 10775-10981.
2. C. Otero-Martínez, N. Fiuza-Maneiro and L. Polavarapu, ACS Applied Materials & Interfaces, 2022, 14, 34291-34302.
3. T. K. Tran Tran, H. N. Nyiera, C. Brea, S. N. Ruiz, C. Wang, H. Tan, S. L. Suib, G. Hu and J. Zhao, ACS Applied Nano Materials, 2024.
4. X. Liao, M. Liu, M. He, C. Yuan, Q. Zhang, Q. Wan, Z. Qu, L. Kong and L. Li, Small, 2024, n/a, 2309902.

O.16: Decoding DNA Triplex Assembly: A Combined Thermodynamic and Kinetic Study Using ITC

Andrea Santisteban-Veiga^{1,2}, S. Chandrasegaran³, V. Domínguez-Arca^{4,5}, J. Sabin¹, T. Pukala³

¹ AFFINImeter Scientific & Development team, Software 4 Science Developments, Santiago de Compostela, 15782, Spain

² Colloids and Polymers Physics Group, Institute of Materials (iMATUS), Department of Applied Physics, University of Santiago de Compostela, Santiago de Compostela, 15782, Spain

³ School of Chemistry, Physics and Earth Sciences, University of Adelaide, North Terrace, Adelaide, South Australia, 5005, Australia

⁴ Marine Research Institute, Spanish Research Council (CSIC), Eduardo Cabello, 6, Vigo, Pontevedra, 36208, Spain

⁵ Physical and Biophysical Chemistry, University of Bielefeld, Universitätsstrasse, 25, 33615, Bielefeld, Germany

DNA structures play a fundamental role in determining biological function, extending beyond the canonical double helix to include non-canonical architectures such as triplex DNA. These triple-helical structures are increasingly recognized for their involvement in genome instability, gene regulation, and their potential application in targeted therapeutic strategies. Despite their relevance, the mechanisms governing triplex DNA formation, particularly the kinetic aspects of association, remain insufficiently understood.

In this work, we employ isothermal titration calorimetry (ITC) to achieve a comprehensive thermodynamic and kinetic characterization of DNA triplex formation. While ITC is widely established for studying protein interactions, its application to nucleic acids has been comparatively limited. Here, we demonstrate its unique capability to simultaneously resolve binding energetics and kinetics in a label-free, in-solution system¹.

Our results provide the first quantitative determination of kinetic parameters for triplex DNA formation using ITC, offering new insights into the dynamic processes underlying triple-helix assembly. We further investigate how key variables, including strand length, sequence composition, and pH, affect triplex stability and formation efficiency. Subtle variations in sequence and environmental conditions are shown to significantly influence both the stability and kinetics of triplex formation, highlighting the importance of optimizing these parameters for the rational design of triplex-forming oligonucleotides. Complementary validation using mass spectrometry and UV-Vis spectroscopy supports the robustness of the ITC-derived data.

Overall, this study establishes ITC as a powerful and versatile tool for the study of nucleic acid interactions, extending its application beyond traditional protein systems. By providing an integrated thermodynamic and kinetic framework, our work advances the understanding of triplex DNA formation and opens new avenues for the precise characterization and design of nucleic acid-based systems in biotechnology and biomedicine.

Acknowledgements We thank the Australian Research Council (Discovery Project DP200102291), the Molecular-Scale Biophysics Research Infrastructure (MOSBRI; EU Horizon 2020, grant no. 101004806), and the Consellería de Educación, Ciencia, Universidades y Formación Profesional of the Xunta de Galicia (industrial PhD program, IN606D) for financial support.

References

1. Santisteban-Veiga, A., Chandrasegaran, S., Domínguez-Arca, V., Sabin, J., & Pukala, T. L. (2025). Thermodynamic and kinetic considerations in DNA triplex formation revealed by ITC. *European Biophysics Journal*. <https://doi.org/10.1007/s00249-025-01805-4>

O.17: Multimodal Polymeric Nanoplatforms for Combined Chemo-, Photodynamic, and Photothermal Therapy of Triple-Negative Breast Cancer

M. Navarro-Real¹, J.O. Zavala-López², J. Juárez³, A. Pardo⁴, G. Prieto⁴, S. Barbosa⁴, P. Taboada⁴, J.M. Godínez-Rubí⁵, Adrián Daneri-Navarro¹, A. Topete⁴

¹ Laboratorio de Inmunología, Departamento de Fisiología, Centro Universitario de Ciencias de la Salud (CUCS), Universidad de Guadalajara, 44340 Guadalajara, México.

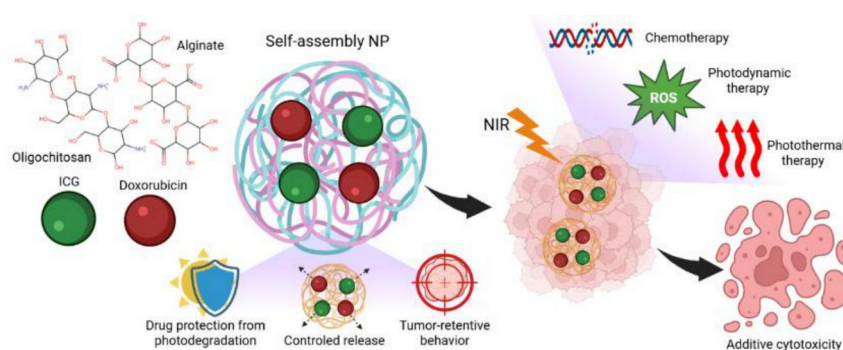
² Laboratorio de Bioquímica Estructural, Departamento de Química, Centro Universitario de Ciencias Exactas e Ingenierías (CUCEI), Universidad de Guadalajara, 44430 Guadalajara, México.

³ Posgrado en Nanotecnología, Departamento de Física, Universidad de Sonora, 83000 Hermosillo México.

⁴ Grupo de Física de Coloides y Polímeros, Departamento de Física de Partículas, Instituto de Materiales (iMATUS) e Instituto de Investigación Sanitaria (IDIS), Universidad de Santiago de Compostela, 15782 Santiago de Compostela, Spain.

⁵ Laboratorio de Patología Diagnóstica e Inmunohistoquímica (LAPADI), Departamento de Microbiología y Patología, Centro Universitario de Ciencias de la Salud (CUCS), Universidad de Guadalajara, 44340 Guadalajara, México.

Breast cancer remains the most prevalent and lethal malignancy affecting women worldwide.¹ Nanomedicine offers innovative approaches to enhance therapeutic efficacy through spatiotemporal control of diagnostics and treatment. In this work, we developed a biopolymeric nanoplatform integrating chemo-, photothermal, and photodynamic therapies to overcome the limitations of conventional monotherapies (Scheme 1). The nanoparticles were synthesized via polyelectrolyte complexation of sodium alginate and oligochitosan, resulting in a biocompatible, non-toxic system optimized for localized therapy. The nanocarriers exhibited an average diameter of 206.1 ± 6.8 nm and a ζ -potential of -23.8 ± 2.5 mV, properties that promote enhanced tumor retention. Furthermore, the system demonstrated high encapsulation efficiency for doxorubicin (DOX) and indocyanine green (ICG), ensuring photostability and photoprotection of the cargo while maintaining photoactivity within the near-infrared (NIR) window. In vitro assays confirmed significant cellular uptake and potent cytotoxicity against triple-negative breast cancer (TNBC) cells.² In vivo, intratumoral administration achieved effective tumor growth inhibition comparable to free DOX, but with significantly improved systemic tolerability. Notably, the nanocarrier-treated groups showed a reduced metastatic burden, whereas free DOX exhibited limited control over dissemination. These results underscore the potential of this alginate-oligochitosan nanoplatform as a multimodal therapeutic system, offering a synergistic approach for localized breast cancer treatment with minimized off-target effects.



Scheme 1: Alginate-oligochitosan nanoparticles were synthesized via polyelectrolyte complexation and loaded with DOX and ICG for multimodal breast cancer therapy.

Acknowledgements The authors thank financial support from grant PID2022-142682OB-I00 funded by MICIU/AEI/10.13039/501100011033 and by the European Union NextGenerationEU/PRTR. The authors also thank support from grants PID2023-152062OA-I00 funded by MICIU/AEI/10.13039/501100011033; and ED431F2025/14 funded by Xunta de Galicia. A.D.N. thanks COECYTJAL for project 2021-9887 2022. M. N.-R. and J. Z.-L. acknowledge SECIHTI for supporting scholarships. We are grateful to Karina Franco, histotechnologist at LAPADI, for her invaluable assistance with the histological staining procedures; and Dr. Dalia Madrigal and UPEA-Bioterio of CUCS, for their support and assistance in animal care and management throughout this study.

References

- [1] F. Bray, M. Laversanne, H. Sung, J. Ferlay, R. L. Siegel, I. Soerjomataram, A. Jemal, *CA: A Cancer Journal for Clinicians* 2024, 74, 229-263.
- [2] M. Navarro-Real, J. O. Zavala-López, J. Juárez, A. Pardo, S. Barbosa, P. Taboada, A. Topete, A. Daneri-Navarro, *Biomedicine & Pharmacotherapy* 2026, 195.

O.19: Engineered Covalent Bacterial-AuNR Biohybrids for Targeted Photothermal Therapy

L. González-Cabaleiro^{1,2,3}, L. Vázquez-Iglesias^{1,2}, C. Renero-Lecuna^{1,2}, L. Liz-Marzán^{1,2,5,6}, G. Bodelón^{1,4}, J. Pérez-Juste^{1,2,3}, I. Pastoriza-Santos^{1,2,3}

¹ CINBIO, Universidade de Vigo, 36310 Vigo, Spain.

² Galicia Sur Health Research Institute (IIS Galicia Sur), SERGAS-UVIGO, 36312 Vigo, Spain.

³ Departamento de Química Física, Universidade de Vigo, 36310 Vigo, Spain.

⁴ Departamento de Biología Funcional y Ciencias de la Salud, Universidade de Vigo, 36310 Vigo, Spain.

⁵ CIC biomaGUNE, Basque Research and Technology Alliance (BRTA), 20014 Donostia-San Sebastián, Spain

⁶ Ikerbasque, Basque Foundation for Science, 48009 Bilbao, Spain

We report the development of bacterial biohybrids that integrate non-pathogenic, genetically programmed *Escherichia coli* (EcM1) with plasmonic gold nanorods (AuNRs) to create a light-responsive therapeutic platform (BH-EcM1).¹ These living hybrid biomaterials are built upon three complementary pillars: (i) nanobody-based synthetic adhesins that enable specific recognition of tumour-associated biomarkers; (ii) covalent anchoring of AuNRs to the bacterial surface via the SpyTag/SpyCatcher system providing stable and selective nanoparticle attachment without compromising bacterial viability or motility; and (iii) on-demand localized photothermal heating induced by near-infrared irradiation.²

In vitro studies confirmed efficient biohybrid assembly and selective binding to epidermal growth factor receptor (EGFR)-expressing tumour cells.³ These biohybrids were evaluated as functional tools for cancer therapy by their combination with photothermal therapy (PTT) when targeting EGFR biomarkers in 2D cell cultures and spheroids tumor models. By combining synthetic biology, nanotechnology and photonics, this work establishes a versatile framework for living inorganic-organic hybrid systems that couple autonomous motility, programmable targeting and externally triggered therapeutic activation. These capabilities position BH-EcM1 as a promising class of functional therapeutic agents for precision oncology.

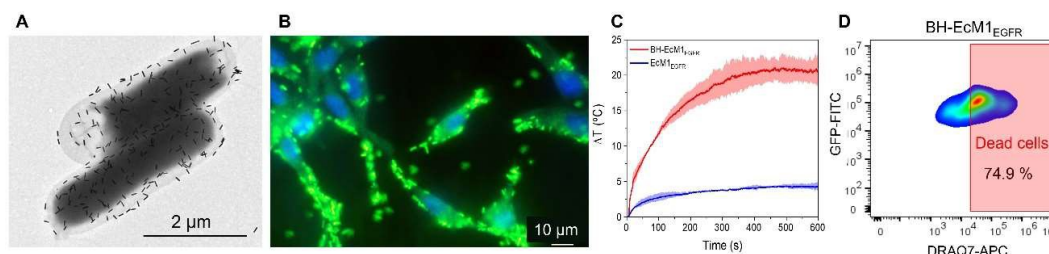


Figure 1: A) TEM image of the EcM1BH_{EGFR}, B) Fluorescence microscopy analysis of MDA-MB-231 cells infected with EcM1BH_{EGFR}. In blue Hoescht (nuclei) channel and in green GFP (bacteria) channel, C) Temperature increment vs. time of EcM1BH_{EGFR} (red), and only bacteria EcM1_{EGFR} (blue), and D) Flow cytometry analysis after PTT of the cells infected with BH-EcM1_{EGFR}. DRAQ7 fluorescence intensity is detected from death cells and GFP signal comes from the bacteria.

References

- 1 S. Xiao, M. Mu, C. Feng, S. Pan and N. Chen, *J. Nanobiotechnology*, 2024, 22, 536.
- 2 Y. Chen, M. Du, J. Yu, L. Rao, X. Chen and Z. Chen, *BIO Integration*, 2020, 1.
- 3 C. Piñero-Lambea, G. Bodelón, R. Fernández-Periáñez, A. M. Cuesta, L. Álvarez-Vallina and L. Á. Fernández, *ACS Synth. Biol.*, 2015, 4, 463–473.

O.20: Droplet-based bacteria biosensor based on SERS spectroscopy

Artai Toba-Pérez¹, Lara Costas-Ríos¹, Diogo Moreira², Carlos Honrado², Alexandre Chicharo², Daniel García-Lojo¹, Lorena Dieguez², Sara Abalde-Cela², Jean-Loup Faulon³, Luis Angel Fernández⁴, Agustín Mihi⁵, Jorge Pérez-Juste¹, Isabel Pastoriza-Santos¹, Gustavo Bodelón¹

¹ CINBIO, Universidade de Vigo, Vigo-36310, Spain

² International Iberian Nanotechnology Laboratory, Braga, Portugal

³ INRA, Micalis Institute, France

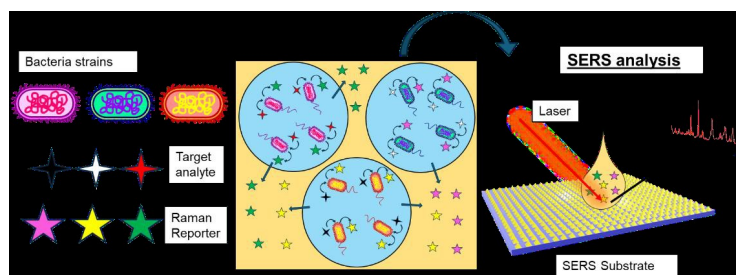
⁴ CSIC, C. Darwin, 3, Fuencarral-El Pardo, 28049 Madrid, Spain

⁵ ICMA, Campus de la UAB, 08193 Barcelona, SPAIN

Bacterial biosensors are increasingly used to detect analytes or pathogens by coupling target recognition to the production of a measurable reporter molecule. Most current designs rely on colorimetric or fluorescence-based outputs, which can limit sensitivity and multiplexing. Here, we present a droplet-based bacterial sensing strategy that uses surface-enhanced Raman scattering (SERS) to detect target analyte triggered biosensor-produced reporters with high sensitivity. SERS enables molecular fingerprinting and ultrasensitive readout by enhancing Raman signals of molecules located near plasmonic nanostructures, offering attractive prospects for early diagnosis and contaminant detection¹.

Our approach integrates microfluidic droplet generation with SERS-based detection. An aqueous suspension containing an engineered bacterial strain was introduced into a T-junction droplet generator and segmented by an immiscible organic phase (oil plus surfactant), forming monodisperse water-in-oil droplets. The droplets were collected and incubated to allow biosensing reactions to proceed. In the presence of a model analyte, arabinose, the bacteria produced a small-molecule reporter that gradually partitioned out of the droplets and accumulated in the surrounding oil phase. At selected incubation times, aliquots of the oil were withdrawn and deposited onto a plasmonic ordered nanostructured substrate, enabling SERS detection of the reporter molecule^{2,3}.

This workflow provides a simple route to decouple biosensing (inside droplets) from SERS readout (on-chip/off-chip), and it was successfully demonstrated with multiple bacterial strains. Ongoing work focuses on implementing three biosensors that generate distinct Raman reporters to evaluate the multiplexing capability of the platform, paving the way toward sensitive, miniaturized, and scalable droplet-based biosensing.



Scheme 1: Encapsulation of three bacteria strains inside water droplets. Each strain interacts with a different analyte and produces a specific Raman active molecule that can be detected by employing a plasmonic ordered nanostructured substrate that enables the SERS detection.

Acknowledgements

This project is funded by Programa de axudas á etapa predoutoral da Xunta de Galicia (Consellería de Cultura, Educación, Formación Profesional e Universidades) cofinanciado pola Unión Europea no marco do Programa FSE+ Galicia 2021-2027.

References

- [1] Schlücker, Sebastian. (2011). Surface enhanced Raman spectroscopy: analytical, biophysical and life science applications, Wiley-VCH.
- [2] Bodelón, G. et al. (2018). Surface-enhanced Raman scattering spectroscopy for label-free analysis of *P. aeruginosa* Quorum Sensing. *Frontiers in Cellular and Infection Microbiology*. <https://doi.org/10.3389/fcimb.2018.00143>.
- [3] Molet, P. et al. (2021). Engineering Plasmonic Colloidal Meta-Molecules for Tunable Photonic Supercrystals. *Advanced Optical Materials*. <https://doi.org/10.1002/adom.202100761>.

O.21: Membrane-targeted nanoparticles for neuronal photo-modulation

Ane Escobar¹, Ana Sánchez-Iglesias¹, Davide Bello^{2,3}, Miriam Feijoo Barriga^{2,3}, Alex Martínez-Ascensión⁴, Laura Rodríguez-Gómez⁴, David Otaegui-Bichot^{4,5}, Francisco Javier Gil-Bea^{4,5,6,7}, Mónica Carril^{2,3,6}, Marek Grzelczak^{1,8}

¹ Centro de Física de Materiales (CFM-MPC) CSIC-UPV/EHU, Paseo Manuel de Lardizabal 5, 20018 Donostia-San Sebastián, Spain

² Instituto Biofisika, Barrio Sarriena, S/N, 48940 Leioa, Spain

³ Fundación Biofísica Bizkaia/Biofisika Bizkaia Fundazioa (FBB), Leioa E-48940, Spain

⁴ Neurosciences Area, Biodonostia Health Research Institute, 20014, San Sebastián, Spain.

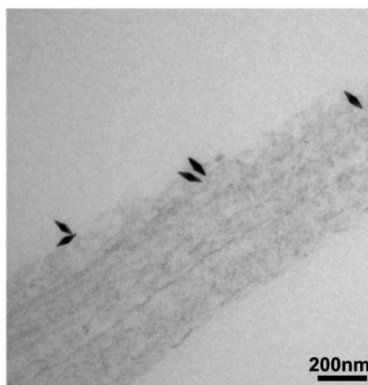
⁵ CIBERNED, Carlos III Institute, 28031, Madrid, Spain.

⁶ IKERBASQUE, Basque Foundation for Science, 48013, Bilbao, Spain.

⁷ Department of Health Sciences, Public University of Navarra (UPNA), Pamplona, Spain.

⁸ Donostia International Physics Center (DIPC), Paseo Manuel de Lardizabal 4, 20018 Donostia-Sebastián, Spain

Selective targeting of nanoparticles to the neuronal interface is central for the tailored development of precision neurotechnologies[1,2]. We will discuss the retention of gold bipyramids [3], as a model nanomaterial, on the membranes of primary neurons using a bioorthogonal approach, resulting in the retention of hundreds of nanoparticles per cell. The labeled neurons we tested in wireless photothermal neuromodulation of primary neurons using NIR laser showed a 45% decrease in MFR at a moderate energy dose of 13 J/cm² per pulse, corroborating results obtained by exposing the neurons to bulk reversible thermal heating. The linker and/or nanoparticles alone have a negligible effect on neuromodulation. Nanoparticle retention at the membrane is rapid, requiring only one hour of total incubation, with no cytotoxic effect. These results expand the repertoire of light-activated nanomaterials for non-invasive neuromodulation.



Acknowledgements This work was supported by the grant PID2022-141017OB-I00 and PID2022-137363OA-I00 funded by MCIN/ AEI/10.13039/ 501100011033 and by “ERDF A way of making Europe”. Authors acknowledge the financial support received from the IKUR Strategy (NanoNeuro) under the collaboration agreement between the Ikerbasque Foundation and Materials Physics Center on behalf of the Department of Science, Universities and Innovation of the Basque Government.

References

- [1] N. S. S. Mousavi, K. B. Ramadi, Y.-A. Song, S. Kumar, *Commun Mater* 2023, 4, 101.
- [2] X. Li, H. Xiong, N. Rommelfanger, X. Xu, J. Youn, P. A. Slesinger, G. Hong, Z. Qin, *Matter* 2021, 4, 1484.
- [3] A. Sánchez-Iglesias, M. Grzelczak, *Small* 2025, 21, 2407735.

O.22: Decoding How Surface Ligands Influence the Oxidative Etching of Bipiramid-Shaped Gold Nanoparticle

Irene López-Sicilia¹, Juan J. Giner-Casares¹, Ali Abou-Hassan^{2,3}

¹ Departamento de Química Física y T. Aplicada, Instituto Químico para la Energía y el Medio Ambiente (IQUEMA), Facultad de Ciencias, Universidad de Córdoba, Campus de Rabanales, 14014, Córdoba (Spain).

² PHENIX Laboratory, Faculté des Sciences et Ingénierie, Sorbonne Université, Campus Pierre et Marie Curie, 75005, Paris (France),

³ Institut Universitaire de France (IUF), 75231 Paris Cedex 05, France

Cancer is one of the most relevant problems of public health worldwide. Advanced and targeted therapeutics to effectively target cancer cells with improved selectivity are highly desirable. Nanomedicine offers several innovative therapeutics to improve therapeutic efficacy while reducing the harmful side effects of current chemotherapy¹. Among the proposed therapies, near-infrared (NIR) laser-induced tissue photothermal therapy (PTT) mediated by plasmonic gold nanoparticles (AuNPs) has several advantages, such as simple and inexpensive instrumentation, good biocompatibility, and minimal damage to healthy cells.

Gold bipyramids (AuBPs)² are premier candidates for anisotropic plasmonic nanoheating; however, their susceptibility to structural deformation under photothermal (PT) stress limits their operational lifespan. This study investigates the mechanisms governing AuBP degradation during 808 nm continuous-wave laser irradiation. We demonstrate that structural reshaping is driven by heat-enhanced oxidative etching, significantly influenced by the formation of oxygen nanobubbles at the metal-liquid interface.

By comparing the stabilizing effects of cetyltrimethylammonium bromide (CTAB), citrate, and polystyrene sulfonate (PSS), we show that surface chemistry dictates nanoparticle fate. While CTAB- and citrate-coated AuBPs suffer from severe tip shortening and facet reconstruction resulting in dramatic LSPR blueshifts, PSS-coated AuBPs exhibit remarkable morphological and optical persistence. Our findings reveal that long-term plasmonic durability arises from a synergistic interplay between ligand shell density and gas-phase interactions, providing a critical framework for engineering robust nanodevices for photothermal therapy and catalysis.

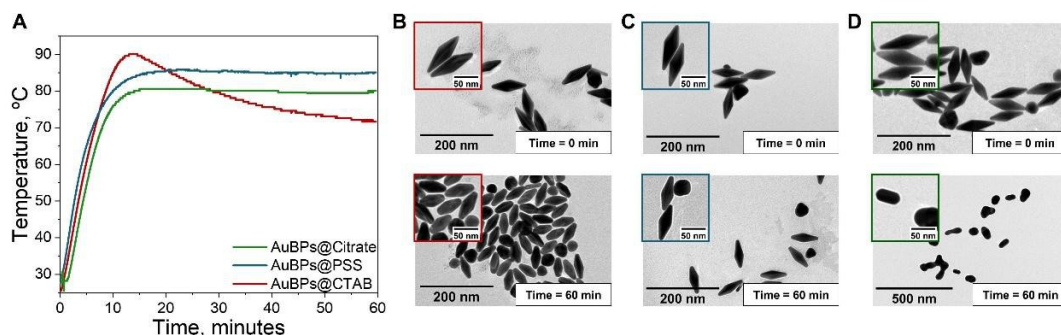


Figure 1. (A) Temperature profile over time during the irradiation of AuBPs suspensions coated with different ligands. A volume of 1 mL of AuBPs suspension at a fixed Au concentration of 0.2 mM was irradiated at a laser power density of 1.0 W·cm⁻² for 60 min. TEM images of (B) AuBPs@CTAB, (C) AuBPs@PSS and (D) AuBPs@Citrate before and after 60 min of irradiation.

Acknowledgements Irene López-Sicilia acknowledges the Ministry of Science and Innovation for a FPI predoctoral contract (PRE2021-097546).

References

1. A. Amendoeira, L. Rivas García, A. R. Fernandes, P. V. Baptista, *Adv. Ther.* 2020, 3, 1900153.
2. A. Sánchez-Iglesias, N. Winckelmans, T. Altantzis, S. Bals, M. Grzelczak, L. M. Liz-Marzán, *J. Am. Chem. Soc.* 2017, 139, 107.

O.24: Pressure-Controlled High Temperature Continuous-Flow Synthesis of Iron-Based Nanoparticles and Au-Fe Heterodimers

Victor Ehrlich¹, Niéli Daffé², Myriam Chaouachi¹, Aude Michel-Tourgis¹, Delphine Talbot¹, Jérôme Fresnais¹, Laurent Michot¹, Nicolas Menguy³, Ali Abou-Hassan^{1,4}

¹ Sorbonne Université, CNRS, PHysicochimie des Électrolytes et Nanosystèmes Interfaciaux (PHENIX), 75005 Paris, France

² Synchrotron Soleil, 91190 Saint-Aubin, France

³ Sorbonne Université, CNRS, Institut de Minéralogie, de Physique des Matériaux et de Cosmochimie (IMPMC), 75005 Paris, France

⁴ Institut Universitaire de France (IUF), 75231 Paris, France

For nearly half a century, nanomaterials such as iron oxides, iron carbides, and Au-iron oxide nanoparticles (NPs) have been extensively investigated because of their unique properties, making their synthesis a major focus of contemporary nanomaterials research. Nevertheless, the batch production of these NPs in large quantities, while retaining fine control over crystalline phase, size, and shape, remains highly challenging. Millifluidic synthesis, in which reagents are continuously delivered through a millimeter-scale reactor, represents a powerful alternative to conventional batch methods. Beyond the inherent advantages of continuous processing for scale-up, flow synthesis can also address key limitations of batch production by improving control, reproducibility, and reaction uniformity.

In this work, we report the large-scale continuous-flow synthesis of iron-based nanoparticles through the thermal decomposition of iron pentacarbonyl in octadecene in the presence of oleylamine and oleic acid. We demonstrate that nanoparticle formation under flow conditions differs markedly from that observed in batch synthesis. In particular, we show that the application of pressure is a key parameter for triggering precursor decomposition and promoting the nucleation and growth of iron-based nanoparticles. At high pressure, alongside spherical nanoparticles, anisotropic nanostructures with diverse morphologies, including rods and star-like particles, were obtained at the end of the synthesis. High-resolution TEM and selected-area electron diffraction suggest that these anisotropic nanoparticles form through the oriented attachment of spherical nanoparticles acting as building blocks, likely facilitated by the flow direction. Beyond iron oxide nanoparticles, the process also enables access to air-sensitive phases that are difficult to obtain in bulk, including iron (0) and iron carbide nanoparticles, as evidenced by X-ray diffraction (XRD), X-ray absorption spectroscopy (XAS), and extended X-ray absorption fine structure (EXAFS). Mechanistic aspects were also investigated, particularly the carbon source involved in the formation of iron carbide NPs, using nuclear magnetic resonance (NMR) and mass spectrometry (MS). Finally, we show that the slow decomposition of the iron precursor under high-temperature flow conditions can be advantageous for inducing and controlling the heterogeneous nucleation of magnetic iron-based domains on preformed metallic seeds such as gold nanoparticles. Using this approach, magnetic iron-gold heterodimers, which combine magnetic and plasmonic properties within a single nanostructure and remain highly challenging to produce in large quantities, can be synthesized in continuous flow.

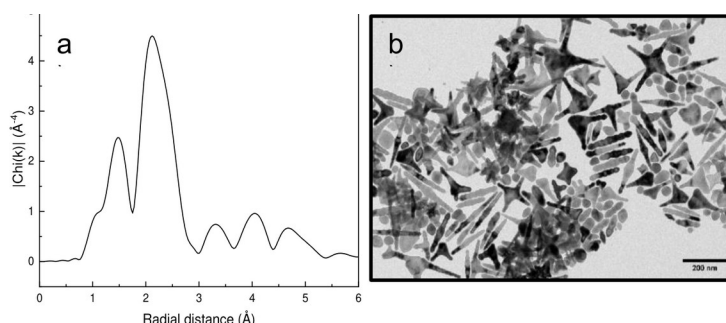


Figure 1. (a) EXAFS pattern of iron carbide NPs, (b) TEM micrographs of iron-based NPs synthesized with the pressurized millifluidic system

O.25: Template-Free Assembly of Magnetic Nanoflowers into Reconfigurable Microstructures

Caterina Landi^{1,†}, Rosa Pérez-Garrido^{2,†}, Julio Marco Cuenca¹, Javier Tajuelo³, Chantal Valeriani¹, Helena Gavilán^{2,*}, Fernando Martínez-Pedrero^{2,*}

¹ Departamento de Estructura de la Materia, Física Térmica y Electrónica, Universidad Complutense de Madrid, 28040 Madrid, Spain.

² Departamento de Química Física, Facultad de Ciencias Químicas, Universidad Complutense de Madrid, Ciudad Universitaria s/n, 28040, Madrid, Spain.

³ Department of Interdisciplinary Physics, Universidad Nacional de Educacion a Distancia UNED, Avda. Esparta s/n, 28232 Las Rozas, Spain.

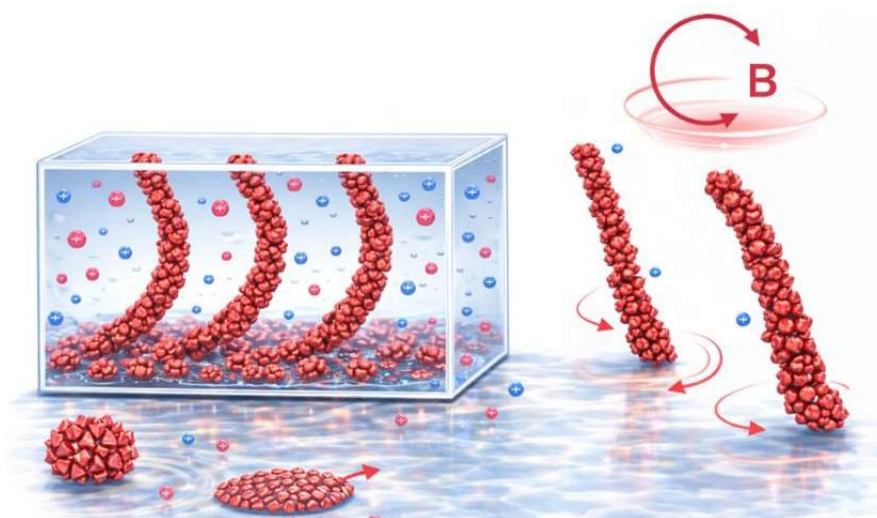


Figure 1: Schematic illustration of the template-free assembly process of magnetic nanoflowers, highlighting the effect of different magnetic field configurations on their formation

Magnetic nanoflowers (MNFs) have emerged as highly efficient nanoheaters due to their large magnetic losses and high specific absorption rates under clinically relevant alternating magnetic fields, making them attractive for hyperthermia-based therapies¹. Beyond their biomedical relevance, their collective behavior also opens new opportunities for the bottom-up fabrication of active microstructures. Here, we develop a scalable and cost-effective strategy to assemble MNFs into dynamic, field-responsive architectures without the need for predefined templates [Fig. 1]. The assembly process is driven by a delicate interplay between interparticle forces, magnetic actuation, and confinement, which can be finely tuned to control structure formation². Importantly, the reversibility of these assemblies can be controlled: low ionic strength favors transient, reversible structures, whereas intermediate salt concentrations lead to robust, permanent configurations. These systems display rich dynamical behaviors under magnetic fields, such as oscillatory motions reminiscent of artificial cilia, coherent rotation, and fragmentation into motile filament swarms.

Acknowledgements: This work was funded by Ministerio de Ciencia e Innovacion (Grant No. PID2022-140407NB-C21 and Grant No. PID2023-150760NA-100) from MCIN/AEI/10.13039/501100011033 and FEDER, UE. H.G. thanks the Ramón y Cajal Contract (RYC2021-032448-I). J.T. acknowledges the support of the Spanish Ministerio de Ciencia e Innovación (MCIN) –Agencia Estatal de Investigación (MCIN/AEI/10.13039/501100011033) through the Project PID2023-147948OB-C33. We would like to thank the Centro de Espectroscopía y Correlación, which forms part of the Research Support Centers (CAI) at the Complutense University of Madrid (UCM).

References

- [1] P. García-Soriano, N. Milán-Rois, N. Lafuente-Gómez, C. Rodríguez-Díaz, C. Navío, Á. Somoza, G. Salas, J. Colloid Interface Sci. 2024, 670, 73–85.
- [2] C. Landi, R. Pérez-Garrido, J. M. Cuenca, J. Tajuelo, C. Valeriani, H. Gavilán, F. Martínez-Pedrero, J. Colloid Interface Sci. 2026, 140294.

O.26: Light-Matter Coupling at the Nanoscale Supported by Artificial Organic Hyperbolic Metamaterials

J. N. Gama¹, D. Cunha², C. Estévez-Varela³, M. Garcia-Pardo⁴, P. Pedreira⁵, A. Miranda², M. Carmen López-González⁴, P. A.A. De Beule², E. Solano⁵, R. Serna⁴, M. Vasilevskiy², M. Lopez-Garcia⁴, I. Pastoriza-Santos¹, S. Núñez-Sánchez³

¹ Universidade de Vigo, Campus Universitario As Lagoas, Marcosende, Vigo 36310, Spain

² International Iberian Nanotechnology Laboratory, INL, Portugal

³ Instituto de Ciencia de Materiales de Madrid, ICMM-CSIC, Spain

⁴ Instituto de Óptica, IO-CSIC, Spain

⁵ ALBA Synchrotron, Spain

Artificial hyperbolic metamaterials (HMMs) are highly anisotropic media where the real parts of the dielectric tensor's in-plane and out-of-plane components have opposite signs. This crucial characteristic results in a hyperbolic dispersion relation, which allows for the propagation of high-wavevector modes and enhances the photonic density of states. While conventional HMMs use metal-dielectric composites, their tunability is often limited. Organic-based HMMs offer an attractive alternative, promising molecular-level design and integration into flexible devices. Organic semiconductors naturally exhibit strong optical anisotropy and can support hyperbolic properties, where the orientation of the molecular transition dipole moments is key. Some organic films, like those made from certain polymethine dyes, exhibit natural hyperbolic dispersion due to spontaneous lamellar packing. However, controlling this molecular alignment in simple spin-coated films remains a challenge, as anisotropy is highly sensitive to the deposition process. To overcome this, layer-by-layer (LbL) assembly is a robust alternative for fabricating artificial HMMs. LbL allows for precise control over thickness and composition, making it ideal for chromophores like J-aggregates whose assembly can be regulated in solution. J-aggregates are particularly useful because their narrow-band absorption allows them to achieve negative values for the real part of the dielectric tensor. While studying diffractograms of synchrotron grazing-incidence wide-angle X-ray scattering (GIWAXS), we demonstrate the fabrication of fully organic artificial HMMs using carbocyanine J-aggregates via an electrostatic LbL protocol. Confirmed by atomic force microscopy (AFM) topography analysis, this technique provides a scalable way to achieve uniaxial films with highly anisotropic optical properties, overcoming the limitations of uncontrolled assembly. By controlling the dye's conformation in solution, we achieve a preferential in-plane orientation of the transient dipole momenta. Our multiscale analysis confirms that the structural ordering induced by LbL is responsible for the bulk hyperbolic response. This is validated by the anisotropic dielectric tensor measured via ellipsometry and the strong agreement between high-momentum angular reflectivity experiments and simulated reflectance. The method's versatility is proven by creating artificial HMMs for three different dyes, all supporting hyperbolic surface exciton polaritons (h-SEPs).

Acknowledgements

This work was supported by MCIN/AEI /10.13039/501100011033 and NextGenerationEU/ PRTR (Grants: TED2021-130522B-I00 and CNS2023-145364), the European Union under Grant Agreement #101129661-ADAPTATION and Xunta de Galicia/ERDF (Grant: GRC ED431C 2020/09). GIWAXS patterns were recorded at NCD-SWEET beamline with the collaboration of ALBA staff during the granted beamtimes 2022025594-2 & 2023097759. D.C. acknowledges FCT PhD Grant 2022.11947.BD (DOI: <https://doi.org/10.54499/2022.11947.BD>).

References

J. N. Gama et al., arXiv:2512.20411 [cond-mat.mtrl-sci] (2025) <https://doi.org/10.48550/arXiv.2512.20411>

O.27: Plasmonic Hydrogel–Bacteria Biohybrids for SERS Detection via Metabolic Raman Reporters

Xavier Manuel de Rada-Piñeiro^{1,3,4}, Lara Costas-Ríos^{1,3,4}, Isabel Pastoriza-Santos^{1,2,4}, Jorge Pérez-Juste^{1,2,4}, Gustavo Bodelón^{1,3,4}

¹ CINBIO, Universidade de Vigo

² Departamento de Química Física

³ Departamento de Biología Funcional y Ciencias de la Salud, Campus Universitario Lagoas Marcosende, 36310 Vigo, Spain

⁴ Galicia Sur Health Research Institute (IIS Galicia Sur)

Surface-enhanced Raman scattering (SERS) provides highly sensitive and molecularly specific detection but is typically limited to analytes with large Raman cross-sections and strong affinity for plasmonic substrates. Here, we report a biohybrid sensing platform that overcomes these limitations by coupling engineered bacterial biosensors with a plasmonic hydrogel matrix. The system comprises gold nanostar-doped hydrogels encapsulating genetically modified bacteria genetically-programmed to detect L-arabinose.

Upon induction, the bacteria biosynthesize Raman-active metabolites, effectively transducing a weak or Raman-inactive chemical input into a strong and characteristic vibrational signature detectable by SERS. The hydrogel matrix preserves the colloidal stability of the embedded gold nanostars while enabling controlled nanoscale proximity, thereby enhancing plasmonic coupling and promoting the formation of SERS-active hot spots. In parallel, it provides a protective and permissive microenvironment that sustains bacterial viability while allowing efficient diffusion of analytes and nutrients.

This approach decouples molecular recognition from intrinsic Raman activity, enabling indirect SERS detection of otherwise challenging targets. By integrating synthetic biology with plasmonic materials, the platform expands the analytical scope of SERS and supports the development of portable, on-site diagnostic systems.

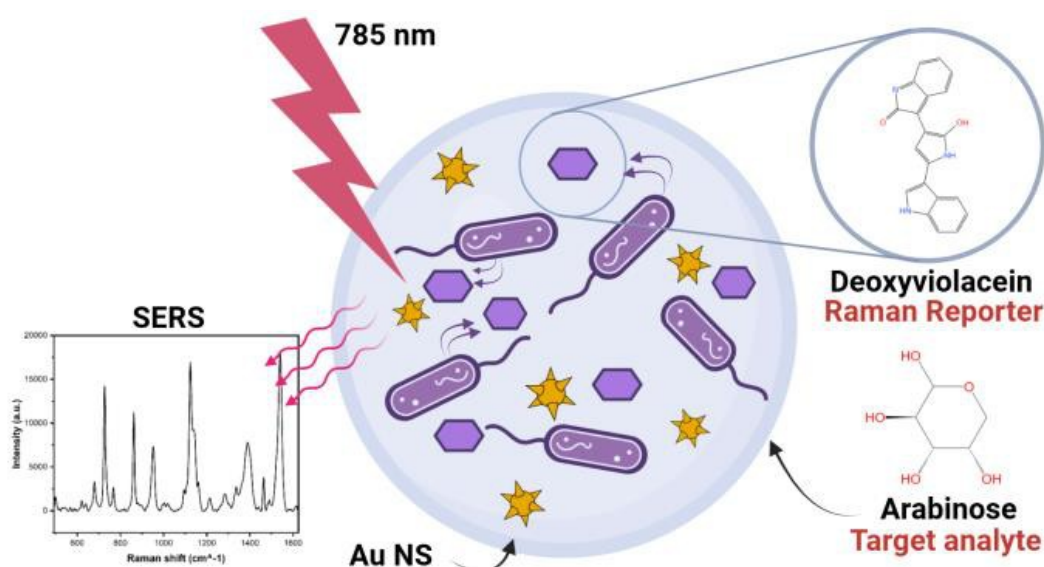


Figure 1: Engineered *Escherichia coli* sense L-arabinose and trigger the production of deoxyviolacein as a Raman reporter. 4×10^8 cells/mL are encapsulated in alginate hydrogel beads together with gold nanostars, which provide SERS enhancement under 785 nm laser excitation, enabling indirect detection of the target analyte through the Raman signal of the reporter molecule.

Acknowledgements We thank the Spanish Ministry of Science, Innovation and Universities (MICIU/AEI/10.13039/501100011033) and the European Union NextGenerationEU/PRTR for funding the project CNS2023-145718. Additionally, we thank financial support from the Consellería de Educación, Ciencia, Universidades e Formación Profesional (Xunta de Galicia) via the predoctoral fellowship (Ref: ED481A-2025-179), co-funded by the European Union under the FSE+ Galicia 2021-2027 Program

O.28: Hybrid thermoresponsive hydrogels with catanionic vesicles for controlled doxorubicin delivery in melanoma therapy

R. L. Machado¹, A. Zoco¹, A. C. Gomes², I. S. Oliveira¹, E.F. Marques¹

¹ CIQUP/IMS, Department of Chemistry and Biochemistry, Faculty of Sciences, University of Porto, Rua do Campo Alegre, 4169-007 Porto, Portugal

² CBMA, School of Sciences, University of Minho, Campus of Gualtar, 4710-057 Braga, Portugal

Skin cancer, particularly melanoma, remains a major therapeutic challenge due to its metastatic potential and the limited efficacy of conventional chemotherapy. Although topical treatments are widely employed, their clinical performance is often hindered by poor drug solubility, limited skin penetration, and off-target cytotoxicity¹. Localized delivery platforms capable of enhancing drug retention and enabling controlled release are therefore highly desirable. Thermoresponsive poloxamer-based hydrogels are attractive in this context, as these polymers undergo temperature-driven self-assembly into micellar and cubic phases, forming injectable matrices under physiological conditions². In parallel, catanionic surfactant systems, formed by the association of oppositely charged species, generate stable vesicles with tunable size, surface charge, and responsiveness to external stimuli, while enabling efficient encapsulation of diverse molecular cargoes³.

Here, we report the development of hybrid thermoresponsive hydrogels combining Pluronic F87 with pH-sensitive catanionic vesicles for improved anti-melanoma drug delivery. The vesicles, formed from sodium lauroyl sarcosinate (SLSar) and a cationic gemini surfactant (12-2-12)₃, were used to encapsulate doxorubicin (DOX) and subsequently incorporated into the polymeric matrix.

Strong polymer-surfactant interactions lead to the formation of mixed micellar and vesicular structures, accompanied by significant changes in physicochemical properties, particularly surface charge. These effects are temperature-dependent and governed by the polymer-to-surfactant ratio. Importantly, the vesicles retain high DOX encapsulation efficiency and remain stable within the hydrogel network. The hybrid system exhibits sustained drug release compared to vesicle-only formulations and shows enhanced transdermal delivery performance. *In vitro* studies reveal increased cellular uptake of DOX and enhanced melanoma cell death, while maintaining excellent biocompatibility. Overall, this work introduces a versatile and tunable platform based on the integration of catanionic vesicles within thermoresponsive polymeric hydrogels, offering a promising strategy for localized skin cancer therapy.

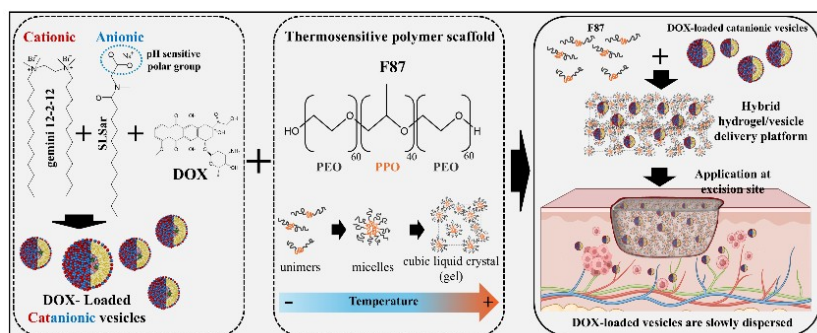


Figure 1: Hybrid thermogels formed by F87–catanionic vesicle co-assembly enable stable nanocarrier encapsulation and controlled doxorubicin delivery.

Acknowledgements We thank FCT for financial support through project 2022.05543.PTDC-Smart4Vir, CIQUP via UID/QUI/0081/2020, IMS via LA/P/0056/2020 and CBMA via UID/BIA/04050/2020.

References

- 1- Kalal, B.S., Upadhyay, D., Pai, V.R., Oncol. Rev., 2017, 11, 326, DOI:10.4081/oncol.2017.326.
- 2- Zarrintaj, P., Ramsey, J.D., Samadi, A., et al., Acta Biomater., 2020, 110, 37, DOI: 10.1016/j.actbio.2020.04.028.
- 3- Machado, R.L., Oliveira, I.S., Santos, K., Gomes, A.C., Marques, E.F. Nanoscale, 2025, 17, 26129, DOI: 10.1039/D5NR03663A.

O.29: Microstructural tailoring of PLA/HAp scaffolds via colloidal-driven integration of cellulose nanofibers for tissue engineering

G. Estrella-Guisado¹, J.M. Luque¹, A. Ferrández², L. Gallego³, B. Ferrari², Z. González^{1,4}

¹ BioPrEn Group (RNM-940), Chemical Engineering Department, Instituto Químico para la Energía y el Medioambiente (IQUEMA), Faculty of Science, Universidad de Córdoba, Córdoba 14014, Spain

² Instituto de Cerámica y Vidrio, CSIC, Campus de Cantoblanco, c/ Kelsen 5, Madrid, 28049, Spain

³ COLFEED4Print S.L. Avenida de los Encuarteres, 19, Tres Cantos, Madrid, 28760, Spain

⁴ Unidad Asociada CSIC-UCO. Fabricación aditiva de materiales compuestos basados en celulosa funcionalizada, obtenida de residuos de biomasa, Spain

The rising demand for bone grafts has increased the need for advanced biomimetic biomaterials in tissue engineering¹. In this context, additive manufacturing, particularly fused filament fabrication (FFF) has emerged as a transformative technology for the design of patient-specific scaffolds with complex and personalized architectures. Currently, composites based on polylactic acid and hydroxyapatite (PLA/HAp) are the most widely used materials due to their Food and Drug Administration (FDA) approval. PLA acts as a versatile thermoplastic matrix, however as a semicrystalline polyester, its clinical application is hindered by a lack of intrinsic cellular affinity. To overcome this, HAp is incorporated as an essential component due to its close mineral analogy to bone, providing osteoinductive properties². Despite this potential, recent studies have demonstrated that the clinical performance of these composites is frequently constrained by microenvironmental acidification during polymer degradation and the slow biodegradability of the ceramic phase³. To address these drawbacks, this study introduces the use of cellulose nanofibers (CNF) as a multifunctional microstructural modifier. These CNF are derived from an integral biorefinery process of agricultural by-products, aligning medical devices with circular economy principles. As a biodegradable, renewable and highly sustainable biopolymer, CNF offer exceptional biocompatibility, mechanical strength and flexibility. The core of this research lies in the meticulous control of interfacial phenomena to drive the electrostatic hetero-assembly of HAp nanoparticles onto the CNF surfaces. By systematically modulating the electrochemical environment, specifically the zeta potential, we ensured the kinetic stability of the hybrid colloidal system. While conventional melt-blending often results in filler agglomeration due to high interfacial tension, this strategy ensures a homogeneous percolated network within the PLA matrix, significantly increasing the specific interfacial area between the filler and the matrix. The established architecture acts as a dynamic homeostatic regulator of the interface. By minimizing the occlusion of HAp nanoparticles within the polymer matrix and maximizing mineral bio-accessibility, the system heightens interfacial reactivity. This facilitates a sustained ionic release and accelerates the degradation kinetics of the mineral phase, while providing a robust buffering effect that counteracts the local acidification triggered by the autocatalytic hydrolysis of the matrix. This approach represents a contribution to the integration of cellulose nanofibers as an advanced structural and functional modifier via a colloidal methodology, establishing a critical synergy for the fabrication of next-generation biomimetic implants.

Acknowledgements

This research is supported by projects CPP2023-010820 and PDC2025-165071-I00, funded by MICIU/AEI/10.13039/501100011033 and “ERDF. A way of making Europe”.

References

- 1Priya, A.S. et al. (2024). Comprehensive Review of Hydrogel Synthesis, Characterization, and Emerging Applications. *Journal of Composites Science* 2024, Vol. 8, Page 457. <https://doi.org/10.3390/JCS8110457>.
- 2Mandeda Madaiah, P. et al. (2025). Advancement in Scaffold-Based 3D Cell Culture Models for Osteosarcoma Drug Screening. *ACS biomaterials science & engineering*. <https://doi.org/10.1021/ACSBIMATERIALS.5C01174>.
- 3Juan-Cano, M.E. et al. (2025). Tuning Biodegradation and Physicochemical Features of PLA/HAp Biomaterials by Incorporating Nanofibrillated Cellulose Through a Colloidal Processing Route. *Polymers* 2025, Vol. 17, Page 1595. <https://doi.org/10.3390/POLYM17121595>.

O.30: Advanced remediation of antibiotics in aqueous media using triazine porous organic polymers

P.M.C. Matias¹, A.D. Assubuji¹, A.C.B. Rodrigues^{1,2}, T.B. Costa^{1,3}, D.S. Rosa³, S.C.C. Nunes¹, A.A.C.C. Pais¹, D. Murtinho¹, A. J. M. Valente¹

¹ CQC-IMS, Department of Chemistry, University of Coimbra, 3004-535 Coimbra, Portugal.

² European Molecular Biology Laboratory (EMBL), Heidelberg, Germany.

³ CECS, Federal University of ABC, 09280-560 Santo André, SP, Brazil.

Water pollution, particularly with antibiotics, contributes to the induction and spread of antimicrobial resistance, which are two of the main problems plaguing humanity [1]. To address these issues, effective yet straightforward remediation strategies are urgently required [2]. This communication describes the development of twelve novel amide-linked triazine porous organic polymers (AT-POPs 1–12, Fig. 1A) prepared through the polycondensation reaction of melamine or 1,3,5-tris-(4-aminophenyl)triazine (TAPT) with six different dicarboxylic acids. The resulting mesoporous materials are highly stable, featuring various functional groups, including nitro, amino and sulfonate moieties. Their adsorption performance was evaluated for amoxicillin (AMX), sulfadiazine (SDZ), sulfamerazine (SMZ), sulfamethazine (SMT), levofloxacin (LVX), tetracycline (TC) and ciprofloxacin (CPX) antibiotics, with AT-POP1, 5, 6 and 12 presenting the best performance. These materials, possessing surface areas of 641, 99, 299 and 10 m² g⁻¹, respectively, showed removal efficiencies of up to 99% in heptacomponent antibiotic mixtures at trace-level concentrations (i.e. 1 μM) in wastewater matrices (obtained from the Choupal WWTP, Coimbra) – Fig. 1B. Individual adsorption studies revealed that AT-POP1 possessed the highest maximum adsorption capacities for SMT ((0.67 ± 0.06) mmol g⁻¹) and TC ((0.25 ± 0.03) mmol g⁻¹), while AT-POP12 was most effective for CPX remediation ((0.32 ± 0.03) mmol g⁻¹). Adsorption equilibrium was reached significantly faster for SMT (60 min) than for TC (240 min) or CPX (600 min) removal. The materials also exhibited high reusability over five cycles, particularly AT-POP1, 5 and 6, whereas AT-POP12 showed a notable loss of activity. Furthermore, several POPs acted as fluorescent probes for the selective, on-site monitoring of antibiotics. Finally, scale-up strategies were developed, including the fabrication of composite beads and continuous-flow systems, while molecular dynamics simulations elucidated the underlying interaction mechanisms. Overall, the multifunctionality and broad applicability of the proposed materials place them at the cutting edge of strategies for the remediation of antibiotic-containing effluents.

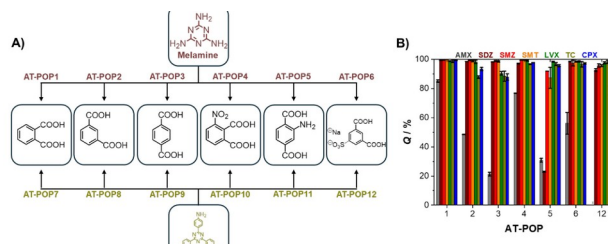


Fig. 1: A) Synthetic approach for the preparation of AT-POPs 1–12; B) comparative adsorption efficiencies (Q, %) using AT-POP adsorbents (1 to 6 and 12) for the removal of all seven antibiotics in wastewater spiked at 1 μM each.

Acknowledgements

To CQC-IMS, supported by FCT (Portugal) through the programs UIDB/00313/2025 & UIDP/00313/2025. P.M.C. Matias also thanks FCT for the PhD Grant 2022.12425.BD. This study was also financed, in part, by FAPESP (Brazil) through processes #2022/11133-0, #2023/11783-8 and #2020/13703-3. The authors thank Águas do Centro Litoral, Dr. Sandra Jorge and Dr. Roberto Barbosa for providing wastewater samples.

References

- [1] Matias, P.M.C. et al. (2024). Assessing interactions between antibiotics and triazine porous organic polymeric sorbents by photophysics. *Environmental Pollution*. <https://doi.org/10.1016/j.envpol.2024.125197>.
- [2] Song, W. et al. (2023). Porous organic polymers with defined morphologies: Synthesis, assembly, and emerging applications. *Progress in Polymer Science*. <https://doi.org/10.1016/j.progpolymsci.2023.101691>.

O.31: Precise Synthesis of Colloidal Palladium Nanospheres with Tunable Dimensions

Ren. Xu, Luis Bañares-Morcillo, Andrés Guerrero-Martínez, Guillermo Gonzalez-Rubio

Departamento de Química Física, Facultad de Ciencias Químicas, Universidad Complutense de Madrid, 28040, Madrid, Spain

Precise control over the synthesis of colloidal palladium nanocrystals has garnered significant attention, as the catalytic, optical and electronic properties are critically determined by their size, shape and surface structure¹. Over the past decade, tremendous progress has been achieved in wet-chemical methods enabling the production of palladium nanocrystals with well-defined morphologies such as cubes, octahedra, and dendritic structures². However, powerful synthetic strategies yielding high quality colloidal palladium nanospheres with defined dimensions in a reproducible manner remain elusive. To address this research gap, our work aims to develop a robust synthesis route that combines seed-mediated growth with nanosecond laser irradiation to produce uniform, colloidal palladium nanospheres with tunable diameters ranging from 28 to 103 nm (Figure 1). Specifically, in the first step, dendritic palladium nanocrystals are produced via seeded growth. Subsequently, nanosecond pulsed laser irradiation is employed to reshape the palladium nanodendrites into smooth structures, with standard deviations of 2-4%. This methodology establishes a versatile approach for producing size-controlled colloidal palladium nanospheres in aqueous solution and provides a foundation for future investigations of their performance in various practical processes, including selective hydrogenation reactions and sustainable fuel synthesis.

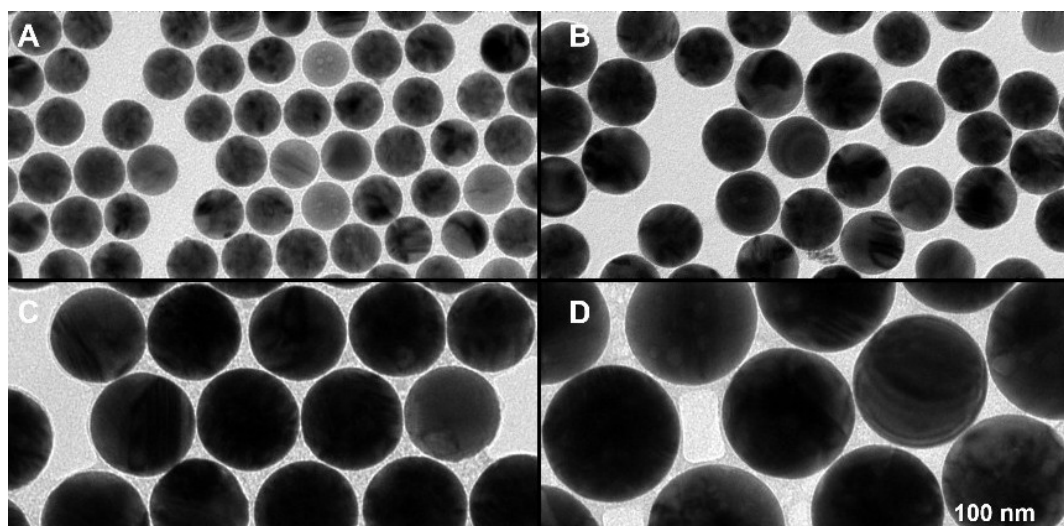


Figure 1: Transmission electron microscopy images of colloidal palladium nanospheres with the sizes of: (A) 28 ± 2 nm, (B) 48 ± 3 nm, (C) 80 ± 3 nm, (D) 103 ± 4 nm (scale bar fits for A to D) obtained via the proposed synthesis strategy.

Acknowledgements This work has been supported by the ERC Starting Grant Time4Nano (101164205), the Spanish Ministry of Science, Innovation, and Universities (grants PID2021-123228NB-I00 and PID2024-159196NB-I00), and the International Research Network-IRN Nanoalloys. G.G-R. acknowledges the Atracción de Talento Fellowship from the Madrid Regional Government (Grant 2022-T1/IND-23908). Ren Xu thanks China Scholarship Council for the financial support to this work (Grant 202206330033).

References

1. W. X. Niu, et al. "Shape-Controlled Synthesis of Single Crystalline Palladium Nanocrystals" *ACS Nano*. 2010, 4, 1987-1996.
2. J. W. Zhang, et al. "Size and Shape Controlled Synthesis of Pd Nanocrystals" *Phys. Sci. Rev.* 2018, 20170101.

O.32: Deciphering the plasma functionalization on the organo-nanoclay and its Cr(VI) removal in simulated water

P. H. Camani¹, S. Sahoo², A. Yadav², K. Rezvanian², T. B. da Costa³, R. R. Ferreira³, D. S. Rosa³, V. K. Rangari², L. H. I. Mei¹

¹ School of Chemical Engineering, Department of Materials Engineering and Bioprocess (DEMBio), State University of Campinas (Unicamp), Albert Einstein Avenue, 13083-852, Campinas, Brazil

² Department of Materials Science and Engineering, Tuskegee University (TU), Tuskegee, Alabama, USA

³ Center for Engineering, Modeling, and Applied Social Sciences (CECs), Federal University of ABC (UFABC), dos Estados Avenue, 09280-560, Santo André, Brazil

Due to the alarming scarcity of drinking water and the inefficiency of conventional water treatment, technologies such as adsorption are emerging as promising solutions to these global environmental issues. Thus, we functionalized an organo-modified nanoclay (C20A) using low-temperature plasma irradiation with SF₆ as the plasma-forming gas, examining the nanoclay's surface functionalization at different contact times (5, 17, and 30 min) and its application for capturing hexavalent chromium (HCrO₄⁻). From XPS survey spectra, a gradual increase in fluorine element was detected on the nanoclay's surface, especially for 17 and 30 min, respectively. Proving the presence of the fluorine element, SEM-EDS obtained the same trend as that found from XPS spectra. Additionally, the oxygen percentage increased with increasing contact time, whereas the carbon percentage decreased, possibly due to the formation of C-F species during plasma irradiation¹. It could be linked to the excellent functionalization of nanoclay via plasma irradiation with SF₆, which favored an interaction between the fluorine functional groups and oxygen and carbon elements found on nanoclay's surface². This carbon element can be associated with the organo-modification of nanoclay with carbon chains from this modifier. In other words, the organo-modification of C20A nanoclay helped to provide more active sites to functionalize the nanoclay's surface with fluorine elements. Additionally, plasma irradiation increased the surface area available for contact time from 17 min to approximately 37.0 m²/g, compared to 2.8 m²/g for untreated C20A, and increased the micropores' volume of this plasma-treated nanoclay. For Cr(VI) removal at pH 2 and C₀ = 0.05 mMol/L, plasma-treated samples achieved a removal efficiency of approximately 66.87%, which decreased as C₀ increased to 0.8 mMol/L. Following the adsorption studies, the highest adsorbent dosage (4 g/L) yielded the best adsorption performance, particularly at longer contact times. At the optimal adsorbent dosage, pH 2 yielded the best adsorption result compared to pH 4 and 6, possibly due to protonation of the aqueous medium, which facilitates interaction between the protonated nanoclay surface and HCrO₄⁻. Therefore, plasma treatment provided an insertion of fluorine elements on the organo-nanoclay's surface, forming oxygen-rich groups and C-F functional groups on the nanoclay's surface. Additionally, plasma treatment led to the formation of more micropores on the plasma-treated C20A within 17 min, thereby increasing the sample's surface area. These factors could have contributed to improved Cr(VI) removal at pH 2 and at higher adsorbent dosages, due to the synergistic effect of increased available surface area and the introduction of reactive functional groups (fluorine-rich groups) on the nanoclay's surface.

Acknowledgements This research was financed by São Paulo Research Foundation (FAPESP) (grant #2023/11229-0, grant #2024/15696-5, grant #2022/11133-0, grant #2023/11783-8, grant #2022/01382-3, #2024/08105-0, grant #2020/13703-3, grant #2021/14714-1), Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) (grant #308053/2021-4, grant #403934/2021-4), and Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) (Finance Code 001). The authors would also like to acknowledge the NSF-CREST# 1735971. The authors thank the technical support of the Multiuser Experimental Center of UFABC (CEM-UFABC), CECS (UFABC).

References

1. Wang, W.-K., Wang, S.-Y., Liu, K.-F., Tsai, P.-C., Zhang, Y.-H., and Huang, S.-Y. (2020) Plasma Etching Behavior of SF₆ Plasma Pre-Treatment Sputter-Deposited Yttrium Oxide Films. *Coatings*, 10 (7), 637.
2. Zanini, S., Papagni, A., Vaghi, L., Kaur Thatti, B., Barton, S., Williams, N., Shokri, N., and Riccardi, C. (2020) Sulfur Hexafluoride (SF₆) Plasma Treatment of Medical Grade Poly(methyl methacrylate). *Coatings*, 10 (2), 135.

O.33: Ophthalmic Hydrogels and Contact Lenses Loaded with Lipid Nanocarriers for the Topical Treatment of Retinopathies

M.J. Faria^{1,2}, M.E.C.D. Real Oliveira¹, G. Carracedo³, M. Lúcio^{1,2,4}

¹ Centre of Physics of Minho and Porto Universities (CF-UM-UP), University of Minho, Braga, Portugal

² LaPMET Associate Laboratory, University of Minho, Braga, Portugal

³ Ocupharm Research Group, Facultad de Óptica y Optometría, Universidad Complutense de Madrid, Madrid, Spain

⁴ Centre of Molecular and Environmental Biology (CBMA), University of Minho, Braga, Portugal

Age-related retinal diseases (ARRD) are vision-threatening conditions affecting the posterior segment of the eye¹. Given the complex ocular anatomy and its barriers, current treatments rely on invasive intraocular injections with associated risks¹. This highlights the urgent need for safer alternatives. Hence, this work focused on the rational design and optimization of cationic lipid-based nanocarriers (LN) enriched with monoolein (MO@LN) or phytantriol (PHY@LN) and loaded with resveratrol (RSV) as a topical treatment strategy towards retinopathies.

MO@LN/PHY@LN (2:1, 1:1, 1:2) were characterized for their physicochemical properties, including size (100-230 nm), polydispersity index (<0.3), zeta potential (>+50 mV), stability (up to 4 weeks), deformability (21-68%), and thermodynamic behavior. Furthermore, the diffusion properties of MO@LN/PHY@LN were determined in three different media (aqueous, simulated lachrymal fluid, and mucin-enriched) before and after PEGylation (10 mol%). All LN demonstrated mainly sub-diffusive behaviors, which is ideal for a good balance between ocular retention and permeation. Finally, the morphology was confirmed using cryogenic transmission electron microscopy².

Ocular safety studies showed that PEGylated MO@LN/PHY@LN did not promote ocular irritation in fertilized chicken eggs (HET-CAM), led to low hemolysis ($\leq 5\%$), and to high cell viability in a human corneal epithelial cell line (HCE) at the tested concentrations (30-160 $\mu\text{g/mL}$). All LN demonstrated high RSV encapsulation efficiencies (>92%)².

Finally, PEGylated RSV-MO@LN/PHY@LN were incorporated into ophthalmic hydrogels (LN@HG) and soft contact lenses (LN@CL) of both hydrogel (sCL) and silicone hydrogel (SiHyCL)². LN@HG showed high transparency ($\geq 90\%$) and ideal non-Newtonian pseudoplastic rheological profiles². LN@SiHyCL did not exhibit clinically relevant changes in transparency, central thickness, optical power, or water content, in contrast to Hy@CL that showed poor transmittance and oxygen transmissibility². Both HG and CL promoted sustained RSV release over several hours, confirming their potential as prolonged-delivery platforms for topical ophthalmic therapy².

Overall, PHY@LN exhibited the most favorable profile for increased interaction and penetration to intraocular tissues, and LN@SiHyCL emerged as a promising, non-invasive strategy for the treatment of ARRD.

Acknowledgements This work was supported by the Portuguese Foundation for Science and Technology (FCT) in the framework of the Strategic Funding UIDB/04650/2025. M. J. Faria acknowledges FCT for PhD grant (2020.06561.BD), Universidad Complutense de Madrid, and Universidad de Santiago de Compostela for hosting international research stays under the PhD Scholarship.

References

1. Faria MJ, González-Méijome JM, Real Oliveira MECD, Carracedo G, Lúcio M. Recent advances and strategies for nanocarrier-mediated topical therapy and theranostic for posterior eye disease. *Adv Drug Deliv Rev.* 2024; 115321. <https://doi.org/10.1016/j.addr.2024.115321>
2. Faria MJ, Romaguera M, Gonçalves H, Ribeiro A, Ribeiro C, Lira M, Real Oliveira MECD, Carracedo G, Lúcio M. Monoolein/phytantriol-enriched lipid-based nanocarriers loaded with resveratrol as topical ophthalmic vehicles: effect of PEGylation and incorporation in ophthalmic hydrogels and soft contact lenses. *J Drug Deliv Sci Technol.* 2025; 107835. <https://doi.org/10.1016/j.jddst.2025.107835>

O.34: Tuning Whey Protein Isolate and Carboxymethylcellulose Blend Films for Food Applications: The Role of Processing Temperature

Raquel Vaz^{1,*}, Ana Gabriela Azevedo¹, Lorenzo M. Pastrana¹, Miguel A. Cerqueira¹

¹International Iberian Nanotechnology Laboratory, Av. Mestre José Veiga, 4715-330, Braga, Portugal

Designing functional biopolymer-based materials for food applications requires precise control over their structural and physicochemical properties. Proteins and polysaccharides are widely explored due to their complementary functionalities, enabling tailoring mechanical and interfacial characteristics¹. In this context, processing conditions influence material performance². This study aimed to develop films based on carboxymethyl cellulose (CMC) and whey protein isolate (WPI), and to evaluate the effect of processing temperature on their structural and functional properties.

CMC (2% w/v) and WPI (4% w/v) mixtures were heated at temperatures ranging from 50 to 90 °C for 15 min, followed by film formation via solvent casting (drying at 37 °C for 16 h). The properties of films were analysed through Scanning Electron Microscopy (SEM), Attenuated Total Reflectance-Fourier Transform Infrared Spectroscopy (ATR-FTIR), mechanical testing by measuring tensile strength (TS), elongation at break (EB) and Young's Modulus (YM), water vapour permeability (WVP), moisture content, solubility, and water contact angle (WCA).

The CMC-WPI films obtained were homogeneous and compact, suggesting a good mixture between WPI and CMC. ATR-FTIR analysis revealed temperature-dependent alterations in the absorption bands: the disappearance of peaks at 1633 and 1542 cm⁻¹ indicated structural reorganization of WPI; the emergence of a band at 1594 cm⁻¹ was attributed to the formation of intermediate compounds from Maillard reactions; and changes at 3280 cm⁻¹ were related to hydrogen bonding and other interactions between the polymers. These results were corroborated by SEM images, which showed smoother surface and cross-section when $T \leq 70^\circ\text{C}$, and different structures and increased roughness with $T \geq 75^\circ\text{C}$. Moreover, the films showed an increase in TS with increasing processing temperature, with significant differences evident up to 80 °C; in contrast, EB decreased, indicating reduced film ductility; and the YM showed a clear increasing trend with temperature, with a marked rise at 90 °C. In terms of water interaction properties, WVP differed significantly only between films processed at 50 °C and 90 °C, indicating that higher thermal treatment slightly increases permeability. Moisture content was not significantly affected by processing temperature, with similar water retention across all films. In contrast, solubility remained at 100% until $T \leq 70^\circ\text{C}$, then decreasing to approximately 75%. WCA measurements showed a clear increase in hydrophobicity until $T = 80^\circ\text{C}$. Over time, a decrease in WCA was observed due to water absorption; however, this reduction was less pronounced at higher temperatures, in agreement with the lower solubility of these films.

In conclusion, the processing temperature governs molecular interactions and network organization in CMC-WPI films, driving structural rearrangements. This results in less soluble, more hydrophobic, and stiffer films, while maintaining largely unaffected WVP. Overall, the results highlight the potential of thermally modified CMC-WPI films for diverse food applications.

Acknowledgements

The authors acknowledge the financial support of the project "IDfoods: Food System of The Future - Investigação e Desenvolvimento em Sistemas Agroalimentares Sustentáveis e Nutrição Saudável" (n.º182848), co-funded by COMPETE 2020 - Operational Programme for Competitiveness and Internationalisation under the PORTUGAL 2020 Partnership Agreement, through the European Regional Development Fund (ERDF).

References

- 1 Hassan, F., Mu, B., Yang, Y. (2024). Natural polysaccharides and proteins-based films for potential food packaging and mulch applications: A review. *International Journal of Biological Macromolecules*, 261(1): 129628. <https://doi.org/10.1016/j.ijbiomac.2024.129628>.
- 2 Flórez, M., Cazón, P., & Vázquez, M. (2023). Selected Biopolymers' Processing and Their Applications: A Review. *Polymers*, 15(3): 641. <https://doi.org/10.3390/polym15030641>.

O.35: Multistimuli-responsive amino acid-based surfactant vesicles as versatile and biocompatible nanocarriers for gene delivery

E.C. Loureiro¹, I.S. Oliveira¹, M. L. do Vale², B. Silva³, A.C. Gomes³, E.F. Marques¹

¹ CIQUP, Department of Chemistry and Biochemistry, Faculty of Sciences, University of Porto, Rua do Campo Alegre, 4169-007, Porto, Portugal

² LAQV-REQUIMTE, Department of Chemistry and Biochemistry, Faculty of Sciences, University of Porto, Rua do Campo Alegre, 4169-007, Porto, Portugal

³ CBMA, School of Sciences, University of Minho, Campus of Gualtar, 4710-057, Braga, Portugal

Recent advancements in non-viral gene therapy have enabled the development of sophisticated colloidal nanocarriers for the efficient delivery of nucleic acids (NAs). Particularly, surfactant-based lipoplexes stand out as safe, versatile and tunable vectors, arising from electrostatic interactions between cationic carriers, such as vesicles, and negatively charged NAs¹. Amino acid-based surfactants, noteworthy for their high biocompatibility, biodegradability and stimuli-responsiveness, have emerged as promising building blocks for delivery systems². In this work, cationic vesicles (Fig.1) were developed using novel pH- and redox-responsive amino acid-based gemini surfactants (12(SerCys)₂12, serine/cysteine-derived) and a cleavable gemini surfactant ((12Ser)₂EA5, serine-derived) combined with helper lipids (DOPE and cholesterol), known to enhance transfection³. Results show that, under appropriate mixing conditions, stable cationic vesicles are formed, with increasing surfactant (12(SerCys)₂12 + (12Ser)₂EA5) concentration leading to higher surface charge and lower size. Light microscopy reveals the coexistence of vesicles and lamellar structures at physiological pH. The vesicles display tunable size and charge, strongly dependent on composition and environmental conditions (pH and redox). Extruded vesicles achieve efficient NA complexation ($\approx 90\%$), forming stable and monodisperse lipoplexes. DLS show that lipoplexes undergo structural rearrangements in response to pH variation and physiologically relevant glutathione (GSH) levels, mimicking intracellular environments, including acidic and reducing conditions encountered during cellular uptake and trafficking. This behavior supports triggered destabilization and NA release, highlighting the potential of these systems for efficient intracellular delivery.

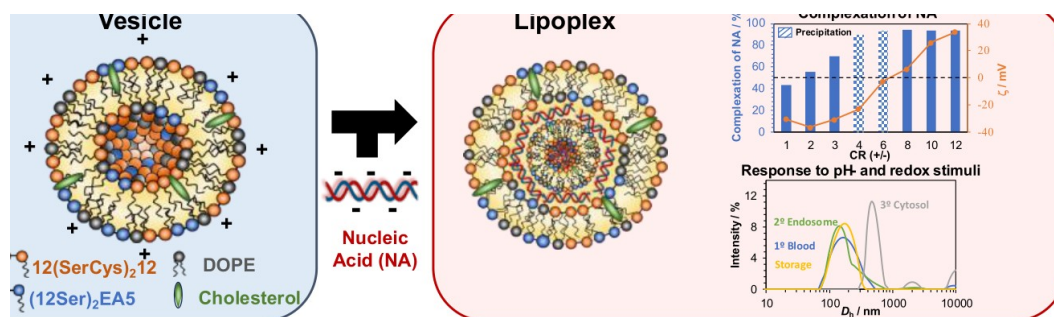


Figure 1: a) molecular structure of the cationic surfactant vesicle components and b) complexation with NAs and lipoplex response to pH- and redox stimuli.

Acknowledgements We thank Fundação para a Ciência e Tecnologia for financial support through project 2022.05543.PTDC-Smart4Vir, through CIQUP via grant UID/QUI/0081/2020, IMS via grant LA/P/0056/2020 and CBMA via grant UID/BIA/04050/2020.

References

1. Moreira, D., Oliveira, I. S., Mateus, P., Seco, A., Roma-Rodrigues, C., Baptista, P.V., Fernandes, A.R., Basílio, N. and Marques, E. F., J. Mater. Chem. B, 2025, 13,15591, DOI:10.1039/D5TB01908G.
2. Oliveira, I.S., Machado, R.L., Araújo, M.J., Gomes, A.C. and Marques, E.F., Chem. Eur. J., 2021, 27, DOI: 10.1002/chem.202003320.
3. Du, Z., Munye, M. M., Tagalakakis, A. D., Manunta, M.D.I. and Hart, S.L., Sci. Rep.,2014, 4,7107, DOI: 10.1038/srep07107.

O.36: *In-Situ* Growth of Plasmonic Nanoparticles in Biopolymeric Matrices: Controlling Nucleation Pathways for Biomedical Integration

Alma González España, Leonardo Scarabelli

Department of Chemistry and Process and Resource Engineering, University of Cantabria, Santander, Spain

In situ growth has emerged as a transformative approach in colloidal nanoscience, enabling the formation of nanomaterials directly within complex environments where traditional colloidal routes often fail. By localizing nucleation and growth processes, this strategy provides unique opportunities to control nanoparticle formation under conditions that would otherwise lead to instability, aggregation, or loss of functionality.

In this work, we study the *in situ* growth of gold nanoparticles within collagen-based systems as a model platform to understand how biological matrices can be exploited to control nucleation pathways and growth dynamics.

We demonstrate that the physicochemical environment plays a critical role in governing *in-situ* growth. Standard cell culture conditions, including buffered media and early pH neutralization, were found to disrupt controlled nucleation by modifying gold speciation and redox kinetics. These effects result in uncontrolled secondary nucleation, heterogeneous particle populations, and premature matrix gelation, ultimately limiting reproducibility and integration.

To overcome these challenges, we establish a synthesis route in which nanoparticle growth is initiated in acidic collagen solutions prior to gelation. This decouples nucleation from matrix solidification, allowing precise control of the growth process. Subsequent pH adjustment induces collagen gelation while preserving nanoparticle distribution and preventing post-synthetic aggregation. Spectroscopic analyses confirm the formation of plasmonic nanostructures intimately associated with the collagen network. This system exemplifies how *in situ* growth can be harnessed to produce hybrid biomaterials with controlled architecture and functionality. As a proof of concept, these materials can be directly implemented in three-dimensional biological models, where embedded nanoparticles act as optical reporters of microenvironmental changes.

Overall, this study highlights the importance of controlling chemical pathways during *in situ* growth and establishes design principles for integrating nanomaterials into biologically relevant matrices. Such approaches open new avenues in colloidal biotechnology, particularly for applications requiring seamless interfacing between synthetic nanomaterials and living systems.

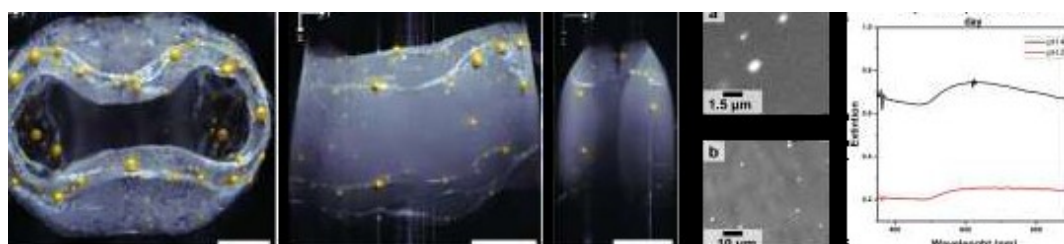


Figure 1 Three-dimensional simulation of the organoid. (A–B) Scanning electron microscopy (SEM) images of a collagen solution containing gold nanoparticles, dried on carbon tape. (Right) Extinction spectrum of the collagen-gold nanoparticle system on day 1.

Acknowledgements

The authors acknowledge the FIBROHEART research group at IBBTEC (Cantabria) for their scientific support. This work was supported by the European Research Council the European Research Council (ERC Starting Grant 101115164, NANOGROWDIRECT) and the Spanish Ministerio de Ciencia e Innovación y Universidades through fellowship RYC2022-037894-I.

References

- Algeciras, L.; Palanca, A.; Maestro, D.; RuizdelRio, J.; Villar, A. V. J. *Mol. Cell. Cardiol.* 2021, 159, 38–47. <https://doi.org/10.1016/j.yjmcc.2021.06.003>
- Vinnacombe-Willson, G. A.; Conti, Y.; Jonas, S. J.; Weiss, P. S.; Mihi, A.; Scarabelli, L. *Adv. Mater.* 2022, 34, 2205330. <https://doi.org/10.1002/adma.202205330>

O.37: Biomimetic PLGA Nanoparticles Coated with Adipose-Derived Membranes for Obesity Therapy

Óscar Abelenda¹, Alba Costa¹, Mariangel Luna¹, Marcos Couselo-Carreira², Pablo Taboada¹

¹ Colloids and Polymer Physics Group (GFCP), Department of Particle Physics, Faculty of Physics and Institute of Materials (IMATUS), Campus Vida, Universidade de Santiago de Compostela, 15782 Santiago de Compostela, Spain

² Institute of Health Research (IDIS) of Santiago de Compostela, 15706 Santiago de Compostela, Spain

White adipose tissue (WAT) browning into energy-dissipating beige adipocytes is a promising strategy to combat obesity. However, the clinical use of inducers such as rosiglitazone (Rosi) is limited by systemic off-target effects.^{1,2} Here, we report a biomimetic nanoplatform based on poly(lactic-co-glycolic acid) (PLGA) nanoparticles (NPs) encapsulating Rosi and coated with depot-specific adipocyte-derived membranes from subcutaneous and visceral adipose tissue.

Rosi was efficiently encapsulated (~80%), and the resulting nanosystems exhibited excellent colloidal stability and high biocompatibility. Membrane coating was confirmed by electron microscopy and proteomic analysis, revealing a proteolipid shell enriched in GLUT4, Caveolin-1, and apolipoproteins. This functionalization conferred homotypic adipocyte targeting and promoted a non-canonical internalization pathway dominated by membrane fusion. While membrane coating modulated browning-associated gene expression, resulting in a tempered UCP1 response compared to bare NPs, it induced a pronounced delipidating effect that shifted hypertrophic adipocytes toward a leaner phenotype, even in the absence of pharmacological cargo. Collectively, these findings indicate that adipocyte-membrane-coated NPs act as active biointerfaces rather than passive carriers. By enabling metabolic modulation through homeostatic buffering mechanisms, this platform offers a highly innovative strategy for adipose tissue-specific metabolic reprogramming in obesity management.

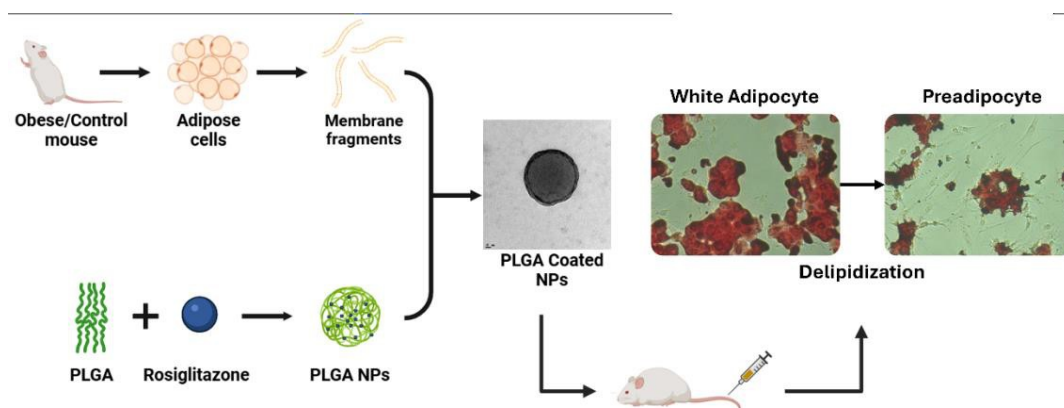


Figure 1: Graphical abstract. Extraction of adipose cell membranes followed by the synthesis of Rosiglitazone-loaded PLGA nanoparticles (NPs). These NPs are then coated with adipose cell membranes to enable homotypic targeting and induce delipidating effect. Created with BioRender.

Acknowledgements The authors thank financial support from grant PID2022-142682OB-I00 funded by MICIU/AEI/10.13039/501100011033 and by the European Union NextGenerationEU/PRTR. The authors also thank support from grants PID2023-152062OA-I00 funded by MICIU/AEI/10.13039/501100011033 and ED431F2025/14 funded by Xunta de Galicia.

References

1. Hiradate, R. et al. (2021) A novel dual-targeted rosiglitazone-loaded nanoparticle for the prevention of diet-induced obesity via the browning of white adipose tissue. *Journal of Controlled Release* 329, 665–675.
2. Tamucci, K. A., Namwanje, M., Fan, L. & Qiang, L. (2018) The dark side of browning. *Protein Cell* 9, 152–163.

O.38: Colloidal Design of Nanocomposite Heterostructures: Towards Efficient Environmental Remediation

J.M. Luque¹, R. Montenegro¹, G. Estrella-Guisado¹, M. Cruz-Yusta², L. Sánchez², A. Rodríguez¹, Z. González¹

¹ BioPrEn Group (RNM-940), Inorganic Chemistry and Chemical Engineering Department, Faculty of Science, Instituto Químico para la Energía y el Medioambiente (IQUEMA), Universidad de Córdoba, 14014 Córdoba, Spain

² Departament of Inorganic Chemistry and Chemical Engineering, Faculty of Science, Instituto Químico para la Energía y el Medioambiente (IQUEMA), University of Córdoba, 14014 Córdoba, Spain

Heterogeneous photocatalysis has emerged as a promising approach to address pressing environmental challenges by harnessing light as a sustainable energy source. However, its large-scale implementation remains limited by several critical factors. Among them, two major challenges stand out: the intrinsic limitations of conventional photocatalysts, such as inefficient charge separation, restricted spectral response, and reliance on costly or scarce materials, and the need for additional, often complex and energy-intensive, steps to recover and reuse dispersed photocatalytic powders from the reaction medium¹.

At the same time, the fabrication of advanced composite photocatalysts, particularly those based on nanoparticle heterojunctions, which are attracting increasing attention, as well as the immobilization of functional nanophases onto supports, typically relies on multistep methodologies involving organic solvents, high temperatures, and energy-intensive conditions. These approaches not only hinder scalability but also raise concerns regarding their environmental impact, limiting the development of truly sustainable photocatalytic technologies².

In this context, colloidal chemistry is proposed as a dual-purpose strategy capable of simultaneously addressing both challenges through the controlled manipulation of interparticle interactions in aqueous media. On the one hand, colloidal assembly enables the formation of nanoparticle heterojunctions, allowing for the tuning of photoresponse and charge separation efficiency through engineered interfacial contact. On the other hand, the same principles can be exploited to drive the heterocoagulation of functional nanoparticles onto structured supports, facilitating their integration into macroscopic and processable architectures³.

In this work, a colloidal approach was explored through the development of a range of nanostructured composite materials, from photocatalytic heterojunctions (combining TiO₂, CuO, g-C₃N₄, etc.) to the immobilization of active nanophases onto surface-modified cellulose nanofibers, as well as their incorporation into dispersions suitable for the fabrication of 3D-printable filaments. This strategy enabled the design of hierarchical materials that combined enhanced functionality with improved handling, recovery, and scalability. These results highlight the promising role of colloidal chemistry as a simple, fast, and scalable platform that bridges the gap between material design and real-world application, providing a versatile route toward the development of efficient and sustainable photocatalytic systems for practical environmental remediation.

Acknowledgements This work was supported by Spain through TED2021-129920A-C42, C41 and CPP2023-010820 projects funded by MICIU/AEI/10.13039/501100011033, by the European Union Next Generation EU/PRTR and “ERDF. A way of making Europe”. The authors also acknowledge the staff of the Central Research Support Service (SCAI) and the Instituto Químico de Energía y Medioambiente (IQUEMA) of Universidad de Córdoba.

References

1. F. R. Amalia, L. Wang, Z. Bielan, A. Markowska-Szczupak, Z. Wei, and E. Kowalska, “Gels in Heterogeneous Photocatalysis: Past, Present, and Future,” *Gels* 10 (2024): 810.
2. B. Baihaqi, M. F. Ihsan, and W. H. Saputera, “Recent Progress and Perspectives on Hydrogel-based Photocatalysts: A Review,” *Materials Science in Semiconductor Processing* 208 (2026): 110545.
3. S. Carrasco, E. Espinosa, Z. González, M. Cruz-Yusta, L. Sánchez, and A. Rodríguez, “Simple Route to Prepare Composite Nanocellulose Aerogels: A Case of Photocatalytic De-NO_x Materials Application,” *ACS Sustainable Chemistry & Engineering* 11 (2023) 2354-2363.

O.39: Conductive MOF Coated Porous Silicon Nanoparticles as Core–Shell Anodes for Durable Lithium Ion Batteries

Pablo Díaz Clemente¹, Alejandro Varela¹, Altair Victoria Marcos¹, José M. Vila-Fungueiriño², Silvia Barbosa¹, Pablo Taboada¹

¹ Grupo de Física de Coloides y Polímeros, Departamento de Física de Partículas, Facultad de Física e Instituto de Materiales (iMATUS), Universidade de Santiago de Compostela, Santiago de Compostela, Spain

² Centro Singular de Investigación en Química Biolóxica e Materiais Moleculares (CiQUS), Universidade de Santiago de Compostela, Santiago de Compostela, Spain

Electrochemical energy storage (EES) is widely regarded as one of the most promising technologies for addressing the intermittent nature of renewable energy sources, reducing the European Union's heavy reliance on fossil fuels, and cutting greenhouse gas emissions and other pollutants¹. Currently, rechargeable lithium-ion batteries (LIBs) are considered the gold standard for EES due to their excellent electrochemical performance and the limited maturity of alternative storage systems².

Silicon has emerged as a highly attractive material for LIB anodes thanks to its high theoretical capacity. However, it faces several major challenges—most notably, its significant volume expansion during charge-discharge cycles. This expansion can cause severe structural degradation, leading to cracking and pulverization of the anode, and loss of electrical contact between the active material and the current collector, ultimately reducing battery life³. Downsizing silicon to the nano- or microscale can help mitigate mechanical stress during cycling, but this also increases surface area, which can lead to poor adhesion, reduced mechanical strength, and side reactions with the electrolyte⁴. To enable the large-scale commercialization of silicon-based anodes, it is essential to find effective strategies that buffer these volume changes while preserving structural integrity and ensuring good contact with the electrolyte.

Metal-organic frameworks (MOFs) have recently gained attention as promising hosts for silicon particles, offering the potential to accommodate their volume expansion, enhance structural stability, and facilitate lithium-ion transport. However, research in this area is still in its early stages, and scarce previous studies have faced several issues, including poor incorporation of silicon into the MOF structure, agglomeration of silicon particles within the framework, and the need of complex, non-scalable synthesis methods^{5,6,7}.

As a starting point for this project, we have synthesized and characterized novel porous silicon nanoparticles (SiNPs) and explored a candidate MOF coating to form a functional core@shell nanostructure. We have investigated how various synthetic parameters—such as reactant ratios, reaction temperature, sintering time, and washing steps—affect the size and morphology of the SiNPs. In parallel, we have studied the synthesis of the conductive MOF Cu₃(HITP)₂, analysing how synthesis conditions influence its structure, porosity, and electrical performance.

Acknowledgements

The authors acknowledge financial support from grant PID2022-142682OB-I00, funded by MICIU/AEI/10.13039/501100011033 and by the European Union (NextGenerationEU/PRTR), and from grant PID2023-152062OA-I00, funded by MICIU/AEI/10.13039/501100011033.

The authors also acknowledge support from grant ED431F2025/14 funded by the Xunta de Galicia, and from the predoctoral grant ED481A (2025), co-financed by the European Union through the European Social Fund Plus (FSE+ Galicia 2021–2027).

References

- 1- P. Vier-Hung, et al. *Energy Storage Mater.* 20 (2019) 71–79.
- 2- S.-G. Ng et al. *Adv. Mater.* 33 (2021) 2008654.
- 3- X. H. Liu et al. *Nat. Nanotechnol.* 7 (2012) 749–756.
- 4- A. Karami et al. *J. Power Sources* 461 (2020) 228155.
- 5- H. Xue et al. *ACS Appl. Mater. Interfaces* 13 (2021) 40471–40480.
- 6- T. Yoon et al. *ACS Nano* 11 (2017) 4808–4815.
- 7- K. Wang et al. *Chem. Eng J.* 356 (2019) 272–281.

O.40: Magnetic bionanosorbents for multi-dye wastewater treatment

Sofia F. Soares, Tito Trindade, Ana L. Daniel-da-Silva

CICECO-Aveiro Institute of Materials, Department of Chemistry, University of Aveiro, 3810-193 Aveiro, Portugal

The discharge of synthetic dyes from industrial effluents represents a major environmental concern due to their toxicity, persistence, and resistance to conventional treatment processes¹. Among available remediation strategies, adsorption stands out as a simple, cost-effective, and scalable approach capable of removing a wide range of organic pollutants². However, conventional sorbents often suffer from limitations such as low selectivity, poor reusability, and reduced efficiency in complex pollutant mixtures. To address these challenges, this work explores the development of magnetic nanostructured sorbents with tunable surface functionalities. In particular, biopolymer-based magnetic nanosorbents provide a sustainable solution by combining the magnetic recoverability of magnetite (Fe_3O_4) with the functional versatility and environmental compatibility of natural polymers³. A dual nanosorbent strategy based on charge-selective magnetic bionanosorbents is proposed for the simultaneous removal of cationic and anionic dyes from aqueous media (Fig. 1)⁴. Two oppositely charged systems were developed: Fe_3O_4 nanoparticles functionalized with trimethyl chitosan (cationic) and with κ -carrageenan (anionic), enabling selective adsorption of positively and negatively charged dyes, respectively. The materials were characterized in terms of morphology, surface properties, and adsorption behavior, and their performance was evaluated under single- and multi-component conditions in both ultrapure water and real wastewater matrices. The system demonstrated high removal efficiency in synthetic solutions and maintained strong performance in real wastewater. Additionally, the nanosorbents exhibited excellent regeneration and reuse over multiple cycles. Ecotoxicity assessment using zebrafish (*Danio rerio*) embryos indicated no acute toxic effects for both pristine and dye-loaded nanosorbents under environmentally relevant conditions.

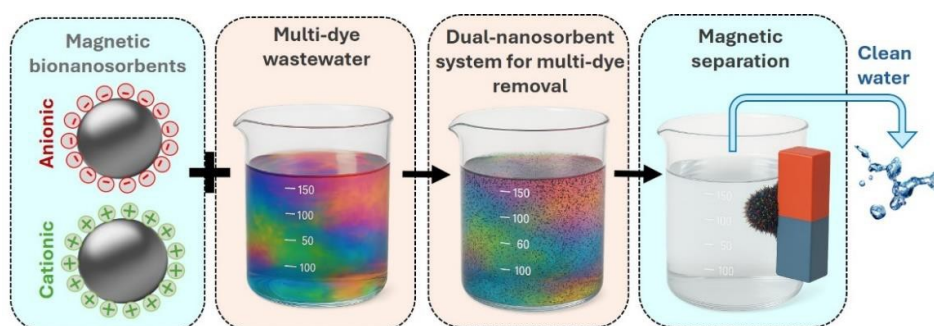


Figure 1: Dual system of cationic and anionic magnetic bionanosorbents for selective multi-dye removal from wastewater, followed by magnetic separation for clean water recovery⁴.

Acknowledgements

This work was developed within the scope of the project CICECO-Aveiro Institute of Materials, UID/50011/2025 (DOI 10.54499/UID/50011/2025) & LA/P/0006/2020 (DOI 10.54499/LA/P/0006/2020) & UID/PRR/50011/2025 (DOI 10.54499/UID/PRR/50011/2025), financed by national funds through the FCT/MCTES (PIDDAC)A.L.D.-d.-S. acknowledges FCT for funding (CEECIND/03075/2018/CP1559/CT0020; DOI: 10.54499/CEECIND/03075/2018/CP1559/CT0020). S.F.S. thanks FCT for her research contract (2023.06221.CEECIND/CP2840/CT0019; <http://doi.org/10.54499/2023.06221.CEECIND/CP2840/CT0019>).

References

- [1] Dutta, S., Adhikary, S., Bhattacharya, S., Roy, D., Chatterjee, S., Chakraborty, A., Banerjee, D., Ganguly, A., Nanda, S., and Rajak, P. (2024) *J. Environ. Manage.*, 353, 120103.
- [2] Patel, D., Singh, A., Ambati, S.R., Singh, R.S., and Sonwani, R.K. (2024) *J. Environ. Manage.*, 370, 122804.
- [3] Soares, S.F., Fernandes, T., Trindade, T., and Daniel-da-Silva, A.L. (2020) *Environ. Chem. Lett.*, 18 (1), 151–164.
- [4] Soares, S.F., Pereira, B., Santos, J., Trindade, T., Barreto, Â., Maria, V.L., and Daniel-da-Silva, A.L. (2025) *Sep. Purif. Technol.*, 378, 134636.

O.41: Sustainable Cyanine J-Aggregate/Silica Hybrids for Nanophotonics

Paula Sanmartín-Rodríguez¹, Sara Núñez-Sánchez², Isabel Pastoriza-Santos¹

¹ CINBIO-Universidade de Vigo, Campus Universitario Lagoas – Estrada Marcosende, Vigo, Spain

² Instituto de Ciencia de Materiales de Madrid (ICMM) – CSIC, Campus de Cantoblanco, Madrid, Spain

Sustainable photonic technologies require the development of new materials that can mimic the properties of critical traditional raw materials such as metals and semiconductors. Some organic dyes, such as cyanines, have shown an excellent potential for use in photonic materials as they can provide organic platforms with high refractive index values similar to semiconductors^{1,2}, or negative values of permittivity like metals³. These properties arise from the formation of supramolecular structures, which are assembled in a specific and highly ordered manner. In this work, we focus on supramolecular structures with a J-type conformation for being the best candidates to achieve the interesting photonic properties described above.

However, supramolecular materials are challenging to control in terms of conformation to obtain the desired photonic properties. In this work, we use colloidal particles as templates to deposit cyanine dyes, controlling their conformation as J-aggregates at the surface of the particle. Silica (SiO₂) was selected as the template material due to its abundance, low environmental impact, and biocompatibility, making it an attractive option for sustainable photonic applications. The strategy is to combine colloidal scattering based on SiO₂ particles with J-aggregates of cyanine dyes. SiO₂ particles enable the manipulation of light at the nanoscale through efficient low-loss electric and magnetic modes. To enhance and modulate their optical properties, the surfaces of these particles have been functionalized with different J-aggregate cyanine dyes, integrating the absorption and emission characteristics of these organic compounds in hybrid structures.⁴

We employed electrostatic self-assembly via the layer-by-layer (LbL) method to sequentially deposit cyanine J-aggregates and polyelectrolytes of opposite charge onto SiO₂ particles (Fig. 1). The effect of the particle size, as well as the nature of the cyanines in the final properties of the hybrid materials has been investigated. This hybrid strategy leverages the synergy between the inherent properties of SiO₂ particles and the photophysical reactivity of cyanines, opening new avenues in the design of active photonic devices, sensors, and energy transfer systems.

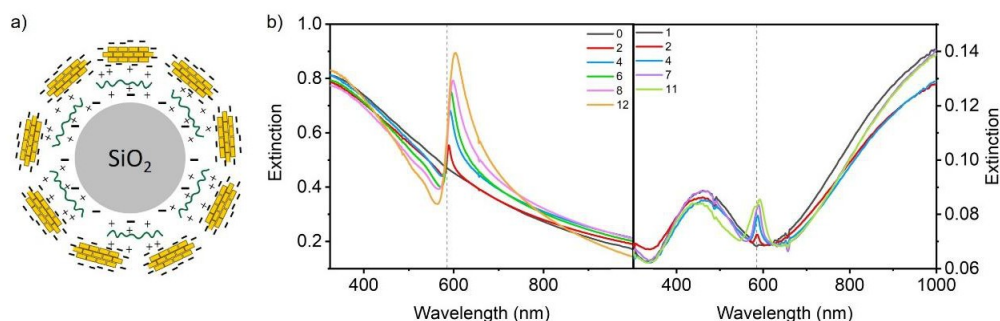


Figure 1: (a) Schematic representation of the building blocks. (b) Extinction spectra of 2 (left) and 8 (right) μm SiO₂ particles functionalized with different amounts of PDDA-TDBC.

Acknowledgements We thank the financial support from project 101129661 – Adaptable bio-inspired polariton-polariton energy management (ADAPTATION) funded by European Union, European Innovation Council and SMEs Executive Agency (EISMEA).

References

1. Yasir, M. et al. (2021). Enhancing the Refractive Index of Polymers with a Plant-Based Pigment. *Small*. <https://doi.org/10.1002/smll.202103061>.
2. Castillo, M.A. et al. (2022). Enhanced Light Absorption in All-Polymer Biomimetic Photonic Structures by Near-Zero-Index Organic Matter. *Advanced Functional Materials*. <https://doi.org/10.1002/adfm.202113039>.
3. Holder, S.T. et al. (2023). Bio-inspired building blocks for all-organic metamaterials from visible to near-infrared. *Nanophotonics*. <https://doi.org/10.1515/nanoph-2022-0690>.
4. Sugimoto, H. and Fujii, M. (2021). Colloidal Mie Resonators for All-Dielectric Metaoptics. *Advanced Photonics Research*. <https://doi.org/10.1002/adpr.202000111>.

O.42: From Colloidal Core@Shell nanostructures to Tailored Oxide Nanocrystals: Pulsed Laser-Driven Transformations of Metal@CeO₂

M. T. Candela, S. Triviño-Sánchez, G. González-Rubio

Departamento de Química Física, Universidad Complutense de Madrid, Avenida Complutense s/n, Madrid 28040, Spain

Metal nanocrystals (NCs) exhibit well-defined optical and structural properties, making them attractive not only for a wide range of technological applications but also as valuable building blocks for designing hybrid nanomaterials. In particular, metal-oxide core@shell architectures provide a versatile platform in which the metal core can serve as a structural template, while the oxide shell provides chemical stability and allows functional tunability¹. Furthermore, these systems enable control over morphology and composition, and they may also serve as precursors for the generation of oxide nanostructures through selective core removal or post-synthetic processing.

Colloidal synthesis allows tuning the composition, morphology, and shell thickness of these hybrid nanostructures. When exposed to pulsed-laser irradiation, colloidal NCs can undergo highly localized heating, leading to modifications in their shape, elemental distribution and crystallinity. Existing studies on metallic core@shell nanorods have demonstrated that laser parameters such as fluence and pulse duration can drive diverse transformation pathways^{2,3}, highlighting the potential of pulsed laser-assisted approaches as a complementary tool to conventional wet-chemical synthesis methods.

In this work, we prepare colloidal metal@CeO₂ core@shell NCs and subsequently remove the metallic cores through chemical etching to obtain hollow ceria architectures. The resulting oxide nanostructures are then subjected to nanosecond pulsed-laser irradiation to investigate their structural evolution and the conditions under which morphological reconfiguration may occur. Changes in morphology, composition or crystallinity will be examined using techniques such as transmission electron microscopy, diffraction and optical spectroscopy. This study aims to elucidate how template-derived cerium oxide nanostructures respond to pulsed laser excitation and to assess the potential of pulsed laser-based processing for tailoring the structure and properties of colloidal nanomaterials.

Acknowledgements

This work has been supported by the ERC Starting Grant Time4Nano (101164205).

References

1. P. C. D. Mendes et al., "Opportunities in the design of metal@oxide core-shell nanoparticles", *Adv. Phys. X* 2023, 8, 2175623.
2. G. González-Rubio et al., "Controlled Alloying of Au@Ag Core-Shell Nanorods Induced by Femtosecond Laser Irradiation", *Adv. Optical Mater.* 2021, 9, 2002134.
3. S. Triviño-Sánchez et al., "Colloidal gold-palladium-platinum alloy nanospheres with tunable compositions and defined numbers of atoms", *Nanoscale* 2025, 17, 8577-858.

O.43: High Size-controlled Synthesis of TAMOF

Sara Rodríguez-Da-Silva¹, Vanesa Lillo², Jose Ramón Galán-Mascarós², Isabel Pastoriza-Santos¹, Jorge Pérez-Juste¹

¹ CINBIO, Universidade de Vigo, Dpto. de Química Física, As Lagoas, Marcosende, 36310 Vigo, Spain.

² Institute of Chemical Research of Catalonia (ICIQ-CERCA) and the Barcelona Institute of Science and Technology (BIST), 43007 Tarragona, Spain.

The metal-organic frameworks (MOFs) have emerged as highly versatile crystalline materials, offering exceptional porosity, high target affinity, and molecular sieving capabilities, which make them attractive for a wide range of applications.¹ Among them, chiral MOFs are gaining increasing attention for their great potential in enantioselective catalysis, target separation, and sensing. However, achieving uniform chiral MOF crystals with controlled size and shape remains a major synthetic challenge.

MOFs have demonstrated high efficiency in selective separation of gases, hydrocarbons, or aromatic compounds. Engineering chirality into these frameworks is a powerful strategy for developing next-generation chiral stationary phases (CSPs) capable of discriminating between enantiomeric molecules.² Recently, Galán-Mascarós et al.³ reported the synthesis of a chiral MOF, TAMOF-1, consisting of Cu²⁺ metal ions forming hexacoordinate complexes with the (S)-3-(1H-imidazol-5-yl)-2-(4H-1,2,4-triazol-4-yl) propanoic acid (S-HTA). While TAMOF-1 was successfully incorporated into high-performance liquid chromatography (HPLC) columns for the enantiomeric resolution of organic molecules, current synthetic protocols lack size control, typically yielding non-uniform particles of approximately 40 µm. Given that particle size and distribution are critical parameters governing the efficiency, mass transfer, and resolution of HPLC, optimizing these morphological features is essential. In this study, we report the synthesis of uniform TAMOF with excellent size-control across a range from 10 µm down to 800 nm (Figure 1). The synthesis is based on a room-temperature precipitation strategy that enables controlled nucleation and crystal growth, yielding uniform and homogeneous particles. By modulating synthesis parameters such as reaction time and stirring conditions, we demonstrate precise control over particle size. Interestingly, we have found that TAMOF has interesting size-dependent optical properties in the UV-visible-NIR range. Moreover, we demonstrate that particle size and uniformity has a clear impact on chromatographic performance, our monodisperse materials delivered the highest HPLC resolution compared to traditional bulk samples.

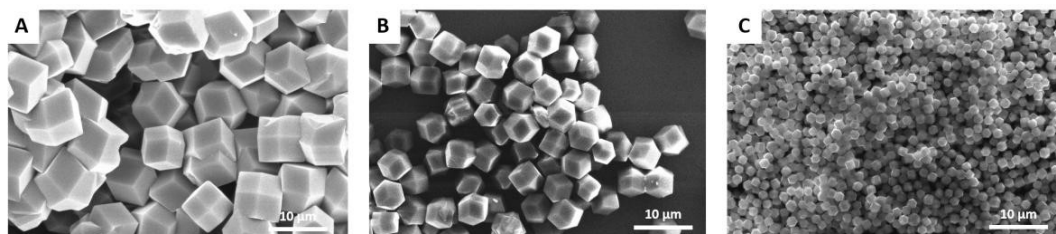


Figure 1: Scanning electron microscopy (SEM) images of TAMOF particles with different sizes A) 10 µm B) 5 µm and C) 1.5 µm.

Acknowledgements

This work was supported by the project PID2022-138724NB-I00, under the aid program for "Knowledge Generation Projects", within the framework of the State Plan for Scientific, Technical and Innovation Research 2021-2023.

References

1. G. Zheng et. al. "Plasmonic metal-organic frameworks" *SmartMat*, 2021, 2, 446.
2. N. Senkuttuvan et al. "The significance of chirality in contemporary drug discovery-a mini review," *Royal Society of Chemistry*, 2024.
3. M. N. Corella-Ochoa et al., "Homochiral Metal-Organic Frameworks for Enantioselective Separations in Liquid Chromatography," *J. Am. Chem. Soc.*, 2019 141, 36, 14306–14316,

O.44: Degradable switchable surfactants as alternatives to CTAB in single-crystal gold nanorod synthesis

Pau Vilches Rueda¹, Mónica Andrea Paz Insua², Jesús Mosquera², Leonardo Scarabelli¹

¹ Universidad de Cantabria, Avenida de los Castros s/n (39005), Santander, Spain

² Universidade da Coruña, As Carballleiras s/n (15071), A Coruña, Spain

Surfactants play a key role in nanoparticle synthesis, providing stabilization and inducing specific morphologies. However, the presence of surfactants on the surface of the grown particles hinders further surface modification and generates undesired side effects such as cytotoxicity and reduced catalytic activity. To overcome these limitations, we propose the use of switchable surfactants, where the amphiphilic character can be modulated in response to an external stimulus, enabling their quantitative removal from the synthesized nanoparticles.

In this work, we explore the use of two synthetic switchable surfactants, MAPI-11 and MV2, substituting CTAB in single crystal gold nanorods (scAuNR) synthesis. Thanks to the ester moiety inserted within the aliphatic chain, a simple base-catalyzed hydrolysis cleaves the molecule into an inactive water-soluble zwitterionic compound, and an insoluble aliphatic tail, leaving a surfactant-free nanoparticle surface. ScAuNRs were fabricated using a seed-mediated synthesis¹ involving exclusively switchable surfactants. The obtained scAuNRs have a length of 35 ± 6 nm and a width of 14 ± 2 nm with a shape yield $> 80\%$. Unlike CTAB, MV2 remains soluble below 15°C , offering an additional degree of control in particle growth, which could lead to new synthetic routes for other morphologies. Currently, we are focusing on optimizing the scAuNR synthesis, adapting other state-of-the-art processes to switchable surfactants.²

Overall, MAPI-11 and MV2 successfully replicate the role of CTAB in the fabrication of scAuNRs while enabling complete surfactant removal *via* a base-catalyzed hydrolysis. Our results introduce switchable surfactants as an interesting alternative to conventional stabilizers, opening new avenues for applications in photothermal therapy, biosensing, and photocatalysis.

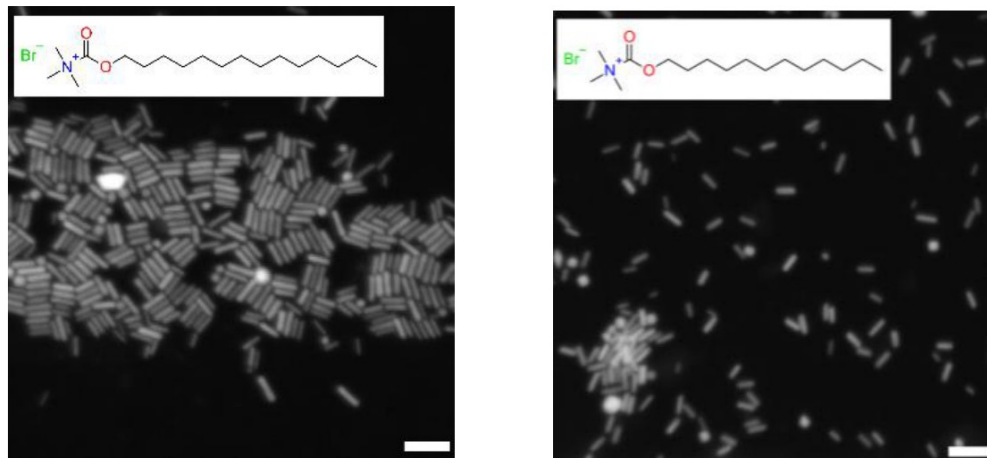


Figure 1: STEM images of scAuNRs synthesized with MV2 seeds and with MAPI (left) and MV2 (right) during its growth, with their molecular representation. Scale bar is 100nm

Acknowledgements This work is supported by the European Research Council Starting Grant NANOGROWDIRECT (101115164) and the Spanish Ministerio de Ciencia e Innovación y Universidades Ramón y Cajal fellowships RYC2022-037894-I, RYC2019-027842-I, RYC2020-030183-I, and FPU fellowship n°:02722.

References

- (1) Scarabelli, L.; Sánchez-Iglesias, A.; Pérez-Juste, J.; Liz-Marzán, L. M. A "Tips and Tricks" Practical Guide to the Synthesis of Gold Nanorods. *J. Phys. Chem. Lett.* 2015, 6 (21), 4270–4279. <https://doi.org/10.1021/acs.jpclett.5b02123>.
- (2) González-Rubio, G.; Kumar, V.; Llombart, P.; Díaz-Núñez, P.; Bladt, E.; Altantzis, T.; Bals, S.; Peña-Rodríguez, O.; Noya, E. G.; MacDowell, L. G.; Guerrero-Martínez, A.; Liz-Marzán, L. M. Disconnecting Symmetry Breaking from Seeded Growth for the Reproducible Synthesis of High Quality Gold Nanorods. *ACS Nano* 2019, 13 (4), 4424–4435. <https://doi.org/10.1021/acs.nano.8b09658>

O.45: Polymer-Encapsulated NIR-Emitting Gold Nanoclusters

B. Casteleiro¹, B. Vale¹, J.M.G. Martinho¹, M.-T. Charreyre², A. Favier², J. P. S. Farinha¹

¹ Centro de Química Estrutural, Institute of Molecular Sciences and Department of Chemical Engineering, Instituto Superior Técnico, University of Lisbon, 1049-001 Lisbon, Portugal

² Université Lyon 1, INSA de Lyon, Laboratoire Ingénierie des Matériaux Polymères, UMR5223, F-69621 Villeurbanne, France

Gold nanoclusters (AuNCs) are ultrasmall nanostructures composed of a few gold atoms, with dimensions below ca. 2 nm. Their unique properties, including size-dependent luminescence, high photostability, large Stokes shifts, long photoluminescence lifetimes, and biocompatibility, make them highly promising for applications across diverse fields, particularly as labels for advanced optical bioimaging. However, key challenges remain, including limited colloidal stability, difficult surface functionalization, and low brightness.

We address these limitations by encapsulating individual AuNCs within polymer nanostructures.¹ This strategy enhances colloidal stability through steric stabilization, provides a versatile platform for functionalization, and significantly improves brightness,^{2, 3} while preserving the intrinsic optical properties of the AuNCs, notably near-infrared (NIR) emission for improved tissue penetration.^{4,5} In particular, “hairy” AuNCs were synthesized directly in aqueous media using thiol-terminated poly(N-acryloyl morpholine) (PNAM-SH), a water-soluble and biocompatible polymer prepared via RAFT polymerization. Compared to conventional AuNCs, these polymer-grafted clusters exhibit markedly improved colloidal stability (stable for months), increased photoluminescence lifetimes, and significantly enhanced NIR quantum yields under both one- and two-photon excitation.⁶ Furthermore, their properties can be systematically tuned by varying the polymer molecular weight and by introducing multiple functional side groups bearing permanent positive or negative charges.⁷

These polymer-encapsulated AuNCs constitute a robust and versatile platform for the development of bright and stable bioimaging probes, without organic dyes.

Acknowledgements This work was supported by Fundação para a Ciência e a Tecnologia (FCT-Portugal) and COMPETE (FEDER) within projects UID/00100/2025 (DOI:10.54499/UID/00100/2025), UID/PRR/00100/2025 (DOI:10.54499/UID/PRR/00100/2025), and LA/P/0056/2020 (DOI:10.54499/LA/P/0056/2020).

References

1. Casteleiro, B.; Martinho, J.M.G.*; Farinha, J.P.S.*, Encapsulation of Gold Nanoclusters: Stabilization and More, *Nanoscale* 2021, 13, 17199
2. Casteleiro, B.; Martinho, J.M.G.*; Farinha, J.P.S.*, Interaction between Gold Nanoclusters and Gold Nanoparticles encapsulated in Polymer Nanoparticles, *Colloid and Interface Science Communications* 2023, 52, 100694
3. Casteleiro, B.; Ribeiro, T.; Mariz, I.; Martinho, J.M.G.*; Farinha, J.P.S.*, Encapsulation of gold nanoclusters by photo-initiated miniemulsion polymerization, *Colloids and Surfaces A: Physicochemical and Engineering Aspects* 2022, 648, 129410
4. Casteleiro, B.; Francesco, T.; Martinho, J.M.G.; Favier, A.; Charreyre, M.-T., Moffitt, M.G.; Farinha, J.P.S.*, NIR-emitting Gold Nanoclusters Encapsulated in PS-b-PEG Polymer Micelles, *Langmuir* 2024, 40, 1594
5. Casteleiro, B.; Alcouffe, P.; Pinto, S.N.; Degrouard, J.; Crépet, A.; Martinho, J.M.G.; Charreyre, M.-T., Farinha, J.P.S.*, Favier, A.*, NIR-emitting Gold Nanoclusters Encapsulated in Photo-RAFT-PISA Polymer Nanoparticles for Bioimaging, *ACS Appl. Nano Mater.* 2025, 8, 24285
6. Casteleiro, B.; Cruz-Boisson, F.; Alcouffe, P.; Pinto, S.N.; Martinho, J.M.G.; Charreyre, M.-T., Farinha, J.P.S.*, Favier, A.*, Near-Infrared-Luminescent Gold Nanoclusters Stabilized by End-Grafted Biocompatible Polymer Chains for Bioimaging, *ACS Appl. Nano Mater.* 2023, 6, 11689
7. Casteleiro, B.; Alcouffe, P.; Cruz, F.; Crépet, A.; Martinho, J.M.G.; Charreyre, M.-T., Farinha, J.P.S.*, Favier, A.*, Chain-End Grafting of RAFT Polyelectrolyte Macroligands to Stabilize Near-Infrared-Emitting Gold Nanoclusters, *Macromolecular Rapid Communications* 2026, accepted

O.46: Gelatin Nanoparticles as Dual Carriers of SPIONs and Temozolomide for Glioblastoma Treatment

B. Velasco-Rodríguez^{1,2}, P. García-Acevedo^{2,4}, M. Bañobre-López², B. Pelaz¹, R. Iglesias Rey⁴, S. Barbosa³

¹ Centro Singular de Investigación en Química Biolóxica e Materiais Moleculares (CiQUS), Departamento de Química Inorgánica, Universidade de Santiago de Compostela, 15782 Santiago de Compostela, Spain.

² Advanced (Magnetic) Theranostic Nanostructures Lab, International Iberian Nanotechnology Laboratory, 4715-330 Braga, Portugal.

³ Colloids and Polymers Physics Group, Particle Physics Department and Institute of Materials (IMATUS); Universidade de Santiago de Compostela, 15782 Santiago de Compostela, Spain.

⁴ Neuroimaging and Biotechnology Laboratory (NOBEL), Clinical Neurosciences Research Laboratory (LINC), Health Research Institute of Santiago de Compostela (IDIS), Santiago de Compostela, Spain.

Glioblastoma multiforme (GBM) is the most aggressive and malignant form of primary brain tumor, being classified as a grade IV neoplasm according to the World Health Organization (WHO)¹. Its current care treatment is removal of the tumor by surgery, followed by radiotherapy and chemotherapy with the temozolomide (TMZ) drug. However, this procedure involves harming healthy brain tissue due to the irregular and invasive growth pattern of the tumor². In this sense, multifunctional nanocarriers, such as those for detection and targeted drug delivery, have emerged as a promising approach to improving treatment outcomes and, thus, patient quality of life. In this context, this study aims to characterize and evaluate gelatin nanoparticles (GNPs) loading superparamagnetic iron oxide nanoparticles (SPIONs) and t TMZ. Gelatin is a protein derived from collagen and has excellent properties, such as biodegradability, biocompatibility, and the ability to cross the blood-brain barrier (BBB), making agent delivery as SPIONs and TMZ more efficient for glioblastoma therapy³. On the other hand, SPIONs have been widely used as contrast agents in magnetic resonance imaging (MRI) for tumor detection, as well as in hyperthermia-based treatment when an external magnetic field is applied⁴. At the same time, TMZ is one of the most potent and effective alkylating drugs for treating glioblastoma multiforme as a second-line therapy⁵.

Based on the above, the proposed GNPs nanocarrier represents a promising alternative for more effective and targeted glioblastoma therapy. Accordingly, its physicochemical and magnetic properties were characterized by dynamic light scattering (DLS), scanning transmission electron microscopy (STEM), MRI, and hyperthermia assays. Moreover, the therapeutic potential of this nanosystem was evaluated through both *in vitro* and *in vivo* studies.

Acknowledgements The authors thank financial support from grant PID2022-142682OB-I00 funded by MICIU/AEI/10.13039/501100011033 and by the European Union NextGenerationEU/PRTR. The authors also thank support from grants PID2023-152062OA-I00 funded by MICIU/AEI/10.13039/501100011033 and ED431F2025/14 funded by Xunta de Galicia. B V-R thanks Xunta de Galicia for the fellowship ED481B-2023-065.

References

1. Wen, P. Y. & Reardon, D. A. *Nat. Rev. Neurol.* 12, (2016).
2. Thakkar, J. P. et al. *Cancer Epidemiology Biomarkers and Prevention* 23, 1985–1996 (2014).
3. Yasmin, R., Shah, M., Khan, S. A. & Ali, R. *Nanotechnol. Rev.* 6, 191–207 (2017).
4. Senturk, F., Cakmak, S., Gumusderelioglu, M. & Ozturk, G. G. *J. Drug Deliv. Sci. Technol.* 68, 103101 (2022).
5. Jatyan, R. et al. *Journal of Controlled Release* 350, 494–513 (2022).

O.48: Application of computational methods in the development of chitosan-based materials for removing antibiotics from water

J. M. C. Marques, J. F. M. Sousa, A. J. M. Valente, P. E. Abreu

CQC-IMS, Department of Chemistry, University of Coimbra, Coimbra, Portugal

Antibiotics are essential pharmaceuticals for treating bacterial infections, but their overuse has caused water bodies contamination. This contributes to the emergence of antibiotic-resistant bacteria, which is probably one of the most relevant threats to public health nowadays. Among a panoply of methodologies available for removing antibiotics from water, adsorption stands out because it is simple, efficient and cost-effective¹. Thus, pollution issues have been mitigated by the development of adsorbing materials, which can also be tailored with specific properties to remove antibiotics from aquatic media. In this work, we show how molecular-based insight acquired by computational methods can be applied to guide the development of new adsorbing materials based on chitosan, which is an abundant and biodegradable polysaccharide extracted from fishery waste. Specifically, we employed electronic structure calculations based on density functional theory (DFT) and molecular dynamics (MD) simulations to investigate chitosan-derivative molecules that may constitute the basis for the synthesis of effective antibiotic-adsorbing materials. The computational approach aids to identify the adsorption mechanism and the main interactions that control the process. First, the methodology was applied to discover promising adsorbents for tetracycline in its zwitterionic form². Then, we have also investigated the adsorption of ciprofloxacin, levofloxacin and cephalexin on chitosan functionalized with different substituents. The ability of the materials to adsorb those antibiotics in different protonated states, which allows to assess the effect of pH, was evaluated and will be presented in this communication.

Acknowledgements We thank the support from the Coimbra Chemistry Centre (CQC-IMS), which is financed by the Portuguese “Fundação para a Ciência e Tecnologia” (FCT) through the Projects UIDB/00313/2025 and UIDP/00313/2025. The authors are also grateful for the provision of computational time in the supercomputer resources hosted at Laboratório de Computação Avançada (2023.10661.CPCA.A1, DOI10.54499/2023.10661.CPCA.A1) which was financed by FCT. J.F.M.S. thanks to the FCT (Portugal) the PhD Grant UI/BD/150803/2020.

References

1. Sousa JFM., Murtinho D, Valente AJM, Marques JMC. The role of chitosan-based materials in interactions with antibiotics: an overview of in vitro and in silico studies. *Int J Mol Sci* 2025; 26:11070.
2. Sousa JFM., Murtinho D, Valente AJM, Marques JMC. On the mechanism of interactions between tetracycline and new chitosan-based materials: experimental development guided by computational methods. *J Polym Sci* 2025; 63:3137-3150.

O.49: Thermo-responsive behaviour of polymer nanogel composites: Insights from computer simulations

A. Martín-Molina^{1,2}, M. M. del M. Ramos-Tejada³, M. Quesada Pérez³

¹ Dpto. de Física Aplicada, Universidad de Granada, Campus de Fuentenueva s/n, 18071 Granada (Spain)

² Instituto Carlos I de Física Teórica y Computacional, Universidad de Granada, 18071 Granada (Spain)

³ Dpto. de Física, Escuela Politécnica Superior de Linares, Universidad de Jaén (Spain)

Polymer nanogel composites (PNCs) are advanced hybrid materials that incorporate nanoparticles within a polymer matrix to achieve superior performance. For instance, PNCs can greatly enhance a wide range of industrial applications, including coatings, paints, electronics, food packaging, and personal care products¹. In some cases, the polymer matrix consists of cross-linked polymer chains that form soft colloidal particles termed nanogels. Interest in nanogels has grown rapidly over the past decades because they can undergo volume phase transitions triggered by external stimuli such as temperature, pH, or electromagnetic radiation. As a result, nanogels are employed in novel technological applications including controlled drug delivery, optoelectronic switches, and artificial muscles. In fact, these hybrid systems have already demonstrated utility as contrast agents for bioimaging and in controlled antibacterial assays².

Under this scenario, coarse-grained computer simulations have proven to be a powerful tool for characterising both nanogels and the PNCs derived from them. Accordingly, the objective of the present work is to simulate thermo-responsive nanogels as vehicles for thermally-triggered drug delivery. In particular, we investigate the conditions under which nanoparticles encapsulated within a nanogel are expelled as the polymeric network shrinks in response to a temperature change. To this end, the effects of polymer charge and nanoparticle size are systematically analysed. Finally, the simulation results are compared with the predictions of a Poisson-Boltzmann cell model³.

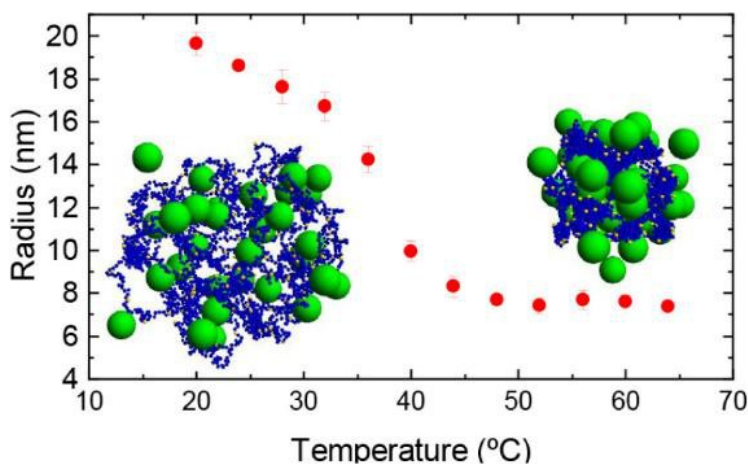


Figure 1: Snapshots of thermoresponsive nanogel composites

Acknowledgements We thank Ministerio de Ciencia e Innovación (PID2023-149387OB-I00) and Consejería de Universidad, Investigación e Innovación and ERDF Andalusia Program 2021-2027 (Grant C-EXP-187-UGR23) for providing financial support.

References

- [1] A. Escañuela-Copado, D. Valero-Carrasco, G Giunta, A. Martín-Molina and A. Patti. Computer Simulation of Polymer Nanocomposites: Challenges and Perspectives. *Fluid Phase Equilibria* (in revision).
- [2] Y. Xiao, K. Pandey, A. Nicolás-Boluda, D. Onidas, P. Nizard, F. Carn, T. Lucas, J. Gateau, A. Martín-Molina, M. Quesada-Pérez, M. del M. Ramos-Tejada, F. Gazeau, Y. Luo and C. Mangeney, *ACS Appl. Mater. Interfaces*, 2022, 14, 54439–54457.
- [3] M. del M. Ramos-Tejada, A. Martín-Molina, D. Montesinos, L. Pérez-Mas and M. Quesada-Pérez, *Macromolecules*, 2026, 59, 2360–2370.

O.50: Chiral Plasmonic Metasurfaces Coupled to Perovskites for Efficient CPL Generation

Leyre Currás¹, Carlos Fernández-Lodeiro¹, Xiaoyu Qi², Luis Alberto Pérez², Agustín Mihi², Subarna Samantha¹, Lakshminarayana Polavarapu¹, Sergio Gómez-Graña¹

¹ CINBIO, Universidade de Vigo, Campus Universitario As Lagoas, Marcosende, 36310 Vigo, Spain

² Institute of Materials Science of Barcelona, ICMA – CSIC, 08193 Bellaterra (Barcelona), Spain

Chiral nanocrystals are rapidly emerging as versatile platforms for spin-dependent optical and optoelectronic phenomena. In parallel, intrinsically chiral plasmonic nanoparticles have gained significant attention in recent years as highly promising building blocks for applications in sensing, optoelectronics, and nanophotonics. Enhancing circularly polarized luminescence (CPL) through plasmonic coupling is a central goal in chiral photonics and optoelectronics¹.

Here, we demonstrate a perovskite–plasmonic hybrid platform that enables strong CPL amplification via near-field chiral interactions. CsPbBr₃-based perovskite thin films were deposited by spin coating onto chiral plasmonic substrates, including gold nanostructures and nanoimprinted metasurfaces. The circular dichroism (CD) response of the substrates was used to guide anion exchange with PbI₂, enabling spectral matching between the perovskite emission and the chiral plasmonic modes. Under optical excitation, the hybrid system exhibited clear circularly polarized photoluminescence, with a dissymmetry factor g_{lum} on the order of 0.01. To further enhance the chiral optical response, we engineered more complex chiral plasmonic architectures and integrated the perovskite semiconductor onto these platforms. This structural optimization resulted in an increase of approximately one order of magnitude in the photoluminescence dissymmetry factor. Silver metasurfaces achieve g_{lum} values up to 0.1, demonstrating efficient near-field transfer of optical chirality and highlighting the role of plasmonic mode matching in CPL amplification. Taken together, these results demonstrate that hybrid plasmon–perovskite architectures constitute a powerful and tunable strategy for engineering spin-selective optical responses. This approach establishes clear design principles for the development of efficient circularly polarized light sources, polarization-selective photonic components, and next-generation chiral optoelectronic devices.

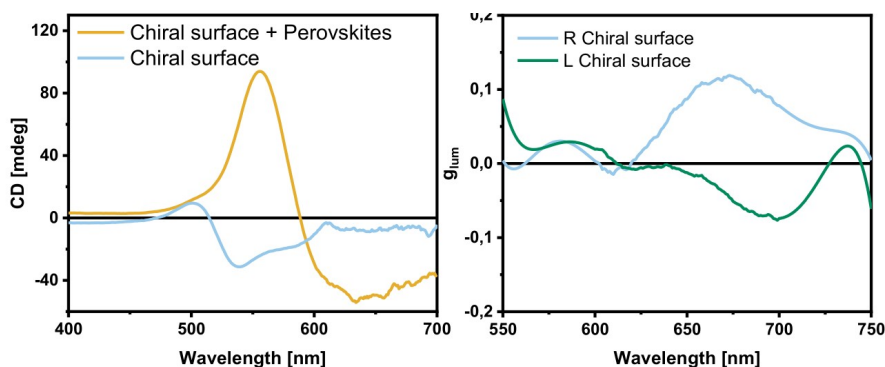


Figure 1: (a) CD spectra of chiral gold substrates, measured before and after deposition of a CsPbBr₃-based perovskite thin film by spin coating, with an emission wavelength centered at 540 nm. (b) G-Lum spectra of chiral silver metasurfaces coated with a Al₂O₃ layer deposited by atomic layer deposition, measured after spin-coating deposition of a CsPbBr₃-based perovskite thin film with an emission wavelength centered at 658 nm.

Acknowledgements

References

1 Fiuza-Maneiro et al. (2024). Inducing Efficient and Multiwavelength Circularly Polarized Emission From Perovskite Nanocrystals Using Chiral Metasurfaces. *Advanced Materials*, 36(52). <https://doi.org/10.1002/adma.202413967>

O.51: Lipid/hybrid biomimetic nanoparticles for gene therapy: a lab-on-a-chip strategy

Alejandro Ogando^{1,2}, Carolina Santos^{3,4,5}, Adriana Cambón^{1,2}, Silvia Barbosa^{1,2}, Susana Simões^{3,4,5}, Pablo Taboada^{1,2}

¹ Grupo de Física de Coloides y Polímeros, Universidade de Santiago de Compostela, Santiago de Compostela, España

² Instituto de Materiales (iMATUS), Universidade de Santiago de Compostela, Santiago de Compostela, España

³ Faculty of Medicine, University of Coimbra, Coimbra, Portugal

⁴ CIBB – Center for Innovative Biomedicine and Biotechnology, University of Coimbra, Coimbra, Portugal

⁵ CNC – Center for Neuroscience and Cell Biology, University of Coimbra, Coimbra, Portugal

Highly monodisperse and reproducible nanoplateforms are a common objective in biomedical research for industrial translation. Traditional methodologies lack precise control on size and monodispersity, due to environmental factors that cannot be fully controlled. Microfluidic devices offer an alternative based on good manufacturing practices with better batch to batch reproducibility than bulk methodologies¹. Optimized sizes, encapsulation of cargos and efficient coating can be achieved by controlling flow rates at the different stages of the lab-o-a-chip device².

Water core poly(lactic-co-glycolic) nanoshells doped with DOTAP were synthesized employing a custom-made PDMS microfluidic device (Figure 1a) and coated with cell membranes. In parallel, lipid nanoparticles composed by an ionizable lipid, a helper lipid, cholesterol and a PEGylated lipid, as commercially available formulations (Onpattro, COVID-19 vaccines...) were also produced. Flow rates optimization was carried to obtain suitable sizes and stable nanosystems (Figure 1b). Also, cell membrane coating was efficiently performed obtaining the complete biomimetic nanoplateform. As a proof of concept, mRNAs encoding Cas9 protein and a single guide to knock out green fluorescent protein expressed by eGFP-HeLa cells were encapsulated, achieving *in vitro* efficiencies up to 60% with increased therapeutic effect of biomimetic carriers compared to standard ones.

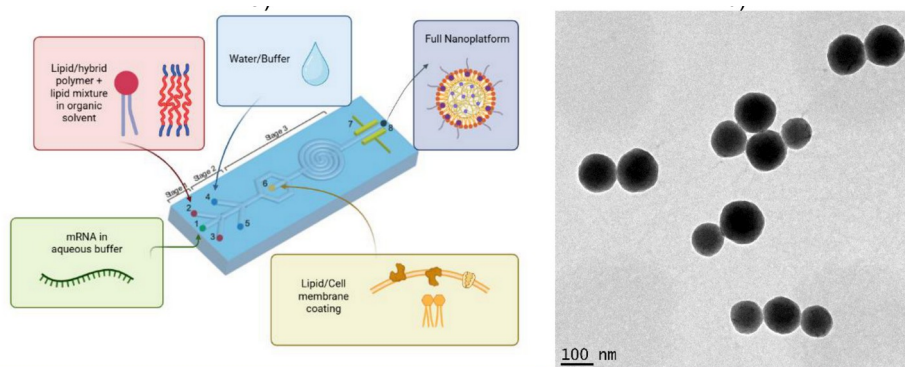


Figure 1: a) Lab-on-a-chip synthesis scheme and b) TEM micrographs of produced nanoparticles.

Acknowledgements The authors thank financial support from grant PID2022-142682OB-I00 funded by MICIU/AEI/10.13039/501100011033 and by the European Union NextGenerationEU/PRTR. A.O. thanks the funded grant for his FPI fellowship. The authors also thank support from grants PID2023-152062OA-I00 funded by MICIU/AEI/10.13039/501100011033 and ED431F2025/14 funded by Xunta de Galicia.

References

- [1] R. Molinaro, M. Evangelopoulos, J. R. Hoffman et al. (2018), *Advance Materials* 30, 1702749-1702758. doi: 10.1002/adma.201702749
- [2] Y. Bao, M. Maeki, A. Ishida et al. (2022), *ACS Omega* 7, 33079-33086. doi: 10.1021/acsomega.2c03137
- [3] C. A. Brimacombe, J. A. Kulkarni, M. H. Y. Cheng et al. (2025), *Molecular Therapy Methods & Clinical Development* 33, 101518-101531. doi: 10.1016/j.omtm.2025.101518

O.52: Laser Speckle Analysis to monitor structure formation in evaporating colloidal droplets

Guillermo Lorite-Méndez, Schon Fusco, Miguel Ángel Rodríguez-Valverde, María Tirado-Miranda

Department of Applied Physics, Universidad de Granada, Campus Fuentenueva S/N, 18071 Granada, Spain.

While colloidal droplet evaporation is central to coating and printing technologies, monitoring particles self-organization in concentrated regimes remains a significant challenge. During this process, particles self-organize into structures whose morphology depends on concentration, interactions with the contact line, and capillary forces. However, the microscopic events leading to the formation of these structures remain difficult to characterize in the concentrated regime. In recent years, several optical techniques, such as Particle Image Velocimetry (PIV), have been applied to better understand the dynamics driving structure formation. Nevertheless, these techniques are limited by particle concentration, only allowing observation in dilute regions where single light scattering is ensured.

To achieve a deeper understanding of this phenomenon, we employ Laser Speckle Analysis (LSA) as a non-invasive technique that enables real-time, spatially resolved monitoring of collective nanoparticle dynamics during droplet evaporation. The analysis of the LSA decorrelation function allowed us to determine the gelation and crystallization points during evaporation (Fig. 1a)—transitions that are inaccessible in opaque, highly concentrated regimes—while also enabling the observation of spatial variations in droplet dynamics, revealing spatial heterogeneities in the arrest dynamics (Fig. 1b).

These results demonstrate that LSA extends dynamic light scattering methods into the opaque, highly concentrated regime, paving the way for industrially relevant applications, such as biopolymer and cementitious droplets, where high substrate concentrations limit the feasibility of other techniques.

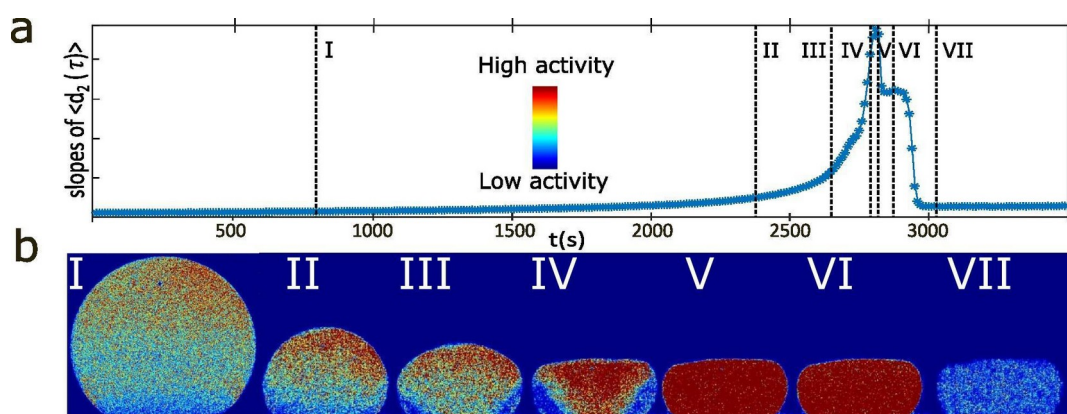


Figure 1: Evaporation dynamics and nanoparticle reorganization. (a) Time evolution of the normalized slopes of the decorrelation functions (b) Speckle images showing the spatial distribution of NP activity at the corresponding time points (I–VII). Warmer colors indicate higher activity, with red representing the maximum activity and blue the minimum.

Acknowledgements We thank PID2023-147135OB.I00, supported by MICIU/AEI/10.13039/501100011033 and by “FEDER, EU for the funding of this project.

References

[1] van der Kooij, H.M., Fokkink, R., van der Gucht, J., Sprakel, J. (2016). Quantitative imaging of heterogeneous dynamics in drying and aging paints. *Scientific Reports* 6: 34383. <https://doi.org/10.1038/srep34383>.

O.53: Annulated Indigo Dyes for Next-Generation Luminescent Solar Concentrators: From Excited-State Dynamics to Device Performance

Paulo D. Nunes Barradas¹, Ana Clara B. Rodrigues^{1,2}, João Pina¹, J. Sérgio Seixas de Melo¹

¹ CQC-IMS, Department of Chemistry, University of Coimbra, 3004-535 Coimbra, Portugal.

² European Molecular Biology Laboratory (EMBL), Heidelberg, Germany.

Solar photovoltaics (PV) are among the most important renewable-energy technologies; however, their efficiency is inherently limited by their spectral response, as only a fraction of the solar spectrum can be effectively harvested. Luminescent solar concentrators (LSCs) offer a promising strategy to address this limitation. These devices comprise a transparent waveguide, typically made of polymer or glass, containing highly emissive chromophores, either embedded within the matrix or deposited as a coating. The chromophores absorb incident sunlight and re-emit it at lower energy through a down-conversion process, enabling improved coupling with photovoltaic devices. Indigo is one of the most recognizable organic pigments, distinguished by its deep blue color and widespread occurrence in natural sources. However, its practical application in photonic devices is hindered by its low fluorescence quantum yield (Φ_F). In contrast, Bay-annulated indigo (BAI) derivatives overcome this limitation due to their rigid π -conjugated backbone, generated through double annulation of the indigo core. This structural modification has made BAI derivatives attractive for applications in organic electronics, singlet fission, fluorescent sensing, organic lasers, and as sustainable dopants in LSC devices.

Herein, four BAI derivatives and their single-annulated indigo (SBAI) counterparts were successfully synthesized and fully characterized. The BAI compounds exhibited high Φ_F values (~50–80%), whereas the SBAI derivatives showed moderate emission efficiencies (~20–40%). Comprehensive photophysical studies, including ultrafast transient absorption spectroscopy and femtosecond up-conversion fluorescence measurements, were carried out to elucidate the mechanisms responsible for these enhanced fluorescence properties. Due to the peripheral substitution with Ph-R, the BAI derivatives undergo fast conformational relaxation, whereas the SBAI derivatives also display an excited-state proton transfer (ESPT) process, leading to distinct spectral and photophysical characteristics. Lab-scale LSC devices ($3 \times 3 \times 0.5 \text{ cm}^3$) were fabricated using PMMA matrices doped with varying concentrations of BAI and SBAI compounds. These devices achieved maximum external efficiencies (η_{ext}) of nearly 6% and photovoltaic device efficiencies (η_{dev}) of 0.4%. Despite the lower Φ_F values of the SBAI derivatives, comparable performance to their BAI counterparts was obtained at higher dye loadings. These results demonstrate that, these materials are promising candidates as novel sustainable dyes for next-generation photovoltaic applications.

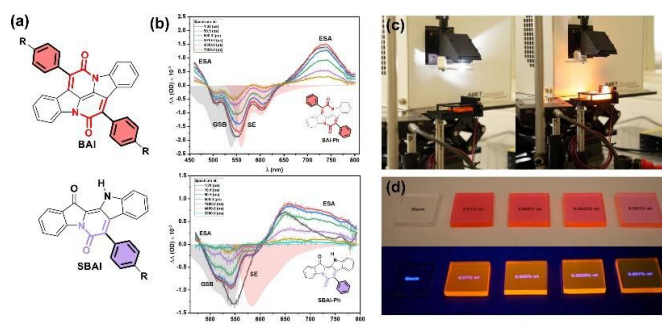


Fig. 1: (a) Generic structures of BAI and SBAI derivatives. (b) Transient absorption (TA) snapshots of BAI-Ph (top) and SBAI-Ph (bottom), with absorption and fluorescence spectra for comparison. (c) BAI-doped LSC under simulated solar light. (d) BAI-doped LSCs at different concentrations under normal and UV light.

Acknowledgements The Coimbra Chemistry Centre - IMS is funded by “Fundação para a Ciência e a Tecnologia” (FCT), through project CQC-IMS UIDB/00313/2025 (<https://doi.org/10.54499/UID/00313/2025>) and by the European Union - NextGenerationEU through PRR - UID/PRR/00313/2025 and UID/PRR2/00313/2025 DOI: <https://doi.org/10.54499/UID/PRR/00313/2025> and <https://doi.org/10.54499/UID/PRR2/00313/2025>) Institute of Molecular Sciences is funded by FCT through project LA/P/0056/2020 (DOI: <https://doi.org/10.54499/LA/P/0056/2020>). PDNB also acknowledges FCT for grant <https://doi.org/10.54499/2023.02479.BD>.

References

J. Seixas de Melo, R. Rondao, H. D. Burrows, M. J. Melo, S. Navaratnam, R. Edge, G. Voss, "Photophysics of an indigo derivative (keto and leuco structures) with singular properties", *J Phys Chem A* 2006, 110, 13653-13661. F. Meinardi, F. Bruni, S. Brovelli, "Luminescent solar concentrators for building-integrated photovoltaics", *Nature Reviews Materials* 2017, 2.

O.54: Colloidal Foundations as a Key Factor in the Shaping process of Composite materials incorporating CNF hydrogels

R. Montenegro¹, J.M. Luque¹, G. Estrella-Guisado¹, A. Rodríguez¹, Z. González¹

¹BioPrEn Group (RNM-940), Chemical Engineering Department, Instituto Químico para la Energía y el Medioambiente (IQUEMA), Faculty of Science, Universidad de Córdoba, Córdoba 14014, Spain.

Cellulose nanofibers (CNF), obtained from agricultural biomass through biorefinery processes, represent a sustainable and renewable platform for the development of composite hydrogels with advanced applications. In this context, the present work emphasizes the importance of understanding and controlling the colloidal foundation of CNF suspensions, considering that their fibrillar nature, high surface area, and surface charge strongly govern interparticle interactions and, therefore, the formation of stable three-dimensional networks.

The colloidal approach is essential for designing hydrogel formulations with controlled behavior, as it enables the adjustment of key parameters such as dispersion stability and induced aggregation. In particular, the analysis of electrostatic forces through zeta potential determination is presented as a critical tool to evaluate colloidal stability and to modulate attractive and repulsive interactions between CNF. Complementarily, rheological characterization provides fundamental information on viscoelastic behavior, the formation of percolated networks, and the response under applied stress, which are decisive aspects for processing.

This colloidal understanding becomes especially relevant when considering the subsequent shaping of hydrogels through various processing techniques, such as freeze-drying, filament-based 3D printing, hydrogel/biotink biofabrication, solvent casting, and tape casting. Proper colloidal engineering of precursor suspensions enables the production of final structures with homogeneous microstructures, minimizing defects associated with uncontrolled aggregation or phase heterogeneity. It also ensures the reproducibility of mechanical, structural, and functional properties, which is crucial for scaling up and application.

In contrast to conventional processing methods, colloidal processing offers significant advantages, including enhanced control over the internal architecture of the material, milder processing conditions, and the possibility of tailoring final properties through the manipulation of nanoscale interactions. Overall, this approach establishes colloidal science as a fundamental pillar in the development of composite hydrogels based on CNF derived from agricultural biomass, enabling the production of sustainable materials with reproducible and application-oriented performance.

Acknowledgements This work was supported by Spain through PID2023-1529320B-I00 and CPP2023-010820 projects funded by MICIU/AEI/10.13039/501100011033, by the European Union and “ERDF. A way of making Europe”

O.55: Efficient EGFR silencing promoted by serine-derived gemini surfactants featuring cleavable ester bonds

Bruna Silva^{1,2}, Isabel S. Oliveira², Sandra G. Silva³, M. Luísa C. do Vale³, Eduardo F. Marques², Andreia C. Gomes¹

¹ Centre of Molecular and Environmental Biology (CBMA) / Aquatic Research Network (ARNET) Associate Laboratory, Universidade do Minho, Braga, Portugal

² CIQUP- IMS, Department of Chemistry and Biochemistry, Faculty of Sciences, University of Porto, Porto, Portugal

³ LAQV-REQUIMTE, Department of Chemistry and Biochemistry, Faculty of Sciences, University of Porto, Porto, Portugal.

A promising approach to cancer treatment is to target particular oncogenes, and small interfering RNA (siRNA) provides a potent mechanism to modulate important genes involved in tumor progression^{1,2}. However, clinical translation of siRNA remains hindered by inefficient systemic delivery^{3,4}. To address this challenge, we synthesized a novel serine-derived gemini surfactant featuring cleavable ester bonds designed to degrade under acidic endosomal conditions. This surfactant was engineered for enhanced biocompatibility and high surface charge to enable efficient siRNA complexation. The novel surfactant was combined with helper lipid monoolein (MO) at varying molar ratios to optimize membrane fusion and delivery efficiency⁴. The resulting nanocarriers were complexed with siRNA at different charge ratios, CR(+/-), to evaluate complexation efficiency. Lipoplex physicochemical characterization was performed, encompassing particle size, surface charge and cryo-TEM imaging. The cytotoxicity of novel surfactant and derived formulations was screened to determine EC₅₀ values, and cellular uptake and intracellular trafficking of fluorescently-labelled lipoplexes were investigated by fluorescence microscopy. Furthermore, the capacity to downregulate expression of Epidermal Growth Factor Receptor (EGFR) was evaluated in EGFR-overexpressing monolayer cultures using immunofluorescence and Western blot analysis. Results show that the nanocarriers efficiently complex siRNA at CR(+/-) ≥ 6 and remain stable for 15 days (Fig. 1B1,B2). Cryo-TEM imaging reveal distinct aggregate morphologies influenced by MO content (Fig. 1C). Further imaging results demonstrate endocytosis-mediated uptake of the lipoplexes and enhanced penetration in spheroids, particularly in systems with higher MO content. Transfection studies in monolayer cultures reveal that all formulations are able to reduce EGFR expression, as confirmed by western blot. Notably, immunofluorescence analysis indicate that lipoplexes with higher surfactant content achieve the most efficient EGFR silencing. These findings suggest that serine-derived gemini surfactant/MO lipoplexes are highly effective platforms for targeted siRNA delivery in cancer therapy.

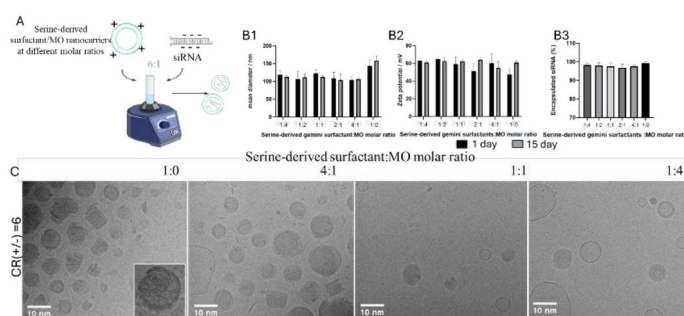


Figure 1. A) Schematic representation of siRNA complexation. Top: Mean diameter (B1) and mean zeta potential (B2) of lipoplexes formed by serine-derived gemini surfactants and MO, at different gemini:MO molar ratios and CR(+/-) = 6. The percentage of encapsulated siRNA (B3) was measured using RiboGreen. Bottom: cryo-TEM imaging of representative lipoplexes.

Acknowledgements We thank FCT for financial support through projects Smart4Vir (2022.05543.PTDC), UID/04050/2025, LA/P/0056/2020 and UIDB/ 00081/2020. B. Silva holds a PhD scholarship from FCT (ref. 2023.00783.BD).

References

- [1] Halder, S.; et al. *Expert Opin. Ther. Targets* 2023, 27, 305–324. <https://doi.org/10.1080/14728222.2023.2218613>
- [2] Mendelsohn, J.; et al. *Oncogene* 2000, 19, 6550–6565. <https://doi.org/10.1038/sj.onc.1204082>
- [3] Kaniowski, D.; et al. *bioRxiv* 2026. <https://doi.org/10.64898/2026.03.29.715100>
- [4] Oliveira, I. S.; et al. *J. Funct. Biomater.* 2024, 15, 224. <https://doi.org/10.3390/jfb15080224>

O.56: Implementation of Raman spectroscopy in bio-based samples

P.G. Argudo^{1,2}, M. Brzezinski¹, W. Chen³, B. Dúzs³, A. Samanta³, A. Walther³, S.H. Parekh^{1,4}

¹ Universidad de Córdoba, IQUEMA, 14014, Córdoba, Spain

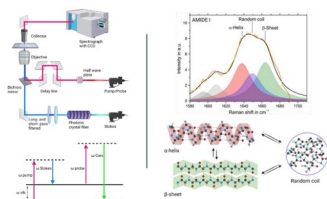
² Max Planck Institute for Polymer Research, Ackermannweg 10, 55128 Mainz, Germany

³ University of Mainz, Saarstraße 21, 55122 Mainz, Germany

⁴ The University of Texas at Austin, 2515 Speedway, Austin, 78712 TX, United States of America

The study of proteins, deoxyribonucleic acid (DNA), and ribonucleic acid (RNA) is fundamental to modern biochemistry and molecular biology, as these molecules drive biological phase separation processes that lead to the formation of membraneless organelles (MLOs). The structure and molecular composition of these biomolecular condensates directly influence their material properties and biological functions. Disruptions in these structural dynamics are linked to various neurodegenerative diseases, such as amyotrophic lateral sclerosis (ALS) and frontotemporal dementia (FTD), yet the competing molecular interactions regulating them remain poorly understood.¹

In this talk, we present the implementation of Coherent Anti-Stokes Raman Spectroscopy (CARS) as a suitable vibrational imaging technique to unravel temporal changes in biological systems, see Fig.1. Unlike traditional fluorescence-based approaches, CARS is a label-free and non-invasive method that operates without the need for dyes, markers, or nanoparticles, thereby avoiding potential secondary interactions or perturbations of delicate phase-separated systems. We demonstrate the versatility of this technique through applications in nucleic acids, noting transitions such as ssDNA to dsDNA,² or in proteins, for the elucidation of secondary structure motifs.³ Furthermore, we discuss the technique's broader applicability beyond living organisms to other structures such as films and solids.



Scheme or Figure 1: (Left) CARS, setup and background. (Right) Data obtained and protein characterization.

Acknowledgements

We thank the support from the Deutsche Forschungsgemeinschaft (DFG) SPP 2191 Molecular Mechanism of functional Phase separation (Project Nr: 402723784) and the Humboldt Research Fellowship for Postdoctoral Researchers.

References

- 1Arseni, D., Hasegawa, M., Murzin, A.G., Kametani, F., Arai, M., Yoshida M., and Ryskeldi-Falcon, B. (2022). TDP-43 forms amyloid filaments with a distinct fold in type A FTLD-TDP. *Nature*, 601, 139-143.
- 2Chen, W., Dúzs, B., Argudo, P.G., Bauer, S.V., Liu, W., Samanta, A., Parekh, S.H., Bonn, M., and Walther, A. (2025). Ballistic diffusion fronts in biomolecular condensates. *Nature Nanotechnology*, 20, 1062-1070.
- 3Brzezinski, M., Argudo, P.G., Scheidt, T., Yu, M., Hosseini, E., Kaltbeitzel, A., Lemke, E., Michels, J., Parekh S.H. (2024). Protein-Specific Crowding Accelerates Aging in Protein Condensates. *Biomacromolecules*, 26, 4, 2060-2075.

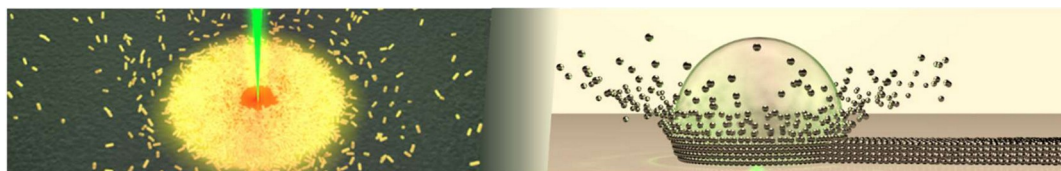
O.57: Colloidal optical assembly of nanomaterials on solid surfaces

Eric H. Hill^{1,2}, Ana Jiménez Amaya¹

¹ BCMaterials, Basque Center for Materials, Applications and Nanostructures, UPV/EHU Science Park, 48940 Leioa, Spain

² IKERBASQUE, Basque Foundation for Science, 48009 Bilbao, Spain

Colloidal assembly of nanomaterials into defined patterns is critical for integration of nanotechnology with solid-state devices. Optical control over colloidal assembly provides a simple and template-free means of patterning colloids into submicron features. In this talk, two recent approaches for the optically-driven colloidal assembly of nanomaterials will be presented. First, the use of laser-driven microbubbles as a mobile interface for convection- and capillary-driven assembly is presented. This approach has proven useful for the rapid, single step fabrication of MXene-based conductive patterns¹, strain sensors², and photodetectors³. Second, the thermophoretic motion of colloids in a laser-induced thermal gradient can drive their aggregation and adhesion at a laser spot. Tuning particle-substrate interactions with surfactants to favor heat-mediated bridging flocculation allows plasmonic gold nanoparticles to be deposited on non-plasmonic substrates, providing a rapid approach for micropatterned plasmonic substrates and opening the door to patterning of other nanomaterials^{4,5}. While these techniques are capable of depositing nanoparticle assemblies under diverse colloidal conditions and onto a variety of substrates, more work is needed to unlock control over particle assembly and orientation. In summary, these nascent approaches lay the foundation for light-directed colloidal assembly-based micropatterning of functional nanostructures for diverse applications such as sensing, devices, and wearable electronics.



Scheme 1: Laser-driven nanomaterial assembly on non-plasmonic substrates via opto-thermophoresis (left), and microbubble printing (right).

Acknowledgements

We thank the Spanish Ministry of Science, Innovation, and Universities (MICIU)/State Agency for Research (AEI)/10.13039/501100011033 for funding through the ATRAE program (ATR2024-154129) and through FEDER/EU (PID2024-160968NA-I00).

References

- [1] M. Herber, D. Lengle, S. Valandro, M. Wehrmeister, E.H. Hill, *Nano Lett.* 2023, 23(14), 6308-6314
- [2] M. Herber, E.H. Hill, *Nano Lett.* 2025, 25(18), 7258-7265
- [3] M. Herber, B. Hanly, E.H. Hill, *ACS Appl. Mater. Int.* 2025, 17(26), 38269-38279
- [4] A. J. Amaya, C. Goldmann, E.H. Hill, *Small Methods* 2024, 2400828
- [5] A. J. Amaya, C. Goldmann, M. Haidasch, C. Hamon, E.H. Hill, *Adv. Opt. Mater.* 2025, 13(34), 2500375

O.58: AI-supported biofabrication of 3D-glioblastoma models for local nanoparticle drug delivery

R. Rocha^{1,2}, F. Branco^{1,2}, M. Mendes^{1,2}, C. Vitorino^{1,2}, A. Pais¹

¹ Coimbra Chemistry Centre, Institute of Molecular Sciences—IMS, Department of Chemistry, University of Coimbra, Coimbra, Portugal

² Faculty of Pharmacy, University of Coimbra, Coimbra, Portugal

Introduction Glioblastoma (GBM) is the most common and deadly brain tumor. Despite numerous efforts to improve prognosis and find a definitive cure, the Stupp Protocol, a combination of resection surgery, radiotherapy, and chemotherapy with temozolomide, has remained the standard of care since 2005 ¹, highlighting the limited progress in GBM research. Some limitations stem from the poor translation of results from two-dimensional (2D) in vitro to in vivo models, which often leads to the discontinuation of drugs later in development. Biofabricated three-dimensional (3D) in vitro models combine the advantages of 2D models (simplicity, reliability, and reproducibility) while more accurately representing reality, enabling a more rigorous drug testing earlier and bridging the gap between 2D in vitro and in vivo models.

Materials and Methods A GBM 3D model with U87 cells was developed by using extrusion-based 3D bioprinting technology. The printable material (hydrogel-based bioink) was based on methacrylate gelatine (GelMA), lithium phenyl-2,4,6-trimethylbenzoylphosphine (LAP, a photoinitiator) and alginate or gelatine; and was optimized through rheology and printability metrics ². The photocrosslinking procedure was fine-tuned with model assessment tests ³, and for the alginate bioink the effect of ionic crosslinking was also observed ⁴. Machine learning models were also employed to assess if prior data on the suitability of bioinks on printing and acting as an extracellular matrix could predict a new appropriate bioink. Additionally, silk nanoparticles were manufactured with nanoprecipitation and microfluidics approaches to test a new GBM therapy and its effectiveness was tested on the prior mentioned developed GBM models.

Results A bioink of GelMA and alginate, 8 and 1.5 %w/v, respectively, and another of GelMA and gelatine, 3 and 4 %w/v, respectively, were found to be suitable for printing. Regarding their photocrosslinking procedure, 20 seconds after printing and 5 seconds each layer, respectively, were found to yield the same degradation level when compared to greater amounts of photocrosslinking time. The ionic crosslink allowed for around 10% overall less degradation when compared to no ionic crosslink on the alginate bioink (Figure 1).

Conclusions Two bioinks were found and may serve as a potential extracellular matrix for GBM.

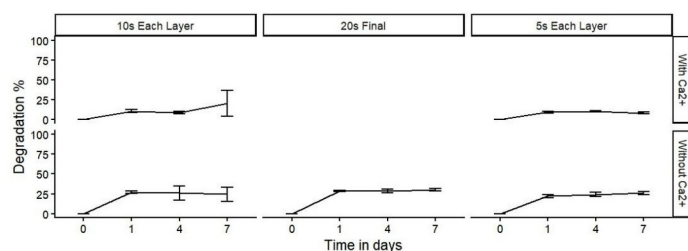


Figure 1: Alginate bioink degradation assay.

Acknowledgements The Coimbra Chemistry Centre (CQC) is supported by the FCT through the projects UIDB/00313/2025 and UIDP/00313/2025. This work was also funded through the project 2022.06174.PTDC.

References

1. Stupp R, Weller M, Belanger K, et al. Radiotherapy plus Concomitant and Adjuvant Temozolomide for Glioblastoma. *n engl j med*. Published online 2005.
2. Ribeiro A, Blokzijl MM, Levato R, et al. Assessing bioink shape fidelity to aid material development in 3D bioprinting. *Biofabrication*. 2017;10(1):014102. doi:10.1088/1758-5090/aa90e2
3. Maity S, Jewell C, Vilgor C, et al. Deciphering pericyte-induced temozolomide resistance in glioblastoma with a 3D microphysiological system mimicking the biomechanical properties of brain tissue. *Acta Biomaterialia*. 2025;200:202-217. doi:10.1016/j.actbio.2025.05.038
4. Hermida MA, Kumar JD, Schwarz D, et al. Three dimensional in vitro models of cancer: Bioprinting multilineage glioblastoma models. *Advances in Biological Regulation*. 2020;75:100658. doi:10.1016/j.jbior.2019.100658

O.59: Opto-thermophoretic patterning of gold nanoparticles on glass surfaces

Ana Jiménez Amaya¹, Eric H. Hill^{1,2}

¹ BCMaterials, Basque Center for Materials, Applications and Nanostructures, UPV/EHU Science Park, 48940 Leioa, Spain

² IKERBASQUE, Basque Foundation for Science, 48009 Bilbao, Spain

The precise placement and arrangement of nanoparticles on solid substrates is a key requirement for the fabrication of next-generation solid-state devices, especially in fields such as plasmonics, sensing, and nanophotonics. Despite this, the reproducible assembly of plasmonic nanoparticles continues to pose significant challenges in colloidal and interfacial science, particularly when avoiding surface modification or high surfactant concentrations. In this work, we introduce a fast and adaptable method for assembling gold nanoparticles (AuNPs) onto untreated glass substrates, based on laser-induced thermal gradients (Fig. 1)^{1,2}.

By employing both spherical and rod-like AuNPs stabilized with cetyltrimethylammonium chloride (CTAC), we show that well-organized structures can be formed at surfactant levels up to an order of magnitude below the critical micelle concentration (CMC). This behavior deviates from conventional depletion interactions driven by polymers or surfactants, instead indicating a bridging flocculation mechanism mediated by ligand-mediated interactions between particles and with the substrate. The assembly process occurs on a timescale of seconds and can be tuned through variations in solvent composition or nanoparticle shape. Notably, while spherical AuNPs assemble readily in aqueous media, gold nanorods require the addition of a co-solvent (e.g., ethanol), likely due to increased ligand packing density on flat crystalline facets such as Au(100) and Au(110).

Furthermore, we extend this strategy by substituting polymeric ligands with small thiolate molecules bearing terminal carboxylate groups. The ligand chain length plays an important role in the resulting structures: longer chains favor hexagonal ordering, whereas shorter ones lead to more aggregated and less ordered arrangements. Overall, these results shed light on nanoparticle assembly under non-equilibrium conditions and offer a route toward the rapid production of tunable plasmonic substrates, with clear relevance for applications including surface-enhanced Raman scattering (SERS).

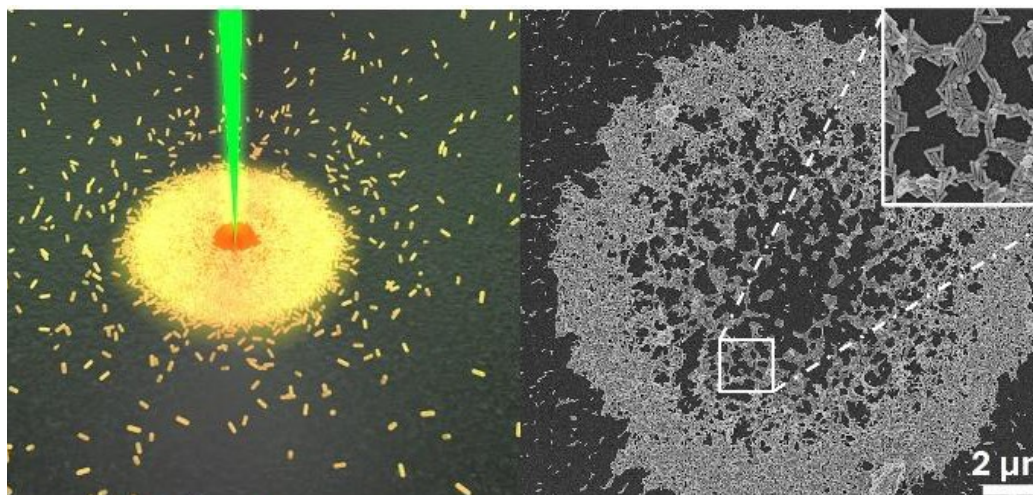


Figure 1: Laser-induced assembly of gold nanorods on bare glass

Acknowledgements We thank the Spanish Ministry of Science, Innovation, and Universities (MICIU)/State Agency for Research (AEI)/10.13039/501100011033 for funding through the ATRAE program (ATR2024-154129) and through FEDER/EU (PID2024-160968NA-I00).

References

- [1] A. J. Amaya, C. Goldmann, E.H. Hill, *Small Methods* 2024, 2400828
- [2] A. J. Amaya, C. Goldmann, M. Haidasch, C. Hamon, E.H. Hill, *Adv. Opt. Mater.* 2025, 13(34), 2500375

O.60: The OCTOPUS Pendant Drop Tensiometer: a collaborative tool for interfacial engineering of emulsions

Julia Maldonado Valderrama¹, Teresa del Castillo Santaella², Juan Antonio Holgado Terriza³, Miguel Ángel Cabrerizo-Vílchez¹

¹ Department of Applied Physics, University of Granada, Campus de Fuentenueva sn, 18071, Granada, Spain.

² Department of Physical Chemistry, University of Granada, Campus de Cartuja sn, 18071, Granada, Spain.

³ Department of Software Engineering, University of Granada, Campus de Aynadamar sn, 18071, Granada, Spain.

Pendant Drop Tensiometry is a cornerstone in the characterization of liquid-fluid interfaces providing a standard experimental technique for measuring interfacial tension and dilatational rheology where the OCTOPUS represents an evolutionary step. Designed and manufactured at the University of Granada, this surface film balance is implemented with a multisubphase exchange device¹. This accessory allows for the dynamic and sequential modification of the bulk solution in the pendant drop without disturbing the adsorbed layer, making it a valuable tool for simulating complex multi-stage processes through international scientific cooperation. This work highlights some recent technical milestones achieved through collaborative research in two main areas:

- Mechanistic Study of In Vitro Digestion: A major challenge in food science is understanding how the interfacial structure of an emulsion evolves as it is digested. This can be mimicked in a single droplet by applying the subphase exchange accessory. International collaborations have focused on the competitive adsorption between food proteins, digestive enzymes and bile salts². This has provided a real-time "molecular map" of how bile salts displace original emulsifiers, a process that is critical for controlling lipid bioavailability and the controlled release of lipophilic nutrients.

- Valorization of Agro-industrial Side-streams: The transition toward a circular economy requires the development of plant-based emulsifiers with performance comparable to animal proteins. Current collaborative efforts are centered on the upcycling of agricultural residues (such as oilseed and plant protein by products)³. The OCTOPUS is used to evaluate the interfacial functionality of these "green" extracts, specifically analyzing how their peptides and proteins form viscoelastic networks at the interface. This technology is crucial for determining how these sustainable ingredients respond to pH shifts and ionic strength changes, ensuring the stability and antioxidant protection of the encapsulated compounds.

The OCTOPUS device transcends its role as a measurement instrument, acting as a collaborative platform that bridges fundamental biophysics with food engineering. Its ability to mimic physiological environments and evaluate upcycled ingredients provides a necessary tool to design the next generation of affordable, functional, and sustainable food products.

Acknowledgements This work was funded by Grant C-EXP-187-UGR23 awarded by Consejería de Universidad, Investigación e Innovación and by ERDF Andalusia Program 2021-2027, PID2023-149387OB-I00 awarded by MICIU/AEI/10.13039/501100011033 and ERDF, a way of making Europe. COST-Action INFOTECH-DATA CA24145 is also acknowledged.

References

- 1 Maldonado-Valderrama, J., del Castillo Santaella, T., Holgado-Terriza, J. A., & Cabrerizo-Vílchez, M. A. (2022). In vitro digestion of emulsions in a single droplet via multi subphase exchange of simulated gastrointestinal fluids. *J. Vis. Exp.*, 189, e64158.
- 2 Dulko, D., Kłosowska-Chomiczewska, I. E., del Castillo-Santaella, T., Cabrerizo-Vílchez, M. A., Łuczak, J., Staroń, R., Krupa, Ł., Maldonado-Valderrama, J., & Macierzanka, A. (2024). Interfacial behaviour of human bile and its substitution for in vitro lipolysis studies. *Food Res. Int.*, 197, 115203.
- 3 M. S. Bisinotto, I. Castro, J. Maldonado-Valderrama, N. C. Jones, T. del Castillo-Santaella, S. V. Hoffmann, E. M. Guadix, P. J. García-Moreno, (2025) Use of emulsifying plant protein hydrolysates from winery, whiskey and brewery by-products for the development of echium oil delivery emulsions. *Int. J. Biol. Macromol.* 308, 142736.

O.62: Stabilizing Gold Seeds for Reliable Growth of Plasmonic Nanorods

Carlos Fernández-Lodeiro, Sergio Rodal-Cedeira, Leyre Currás-Barreiro, Nadesh Fiuza-Maneiro, Jorge Pérez-Juste, Isabel Pastoriza-Santos, Lakshminarayana Polavarapu, Sergio Gómez-Graña

CINBIO, Universidade de Vigo, Campus Universitario As Lagoas, Marcosende, 36310, Vigo, Spain.

Gold nanorods (AuNRs) are among the most versatile plasmonic nanostructures,¹ but their reliable synthesis is still hindered by the instability of conventional seeds, which typically lose their properties within hours. We present a modified seed preparation strategy that enhances both the temporal stability and reproducibility of the seeds, as well as the reproducibility of subsequent AuNRs synthesis over time. The optimized seeds remain stable for more than two weeks, enabling the synthesis of high-quality AuNRs with reduced variability, minimized reagent waste, and improved sustainability. In addition to extended longevity, the modified conditions introduce a mild *in situ* reductant that can be exploited for post-synthetic tuning of AuNRs properties. This approach allows the controlled deposition of metallic shells, yielding Au@Ag and Au@Pd nanorods with distinct optical and catalytic behaviours. The resulting Au@Ag structures exhibit enhanced plasmonic features ideal for surface-enhanced Raman scattering (SERS), while Au@Pd nanorods retain strong catalytic potential despite plasmon damping. Altogether, this methodology provides a simple and versatile route for producing plasmonic nanostructures with tailored optical and catalytic properties. The combination of improved seed stability and controlled overgrowth opens new opportunities for sustainable fabrication of nanomaterials relevant to sensing, catalysis, and photonic technologies.

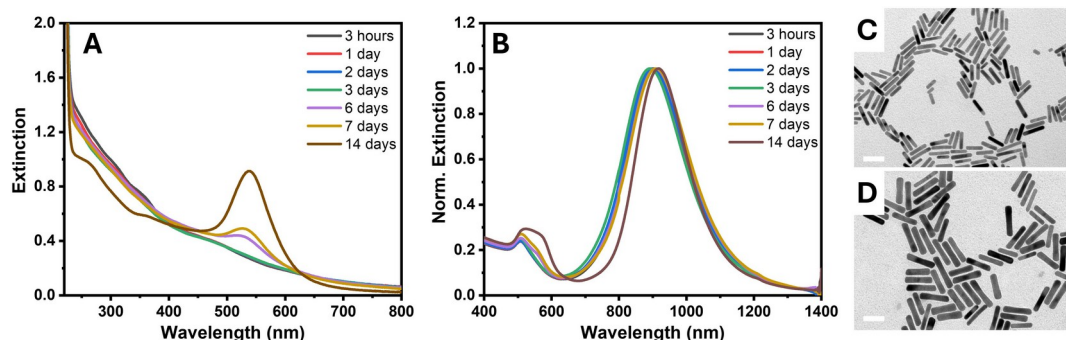


Figure 1. Temporal stability of modified gold seeds and preservation of their seeding capability. (A) UV-Vis-NIR extinction spectra of seed solutions recorded from 3 h to 14 days, showing a gradual spectral evolution over time. (B) Normalized extinction spectra of Au nanorods grown using seeds aged for the same periods, demonstrating preserved seeding activity and highly reproducible longitudinal plasmon bands even after two weeks. (C) TEM image of Au nanorods synthesized using freshly prepared seeds. (D) TEM image of Au nanorods synthesized using seeds aged for 14 days. Both samples show comparable morphology and dimensions, confirming that the long-term stability of the seeds does not compromise nanorod growth. Scale bars: 50 nm.

References

1Chen, Huanjun et al. Gold nanorods and their plasmonic properties, 2013, 42, 2679-2724. <https://doi.org/10.1039/C2CS35367A>.

Acknowledgements

PID2022-138724NB-I00 and PID2023-147567NB-I00, funded by MICIU/AEI/10.13039/501100011033, GPC ED431B 2025/42 and GRC ED431C 2020/09 funded by Consellería de Cultura, Educación e Ordenación Universitaria, Xunta de Galicia and European Union Next Generation EU/PRTR, EIC PATHFINDERCHALLENGE3S project 101162112 (RADIANT).

O.63: Electro-responsive polymer nanocomposites: Structural and transport properties through coarse-grained Langevin dynamics

Daniel Valero¹, Adri Escañuela-Copado¹, Alberto Martín-Molina^{1,2}, Alessandro Patti^{1,2}

¹ Department of Applied Physics, University of Granada, 18071 Granada, Spain

² Carlos I Institute for Theoretical and Computational Physics, Avenida Fuentenueva, 18071 Granada, Spain

Responsive polymer nanocomposites (PNCs) constitute a promising class of advanced functional materials for the design and implementation of smart, stimuli-adaptive systems. In the present study, we employ coarse-grained Langevin dynamics simulations to investigate the structural, dynamical, electrical, and rheological properties of a model PNC system. This model PNC is constituted by polarizable nanorods (NRs) embedded within a polymer matrix, and it is subjected to direct-current electric fields of varying amplitude. We also investigate the electro-orientation¹ response times of the NRs through non-equilibrium dynamical simulations. Our results present different structural motifs of the NRs depending on the applied field amplitude. At low field amplitudes, the NRs orient along the field direction. In contrast, at higher amplitudes, they undergo self-assembly into percolating filaments and columnar structures. Applying a resistor network model², we calculate the system's electrical conductivity and characterize its rheological response under shear flow. Our simulations demonstrate that NRs structural motifs significantly influence both electrical and rheological properties. Specifically, we observed a four-order-of-magnitude enhancement in conductivity and a 15-fold increase in viscosity when transitioning from low to high electric field amplitudes.

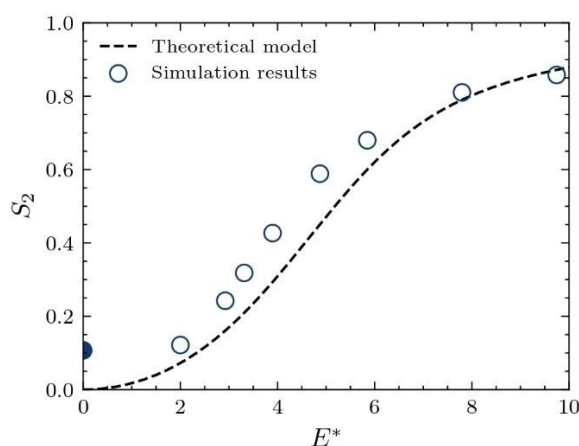


Figure 1: Nematic order parameter S_2 as a function of the electric field E^* (empty symbols) against the theoretical prediction (dashed lines) for the electro-orientation of anisotropic nanoparticles. The solid symbol represents the nematic order parameter S_2 when no field is applied. The error bars are smaller than the symbols used.

Acknowledgements

AP thanks grant no. PID2022-136540NB-I00 awarded by MICIU/AEI/10.13039/501100011033 and ERDF, a way of making Europe. DV, AEC and AP acknowledge grant no. W911NF-23-1-0099 awarded by the U.S. Army Research Office. AMM thanks grant PID2023-149387OB-I00 awarded by MICIU/AEI/10.13039/501100011033 and FSE+ and grant C-EXP-187-UGR23 awarded by Consejería de Universidad, Investigación e Innovación and by ERDF Andalusia Program. All authors thank Servicio de Supercomputación UGR and PROTEUS, the supercomputing center of the Institute Carlos I for Theoretical and Computational Physics, for the computational time provided.

References

1. Bao, W.S., Meguid, S.A., Zhu, Z.H., Pan, Y., Weng, G.J. (2012). A novel approach to predict the electrical conductivity of multifunctional nanocomposites. *Mechanics of Materials* 46: 129-138.
2. Arenas-Guerrero, P., Jiménez, M.L., Scott, K., Donovan, K.J. (2018). Electric birefringence of carbon nanotubes: Single- vs double-walled. *Carbon* 126: 77-84.

O.64: Magnetic colloidal guided on self-assembled colloidal tracks

José Martín-Roca^{1,3}, Francisco Ortega², Ramón González Rubio², Ignacio Pagonabarraga¹, Carles Calero¹, Fernando Martínez Pedrero²

¹ *Universitat de Barcelona, Address, Barcelona, Spain*

² *Departamento de Química-Física, Universidad Complutense de Madrid. Avda. Complutense, 28040 Madrid, Spain*

³ *GISC-Grupo Interdisciplinar de Sistemas Complejos*

Understanding and controlling directed transport at the microscale remains a fundamental challenge with far-reaching implications in biophysics, nanotechnology, and biomedical engineering. Here, we present a unified approach based on magnetic colloidal systems that provides a model platform to investigate the fundamental physics of driven motion.

We exploit the self-assembly of magnetic colloids to create tracks (Fig. 1) that can be immobilized on solid substrates and used as guiding pathways for particle transport under externally applied time-dependent magnetic fields¹. These structures support robust and tunable non-diffusive motion, even in complex and irregular environments, demonstrating strong potential for applications such as targeted delivery and lab-on-a-chip technologies. Building on this framework, we further show that the same system can be used to emulate ratchet-like transport mechanisms analogous to those of biological molecular motors².

By combining experiments and simulations, we uncover how key parameters, such as particle size, field asymmetry, track roughness, and actuation frequency, govern transport efficiency. This enables direct experimental access to mechanisms that are otherwise difficult to probe in biological systems, and reveals optimal conditions for directed motion emerging from the interplay between fluctuations and external driving.

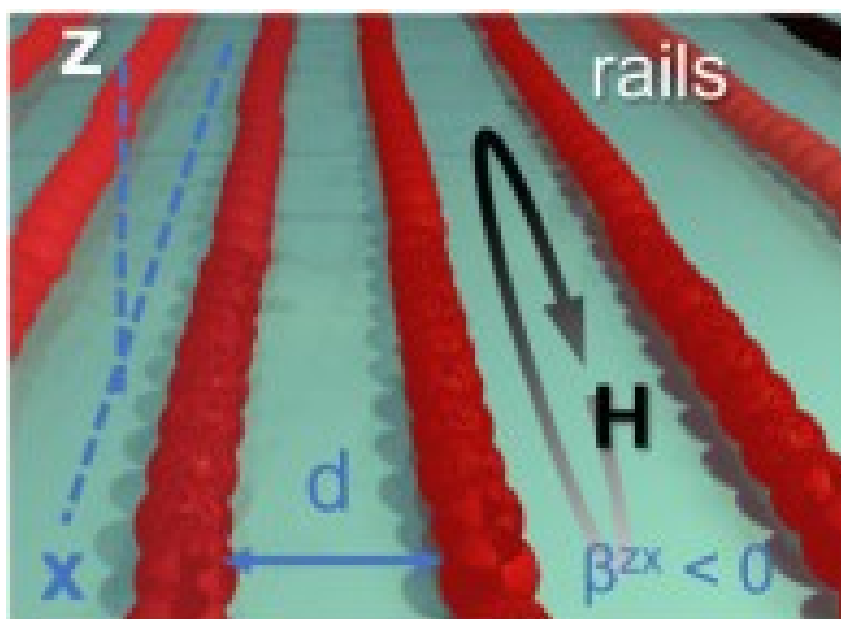


Figure 1: (Left) Scheme for the system of rails constructed to perform the experiment. (Right) Example of two trajectories of a big particle (red) and a small particle (blue) along the rail.

References

- [1] Martín-Roca, J., Izquierdo Solis, L., Martínez Pedrero, F., Casadejust, P., Pagonabarraga, I., & Calero, C. (2025). Colloidal Model for Investigating Optimal Efficiency in Weakly Coupled Ratchet Motors. *Physical review letters*, 135(2), 028301.
- [2] Martín-Roca, J., Ortega, F., Valeriani, C., Rubio, R. G., & Martínez-Pedrero, F. (2023). Magnetic colloidal currents guided on self-assembled colloidal tracks. *Advanced Functional Materials*, 33(52), 2306541.

O.65: MolecuTas: A deep learning framework for modeling electronic properties of complex molecules

Álvaro Vallejo-Bay^{1,2}, Jannis Krüger³, Manuel Lama², Andrea Santisteban-Veiga^{1,4,5}, Juan Sabin^{5,6}, Antonio Topete^{1,4}, Gerardo Prieto^{1,4}, Vicente Domínguez-Arca^{3,7}

¹ Colloids and Polymers Physics Group, Department of Physics of Particles, Universidade de Santiago de Compostela, 15782 Santiago de Compostela, Spain

² Centro Singular de Investigación en Tecnoloxías Intelixentes (CiTIUS), Universidade de Santiago de Compostela, Santiago de Compostela, Spain

³ Physical and Biophysical Chemistry, Bielefeld University, Universitätsstr. 25, 33615 Bielefeld, Germany

⁴ Institute of Materials, Universidade de Santiago de Compostela, 15782 Santiago de Compostela, Spain

⁵ AFFINImeter Scientific & Development team, Software 4Science Developments, Santiago de Compostela 15782, Spain

⁶ College of Engineering and Technology, Universidad Internacional de La Rioja (UNIR), Av. de la Paz, 137, Logroño, La Rioja, 26006, Spain

⁷ Biosystems and Bioprocess Engineering (Bio2Eng) Group. IIM-CSIC. C/ Eduardo Cabello,6. 36208 Vigo, Spain

MolecuTas is a deep learning based platform designed for the characterization of electronic properties of molecular compounds. To address two central challenges in computational chemistry, model dependence on molecular size and the loss of structural detail in conventional representations, we have developed a custom molecular fragmentation pipeline based on geometric motifs, ensuring the preservation of essential information such as connectivity, symmetries, chemical environments, and electronic features. On this platform, a series of graph neural network models were trained, showing results comparable to density functional theory, at a fraction of the computational cost. Ultimately, we aim to incorporate MolecuTas into molecular dynamics programs, enabling fast and precise prediction of partial charges and other key properties.

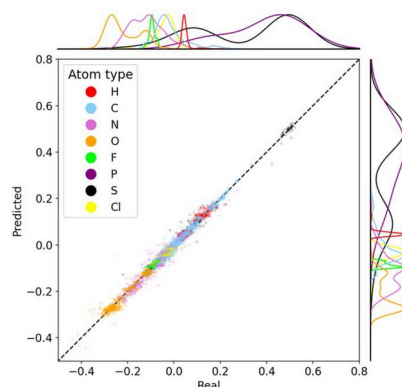


Figure 1: Scatter plot of partial charge predictions for all atoms in a test subset of molecules from the Aquamarine¹ dataset. Outside the axes, the smoothed distributions of partial charges for each atom type are shown, with reference values on the top and predicted values on the right.

Acknowledgements

This work was supported by the ENIA Chairs programme (TSI-100932-2023-3), under Order ETD/180/2022 of 25 November, funded by the European Union – NextGenerationEU and the Spanish Secretariat of State for Digitalization and Artificial Intelligence and by Xunta de Galicia through project ED431F 2025/14. VDA thanks Xunta de Galicia through grant IN606B-2023/006 and AS through the industrial PhD program (code IN606D).

References

1 Medrano Sandomas, L., Van Rompaey, D., Fallani, A. et al. Dataset for quantum-mechanical exploration of conformers and solvent effects in large drug-like molecules. *Sci Data* 11, 742 (2024). <https://doi.org/10.1038/s41597-024-03521-8>

O.66: Tracking and Isolation of Subcellular Trafficking Events via Fluorescent Magnetic Nanoparticles

Pablo Graván¹, Yuchen Lin¹, Andrea Marcantonigni¹, Yanqiu Ye¹, Breno Moura Motta¹, Zixu Zhao¹, Wanting Zhang¹, Ester Canepa¹, Camille Legentil¹, Yan Yan^{1,2}, Kenneth Dawson¹

¹ Centre for BioNano Interactions, School of Chemistry, University College Dublin, Belfield, Dublin 4, Ireland

² School of Biomolecular and Biomedical Science, UCD Conway Institute of Biomolecular and Biomedical Research, University College Dublin, Belfield, Dublin 4, Ireland

Despite the growing interest in bio-nano interactions, the detailed intracellular mechanisms governing nanoscale recognition and signaling remain largely unresolved. Conventional fluorescent probes often suffer from dye leakage in biological environments, creating severe intracellular artifacts and limiting long-term tracking. To address these challenges, we developed a multifunctional nanotechnology platform consisting of biocompatible, superparamagnetic multicore nanoparticles protected by a bright, highly stable fluorescent silica shell¹. A key innovation in our synthesis is the addition of a dense encapsulating silica layer that prevents dye loss, ensuring probe integrity even after three days in cellular environments. Coupled with the particles' superparamagnetic core, this exceptional stability allows for the efficient magnetic recovery and isolation of specific intracellular trafficking events². We demonstrate the utility of this platform in uncovering novel biological mechanisms through two primary applications:

Extracellular Communication: By employing these magnetic nanoparticles, we isolated and characterized unconventional extracellular RNA-protein complexes, revealing a previously unrecognized mechanism for RNA transport and noncanonical intercellular communication³.

Subcellular Mapping: We utilized the magnetic properties of the probes to achieve the high-purity isolation of nanostructure-containing endosomes, allowing us to map early endocytic events.

Overall, this robust magnetic-fluorescent platform provides access to the spatiotemporal dynamics of trafficking networks, offering a powerful tool for the fundamental understanding of bionanointeractions and the extraction of specific cell compartments involved in intracellular transport.

Acknowledgements

K.D. and Y.L. acknowledge financial support from the European Research Council (ERC) under the European Union's Horizon Europe research and innovation programme (Grant Agreement No. 101097834 — FunctionalNanoTher) and from Science Foundation Ireland (SFI) under Grant Agreement No. 22/SPP/10515 — Bio-PADT. P.G. acknowledges the Specialized Group on Colloids and Interfaces (GECI) from RSEQ and RSEF for granting the Elvira Ciller Award and for the invitation to participate at RICI XI. The authors would like to acknowledge all group members who have been involved in this work and encourage interested readers to consult the references to identify the key contributors to the conception and development of these technologies, as this research represents a long-standing collaborative effort of our group.

References

- 1L. Cursi, S. Vercellino, M. M. McCafferty, E. Sheridan, V. Petseva, L. Adumeau, K. A. Dawson, "Multifunctional superparamagnetic nanoparticles with a fluorescent silica shell for the in vitro study of bio-nano interactions at the subcellular scale". *Nanoscale* 2021, 13, 16324–16338.
- 2E. Sheridan, S. Vercellino, L. Cursi, L. Adumeau, J. A. Behan, K. A. Dawson, "Understanding intracellular nanoparticle trafficking fates through spatiotemporally resolved magnetic nanoparticle recovery", *Nanoscale Adv.* 2021, 3, 2397.
- 3 Y. Lin, L. Adumeau, M. M. McCafferty, S. Vercellino, Y.-F. Wang, X. Yang, W. Zhang (...), Y. Yan, K. A. Dawson, "Condensate corona –nanoparticle complexes transfer functional biomolecules between cells", *Nat. Mater.* 2026, DOI: 10.1038/s41563-026-02534-5.

Poster Presentations

44 poster presentations • P.1–P.44

P.1: Noble-Metal-Decorated ZnO Nanostructures for Photocatalytic Ibuprofen Degradation

G. Manca^{1,2}, S. Bettini^{2,3}, M. Cano Luna⁴, J.J Giner-Casares⁴, V. García Caballero⁴, G. Giancane^{2,5}, L. Valli^{2,3}

¹ Department of Chemistry, Biology and Biotechnology, Centro di Eccellenza per I Materiali Innovativi Nanostrutturati (CEMIN), University of Perugia, via Elce di Sotto 8, Perugia, 06123, Italy

² Dipartimento di Scienze e tecnologie Biologiche e Ambientali, Università del Salento, Via Monteroni, Lecce, I-73100, Italy

³ Consorzio Interuniversitario Nazionale per la Scienza e la tecnologia dei Materiali, INSTM, Via G. Giusti, Firenze, I-50121, Italy

⁴ University of Córdoba, Department of Physical Chemistry and applied Thermodynamics, Campus de Rabanales, Edificio Marie Curie, Córdoba, Spain E- 14014

⁵ Department of Cultural Heritage, University of Salento, Via D. Birago 64, Lecce, 73100, Italy

Ibuprofen (IBU) is a widely used non-steroidal anti-inflammatory drug and an emerging organic contaminant routinely detected in waste-, surface and groundwaters. The limited removal achieved by conventional wastewater treatments¹ has stimulated growing interest in advanced oxidation processes (AOPs), particularly heterogeneous photocatalysis, for its abatement². Here, pristine ZnO and noble-metal-decorated nanostructures, Au- and Pt-modified ZnO (ZnO@Au, ZnO@Pt), are prepared through a rapid solvent-based piezo-assisted ultrasound route, where mechanical excitation of ZnO drives the in-situ reduction of metal precursors at the semiconductor surface. Building on our previous piezo-triggered interface engineering of ZnO – Au hybrids³, this approach promotes the formation of intimate metal–ZnO contacts without impactful reducing agents or thermal treatments, yielding Pt-decorated ZnO photocatalysts via a simple and scalable process. Structural and spectroscopic analyses confirm the preservation of the ZnO wurtzite phase and the formation of well-defined metal–semiconductor interfaces. Under simulated solar irradiation, ZnO@Pt removes ≈90% of ibuprofen after 90 min, i.e. about 2,5 and 10 times more than ZnO@Au and pristine ZnO, respectively. This enhancement is consistent with literature reports and with our photoluminescence data, both indicating that noble-metal decoration suppresses the fast charge-carrier recombination typically observed in pristine ZnO⁴. Cut-off filter tests indicate that the metal nanoparticles do not behave as independent plasmonic photocatalysts, but operate in synergy with ZnO. Reactive oxygen species measurements and scavenger experiments further clarify the reaction mechanism, highlighting oxygen-based radicals as key oxidising species and confirming the beneficial impact of Pt decoration on charge-carrier utilisation. Tests in a commercial mineral water containing bicarbonate and alkaline-earth ions demonstrate that ZnO@Pt still achieves ≈75% removal at 90 min, highlighting its robustness in the presence of competing matrix components.

Overall, this study shows that piezo-driven interfacial engineering combined with Pt decoration provides a rapid and sustainable route to ZnO-based photocatalysts capable of efficiently degrading ibuprofen and other pharmaceutical contaminants in realistic aqueous environments.

References

- 1 Sá S.A., Feitosa R. P., et al. A Brief Photocatalytic Study of ZnO Containing Cerium towards Ibuprofen Degradation. *Materials* 2021, 14, (19), 5891; <https://doi.org/10.3390/ma14195891>.
- 2Jallouli N., Pastrana-Martínez L. M., et al. Heterogeneous photocatalytic degradation of ibuprofen in ultrapure water, municipal and pharmaceutical industry wastewaters using a TiO₂/UV-LED system. *Chemical Engineering Journal* 2018, 334, 976-984; <https://doi.org/10.1016/j.cej.2017.10.045>.
- 3 Bettini S, Manca G, et al. Piezo-Triggered Formation of Functional ZnO@Au Interfaces: Toward Instant and Sustainable Interface Engineering. *Surfaces and Interfaces* 2025, 73, 107611; <https://doi.org/10.1016/j.surfin.2025.107611>
- 4Thi Hanh N., Le Minh Tri N., et al. Monocrotophos pesticide effectively removed by novel visible light driven Cu doped ZnO photocatalyst. *Journal of Photochemistry and Photobiology A: Chemistry* 2019, 382, 111923; <https://doi.org/10.1016/j.jphotochem.2019.111923>

P.2: Multifunctional GO/MoS₂ membranes for removal and optical detection of Rhodamine B in contaminated food and water

Beatriz P. de Sousa¹, Leonardo Amaral¹, Ana L. Daniel-da-Silva¹, Tito Trindade¹, Gil Gonçalves^{2,3}, Sara Fateixa^{1,4}

¹ CICECO—Aveiro Institute of Materials and Department of Chemistry, University of Aveiro, 3810-193 Aveiro, Portugal

² Centre for Mechanical Technology and Automation (TEMA), Mechanical Engineering Department, University of Aveiro, 3810-193 Aveiro, Portugal

³ Intelligent Systems Associate Laboratory (LASI), 3810-193 Aveiro, Portugal

⁴ University of Coimbra, CEMMPRE, ARISE, Department of Mechanical Engineering, Rua Luís Reis Santos, 3030-788 Coimbra, Portugal

The illegal use of synthetic dyes and hazardous substances in food remains a critical concern for modern societies and public health. Among these, Rhodamine B (RhB), a fluorescent dye with a characteristic fluorescent pink color, is particularly alarming due to its genotoxic and carcinogenic properties. Despite being banned, it is frequently used as an adulterant in products such as chili powder and sweets to enhance visual appeal.^{1,2}

In this study, we report the fabrication of multifunctional hybrid films composed of graphene oxide (GO) and molybdenum disulfide (MoS₂) nanosheets, engineered for the simultaneous removal and detection of RhB via surface-enhanced Raman scattering (SERS).³ Our results demonstrate that RhB adsorption efficiency is directly correlated with MoS₂ content, achieving up to 99.9% removal with pure MoS₂ films. Furthermore, these films enable sensitive, label-free SERS detection without the need for noble metal nanoparticles. As a proof-of-concept, the films were tested on RhB-spiked sweet pepper powder, achieving detection limits as low as 100 ppm (0.01 wt%) for pure MoS₂ and 1000 ppm (0.1 wt%) for GO/MoS₂ (25/75) ratio. The efficiency to detect RhB in complex water matrices, including wastewater, tap water, and Estuary Aveiro Lagoon was further validated using the GO/MoS₂ (0/100) hybrid film. Overall, this research provides a sustainable, low-cost and scalable approach to produce multifunctional 2D-material-based hybrid films for the integrated monitoring and remediation of illicit dyes in the food industry and environmental monitoring.

Acknowledgements This work was developed within the scope of the project CICECO-Aveiro Institute of Materials, UIDB/50011/2020 (DOI 10.54499/UIDB/50011/2020), UIDP/50011/2020 (DOI 10.54499/UIDP/50011/2020) & LA/P/0006/2020 (DOI 10.54499/LA/P/0006/2020). This work is funded by national funds through FCT, I.P., under UID/00481 – TEMA, UID/00285/2025 - CEMMPRE and LA/P/0112/2020-ARISE. GG thanks FCT for financial support for the project CarboNCT 2022.03596.PTDC (DOI: 10.54499/2022.03596.PTDC) SF thanks FCT for her research contract (REF- 069-88-ARH-2018), which is funded by national funds (OE) through FCT, I. P., in the scope of the framework contract foreseen in numbers 4, 5, and 6 of article 23 of the Decree-Law 57/2016, of August 29, changed by Law 57/2017, of July 19. Bpds and LOA thank FCT for their PhD grants (2024.02680.BD and BD/151138/ 2021), respectively. ALD-d-S acknowledges FCT for funding (CEECIND/ 03075/2018/CP1559/CT0020; DOI 10.54499/CEECIND/03075/2018/CP1559/CT0020).

References

- 1 M. Oplatowska-Stachowiak and C. T. Elliott, Crit. Rev. Food Sci. Nutr., 2017, 57, 524–548.
- 2 M. Wang, X. Nie, L. Tian, J. Hu, D. Yin, H. Qiao, T. Li and Y. Li, Food Addit. Contam. Part B Surveill., 2019, 12, 59–64.
- 3 B. P. de Sousa, L. Amaral, A. L. Daniel-da-Silva, T. Trindade, G. Gonçalves and S. Fateixa, FlatChem, 2025, 54, 100969.

P.3: At the Interface: Biophysical Insights into Drug–Membrane Interactions in Triple-Negative Breast Cancer Treatment

Ana Carolina Casal^{1,2}, Bruna Silva¹, Irene Sicília³, Juan Giner-Casares³, Andreia C. Gomes¹, Marlene Lúcio²

¹ Centro de Biologia Molecular e Ambiental (CBMA) /Aquatic Research Network (ARNET) Associate Laboratory, and IB-S, Institute of Science and Innovation for Bio-Sustainability, Universidade do Minho, 4710-057 Braga, Portugal.

² Centro de Física das Universidades do Minho e Porto (CF-UM-UP)/ Laboratory for Physics of Materials and Emerging Technologies (LaPMET), Universidade do Minho, 4710-057 Braga, Portugal

³ Departamento de Química Física y T. Aplicada, Facultad de Ciencias, Universidad de Córdoba, Campus de Rabanales, 14014, Córdoba, Spain.

Triple-negative breast cancer (TNBC) is one of the most aggressive breast cancer subtypes, characterized by the absence of estrogen, progesterone, and HER2 receptors, which limits targeted therapeutic options(1). In this context, understanding the interactions between therapeutic agents and cellular membranes is essential for the development of more effective treatments(2,3).

Biomimetic lipid monolayers were used as simplified models of biological membranes to investigate the interactions of therapeutic systems in TNBC. Langmuir monolayers, composed of lipid mixtures representative of healthy and cancer cell membranes, were employed to evaluate the effects of doxorubicin (DOX) and green quantum dot–doxorubicin conjugates (GQD@DOX) on membrane biophysical properties. Surface pressure–area (π -A) isotherms showed that DOX induces monolayer condensation and increased lipid packing, indicating strong interactions with the lipid matrix. In contrast, GQD@DOX induced monolayer expansion and reduced packing, likely due to steric hindrance effects. Cancer-mimicking monolayers also exhibited lower compressibility and higher susceptibility to morphological changes compared to healthy models.

These findings demonstrate the ability of Langmuir monolayers to discriminate between different therapeutic systems and provide relevant insights into their interaction mechanisms with cellular membranes. This approach represents a valuable tool for evaluating nanocarriers with potential therapeutic applications in TNBC.

Acknowledgements We thank the Portuguese Foundation for Science and Technology (FCT) for financial support through the Strategic Funding: UIDB/04650/2025 <https://doi.org/10.54499/UID/04650/2025> (CF-UM-UP), “Contrato-Programa” UID/04050/2025 <https://doi.org/10.54499/UID/04050/2025> (CBMA) and the Erasmus+ programme.

References

1. Li Y, Zhang H, Merkher Y, Chen L, Liu N, Leonov S, et al. Recent advances in therapeutic strategies for triple-negative breast cancer. *J Hematol Oncol.* 2022;15(1):121.
2. Fernandes E, Soares TB, Gonçalves H, Lúcio M. Spectroscopic Studies as a Toolbox for Biophysical and Chemical Characterization of Lipid-Based Nanotherapeutics. *Front Chem.* 2018;6:323.
3. Lúcio M, Lima JLFC, Reis S. Drug–Membrane Interactions: Molecular Mechanisms Underlying Therapeutic and Toxic Effects of Drugs. *Ideas in Chemistry and Molecular Sciences* 2010. p. 191-214.

P.4: Formation of Water-in-Water Emulsions and Microgels in Surfactant–Gelatin Mixtures below the Cloud Point

Jonathan Miras^{1,2,*}, Susana Vílchez^{1,2,*}, Cyprien Bouju^{1,3,§}, Martí Blanco-Pérez^{1,4}, Marc Ros-Espinal^{1,5}, Carlos Rodríguez-Abreu^{1,2}, Jordi Esquena^{1,2}

¹ Institute of Advanced Chemistry of Catalonia (IQAC), Consejo Superior de Investigaciones Científicas (CSIC), Jordi Girona, 18-26, 08034 Barcelona, Spain

² Networking Research Center on Bioengineering, Biomaterials and Nanomedicine (CIBER-BBN, ISCIII), Jordi Girona, 18-26, 08034 Barcelona, Spain.

³ ChimieParisTech – PSL, 11 Pierre et Marie Curie, 75231 Paris, France

⁴ Institut Escola del Treball, Comte Urgell 187, 08036 Barcelona, Spain

⁵ IQS School of Engineering, Universitat Ramon Llull, Via Augusta, 390. 08017 Barcelona, Spain.

* These co-authors equally contributed to this work. § Current address: AgroParisTech, 22 Place de l'Agronomie, 91123 Palaiseau, France

Aqueous solutions of ethoxylated nonionic surfactants exhibit a cloud point temperature, above which a surfactant-rich liquid phase coexists with another liquid phase containing the surfactant at its critical micelle concentration (CMC). Consequently, these nonionic surfactants form aqueous two-phase systems (ATPS). However, such ATPS typically undergo very rapid phase separation and, therefore, are not suitable for the preparation of water-in-water (W/W) emulsions. In the present study, stable W/W emulsions were successfully obtained by adding gelatin to aqueous mixtures of an ethoxylated triglyceride surfactant (Kolliphor ELP), obtaining an ATPS at room temperature. Gelatin-Kolliphor ELP surfactant mixtures allowed the preparation of both gelatin-in-surfactant and surfactant-in-gelatin W/W emulsions (examples shown in Fig. 1). Bovine gelatin was selected as a polyelectrolyte because of its ability to form gels at room temperature. Therefore, gelatin microgels were obtained by cooling gelatin-in-Kolliphor ELP W/W emulsions. Genipin, a low-toxicity reagent, was added to crosslink the gelatin microgels and the colloidal stability of gelatin microgels was improved by incorporating mucin particles, which adsorbed at the gelatin-surfactant interface to form Pickering W/W emulsions. This study demonstrates that W/W emulsions can be prepared in polymer-surfactant mixtures, in contrast to conventional W/W systems based on two mutually incompatible polymers in the absence of surfactants. To the best of our knowledge, this is the first report describing W/W emulsions formed from aqueous mixtures of a polymer and a surfactant. These findings open new prospects for designing W/W emulsions with tunable characteristics. The development of such water-in-water systems, capable of forming chemically crosslinked microgels, holds a great potential for applications in drug delivery and food technology.

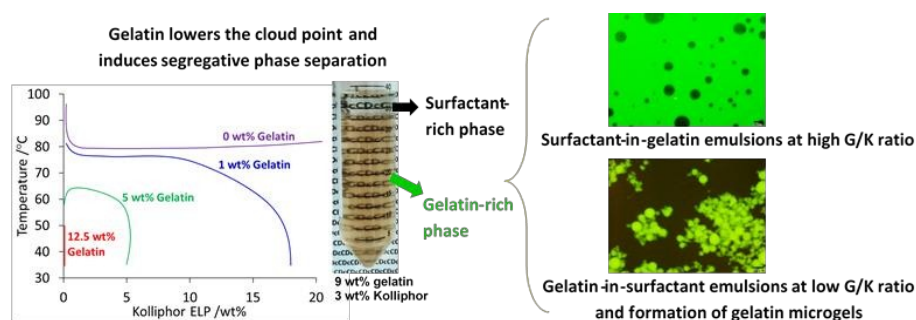


Fig. 1. Phase diagram and scheme of the formation of water-in-water (W/W) emulsions in aqueous mixture of gelatin (G) and the nonionic surfactant Kolliphor ELP (K), at temperatures above the surfactant's cloud point. The scale bars in the optical microscopy images represent 20 μm (Reproduced from [1]).

References

[1] Jonathan Miras; Susana Vílchez; Cyprien Bouju; Martí Blanco-Pérez; Marc Ros-Espinal; Carlos Rodríguez-Abreu; Jordi Esquena. Formation of water-in-water emulsions and microgels in nonionic surfactant+gelatin aqueous mixtures. *Journal of Colloid and Interface Science*. 684, pp.319-330, 2025.

P.5: Encapsulation of Eugenol in Low-G Alginate-Based Microcarriers for Controlled Release and Volatility Reduction

M. B. O. Silva, E. R. Oliveira, D. S. Rosa

Center for Engineering, Modeling and Applied Social Sciences (CECS), Federal University of ABC (UFABC), Santo André, SP, Brazil

The high volatility of essential oils limits their effectiveness in agricultural applications, particularly due to rapid loss and irregular distribution. While encapsulation strategies have been widely explored, the interaction between interfacial stabilization and natural polymer matrix structure in controlling droplet mobility remains insufficiently addressed^{1,2}. In this study, a suspo-emulsion system based on sodium alginate (M/G ~3.5, indicating a mannuronic-rich composition as determined by ¹H-NMR) and a mixed surfactant system (Tween 80/phospholipid-based emulsifier) was developed for the encapsulation of eugenol^{3,4}. The incorporation of a zwitterion emulsifier enhanced interfacial stability by reducing surfactant desorption and promoting electrostatic repulsion. This interfacial charge contributes to repulsion between droplets and stabilizes the dispersion, resulting in nanoemulsions with a negative zeta potential (-40 mV), and limiting droplet mobility within the structured matrix. A systematic variation of alginate concentration (0.1-2% m/m) and mixing energy (200-1600 rpm) allowed decoupling the effects of droplet size and matrix structure. Optical microscopy revealed that the mannuronic-rich alginate forms a more deformable hydrogel network, in which oil droplets are physically entrapped within a continuous matrix with mean particle diameters (d_{4,3}) ranging from 5 to 50 μm (Fig. 1). Dynamic light scattering and stability analyses indicate that alginate contributes not only to increased viscosity but also to interfacial structuring effects, reducing droplet mobility and limiting coalescence and Ostwald ripening. Volatility assays demonstrated a significant reduction in eugenol loss, where the encapsulated compound exhibited a 60% reduction in volatilization over 24 hours compared to a rapid 50% loss within 10 minutes for free eugenol. Accelerated stability tests (54 °C/14 days) further confirmed superior retention in crosslinked systems with 2% m/m alginate (85-90%) compared to non-crosslinked formulations (60-70%). The results support the potential of this suspo-emulsion-based system for the sustainable release of volatile substances across diverse applications including agriculture, cosmetics, and pharmaceuticals.

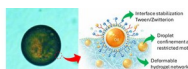


Figure 1: Optical micrograph of alginate-based microcarrier for eugenol (left) and schematic representation of droplet interfacial stabilization and confinement (right). Scale bar: 200 μm .

Acknowledgements

We thank the National Council for Scientific and Technological Development (CNPq, Brazil: 403934/2021-4), the Multiuser Experimental Centers (CEM-UFABC, Brazil), and Agrivale (23006.004107-2023-77 Process, Brazil).

References

- [1] Salager, J.L. et al. (2023). Review on Some Confusion Produced by the Bicontinuous Microemulsion Terminology and Its Domains Microcurvature: A Simple Spatiotemporal Model at Optimum Formulation of Surfactant-Oil-Water Systems. *ACS Omega*. <https://doi.org/10.1021/acsomega.3c00547>.
- [2] Mostaghimi, M. et al. (2021). Characterization of Alginate Hydrogel Beads Loaded with Thyme and Clove Essential Oils Nanoemulsions. *Journal of Polymers and the Environment* 2021 30:4. <https://doi.org/10.1007/s10924-021-02298-w>.
- [3] Cai, W.Q. et al. (2023). Synergistic effect of lecithin and alginate, CMC, or PVP in stabilizing curcumin and its potential mechanism. *Food Chemistry*. <https://doi.org/10.1016/j.foodchem.2023.135634>.
- [4] Homayouni, A. et al. (2007). Effect of Lecithin and Calcium Chloride Solution on the Microencapsulation Process Yield of Calcium Alginate Beads. *Iranian Polymer Journal*.

P.6: The role of the mannuronate/gulonate ratio in the obtention of gelled alginate microparticles

É. Ramin de Oliveira¹, M. B. da Silva¹, D.S. Rosa¹

¹Universidade Federal do ABC, Av. Dos Estados, 5001, São Paulo, Brazil

Two commercial sodium alginates (ALG1: 198,1 g/mol; ALG2: 198,0 g/mol, CAS 9005-38-3), each with distinct mannuronate/gulonate (M/G) ratios, were compared to identify differences in the encapsulation properties of cinnamon essential oil (CEO). To achieve this comparison, Emulsions containing ALG1 or ALG2 and CEO were prepared at three concentrations of the nonionic surfactant Tween 80. These emulsions were then atomized in a CaCl₂ solution to form microparticles. For characterization, alginates were analyzed using FTIR-ATR and H-NMR, while emulsions were assessed rheologically. Next, the resulting gelled particles were evaluated for particle size, morphology, and ζ potential. FTIR-ATR results showed the absence of peaks in the fingerprint region of ALG2 spectrum, between 948 cm⁻¹ and 903 cm⁻¹, indicating that ALG2 was deficient in guluronic residues¹. In addition, H-NMR analysis confirmed this finding and showed ALG1 contained 32 times more guluronic acid than ALG2. Regarding viscosity, emulsions made with ALG1 had higher values of viscosity than those made with ALG2. All formulations displayed pseudoplastic behavior². Furthermore, increasing Tween 80 concentration from 0.001% to 0.125% reduced particle size from 169 ± 32 µm to 61 ± 2 µm, due to improved emulsification³. While using more surfactants, however, sample uniformity improved, but particle size increased. Alginate composition influenced the particles' morphology: ALG1 produced more defined, structured particles than ALG2. The higher M/G ratio of ALG2 resulted in less distinct particles under microscopy. ALG1 microcapsules appeared as aggregates with visible droplets. In terms of ζ -potential, analysis showed that lower Tween 80 concentrations increased the magnitude of the surface charge. For ALG1, it changed from -14.4 ± 1.5 mV to -17.4 ± 1.3 mV. For ALG2 samples, they increased from -15.1 ± 0.4 mV to -24.5 ± 1.2 mV, possibly due to the shielding effect of the non-ionic surfactant^{4,5}. In this way, the properties of sodium alginate directly influenced the properties of emulsions and capsules. Emulsions with ALG1 had higher viscosity and structural properties due to higher guluronic acid content, while increasing non-ionic surfactant concentration modulated emulsion viscosity, particle size, and surface charge.

Acknowledgements

The authors gratefully acknowledge Fundep (Project n°. 30424 - PROCESS: 23006.004107-2023-77), Agrivalle Brasil Indústria e Comércio de Produtos Agrícolas S/A, CNPq (308053/2021-4 and 403934/2021-4), FAPESP (2021/14714-1, 2020/13703-3), UFABC, CAPES (Code 001), the REVALORES Strategic Unit, and the Multiuser Central Facilities (CEM—UFABC) for their support and contributions to this research.

References

1. Mollah, M.Z.I., Faruque, M.R.I., Bradley, D.A., Khandaker, M.U., and Assaf, S. Al (2023) FTIR and rheology study of alginate samples: Effect of radiation. *Radiation Physics and Chemistry*, 202 (110500).
2. Cofelice, M., Cuomo, F., and Lopez, F. (2018) Rheological properties of alginate- essential oil nanodispersions. *Colloids and Interfaces*, 2 (4).
3. Baranauskaite, J., Ockun, M.A., Uner, B., Tas, C., and Ivanauskas, L. (2021) Effect of the amount of polysorbate 80 and oregano essential oil on the emulsion stability and characterization properties of sodium alginate microcapsules. *Molecules*, 26 (20).
4. Panbehchouleh, F.A., Amani, H., and Saeedi, M. (2024) Menadione Sodium Bisulfite Loaded Rhamnolipid Based Solid Lipid Nanoparticle as Skin Lightener Formulation: A Green Production Beside In Vitro/In Vivo Safety Index Evaluation. *Adv. Pharm. Bull.*, 14 (3), 623–633.
5. Lertsutthiwong, P., Noomun, K., Jongaroonngamsang, N., Rojsitthisak, P., and Nimmannit, U. (2008) Preparation of alginate nanocapsules containing turmeric oil. *Carbohydr. Polym.*, 74 (2), 209–214.

P.7: Effect of molecular architecture on the micellization, gelation and rheological behavior of triblock copolymers

R. L. Machado, D. Moreira, I. S. Oliveira, E. F. Marques

CIQUP/IMS, Department of Chemistry and Biochemistry, Faculty of Sciences, University of Porto, Portugal

Owing to their tunable nanostructure and thermoresponsive behavior, poloxamers are widely investigated in soft matter science and in various biomedical applications, including tissue regeneration, photothermal therapy, and controlled drug delivery.^{1,2} They consist of block copolymers composed of hydrophilic polyethylene oxide (PEO) and hydrophobic polypropylene oxide (PPO) segments, exhibiting temperature-responsive self-organization in aqueous solutions; they form micelles and, at sufficiently high concentrations, liquid-crystalline mesophases. These mesophases behave phenomenologically as hydrogels, retaining large amounts of water and displaying complex, non-Newtonian rheological behavior.

Here, we investigate the influence of PEO-PPO-PEO poloxamer composition and block architecture on self-organization, micellization thermodynamics, gelation, and rheological behavior. Two concentration regimes were examined. In the lower poloxamer concentration regime ($c_p \leq 10$ wt%), micellization was characterized using differential scanning microcalorimetry (micro-DSC) to determine the micellization temperature, enthalpy, and entropy, while dynamic light scattering was employed to probe micelle size. In the high concentration regime ($c_p = 25.0$ wt%), temperature-dependent oscillatory shear rheology was used to assess gelation and mechanical response, including gelation temperature, pre- and post-gelation viscosity, the evolution of the storage (G') and loss (G'') moduli, and gel strength.

The results demonstrate that micellization is primarily governed by PPO block length, whereas gelation and mechanical robustness in the concentrated systems arise from collective micellar behavior, depending on a balance between PPO-driven intermicellar attraction and PEO-mediated steric interactions. Notably, gelation temperature and gel strength do not vary monotonically with polymer composition; instead, non-monotonic trends reveal an optimal PEO corona size that maximizes network connectivity while limiting junction compliance. These findings provide mechanistic insight into the multiscale structure-property relationships of poloxamer hydrogels from a soft-matter perspective and help to inform the rational design of thermoresponsive soft materials for biomedical applications.

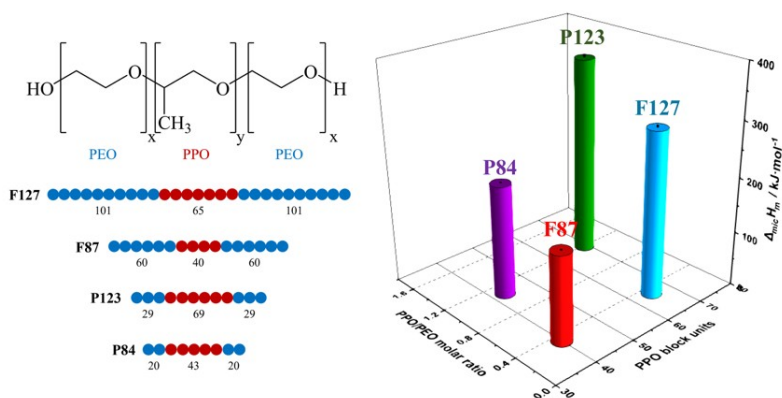


Figure 1: Triblock copolymer architecture, and dependence of molar enthalpy of micellization on PPO/PEO ratio and PPO block length.

Acknowledgements We thank FCT for financial support through CIQUP via UID/QUI/0081/2025 and IMS via LA/P/0056/2020.

References

1. Hamley, I., Block Copolymers in Solution: Fundamentals and Applications; John Wiley & Sons, 2005.
2. Machado, R.L., Loureiro, E.C., Silva, S.G., Oliveira, I.S., Gomes, A.C. and Marques, E.F., Mater. Today. Chem, 2026, 52, 103362.

P.8: Flavylium–Chalcone Switching in Lower-Rim Functionalized Calix[4]arene Amphiphile

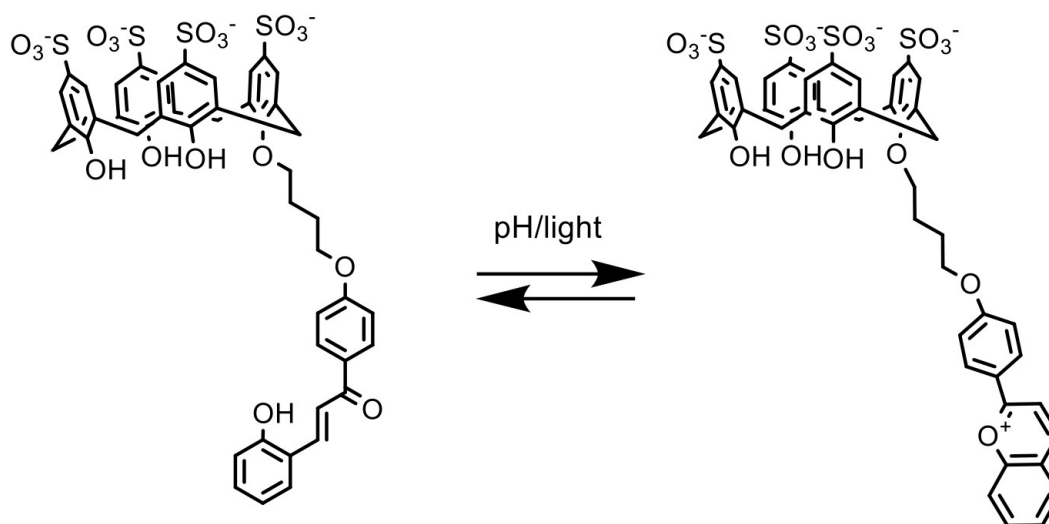
H. Mahmoodi, N. Basílio

LAQV-REQUIMTE, Departamento de Química, Faculdade de Ciências e Tecnologia, Universidade NOVA de Lisboa, 2829-516 Caparica, Portugal

Calix[4]arenes serve as versatile scaffolds for the development of amphiphilic supramolecular systems. In this study, a sulfonated calix[4]arene (SC4) platform was selectively mono-functionalized at the lower rim with a flavylium moiety. Subsequent transformation into the corresponding chalcone derivative provides access to a photo- and pH-responsive molecule within a single macrocyclic framework.

The presence of the cationic flavylium unit, together with its reversible conversion to the neutral chalcone form, enables modulation of charge distribution, hydrophobicity, and intermolecular interactions. This switching behavior is expected to promote the formation of stimuli-responsive amphiphilic assemblies driven by electrostatic and hydrophobic effects.

In this communication, we present results on the synthesis and spectroscopic characterization of this stimuli-responsive, water-soluble calixarene.¹



Scheme 1: stimuli-induced between chalcone and Flavylium

Acknowledgements

This work was financed by national funds from FCT - Fundação para a Ciência e a Tecnologia, I.P., under the scope of the project UID/50006/2023 of the Associate Laboratory for Green Chemistry- LAQV REQUIMTE. FCT is also acknowledged for the project 2023.16144.ICDT; cofinanced by FEDER through COMPETE 2023 with reference COMPETE2030-FEDER-00899900.

References

- [1] Photoswitchable Calixarene Activators for Controlled Peptide Transport across Lipid Membranes. *J. Am. Chem. Soc.* 2023, 145, 24. <https://doi.org/10.1021/jacs.3c01829>

P.9: Effect of Algal Lipid Extracts on the Interface of Rhamnolipid-Stabilized Nanoemulsions

F. Marques^{1,2}, L. Pastrana¹, H. Cardoso³, M. H. Abreu⁴, M. R. Domingues^{2,5}, M. A. Cerqueira¹

¹ International Iberian Nanotechnology Laboratory, Av. Mestre José Veiga s/n, 4715-330, Braga, Portugal

² CESAM, Department of Chemistry, University of Aveiro, Santiago University Campus, 3810-193 Aveiro, Portugal

³ Allmicroalgae – Natural Products S.A., R&D Department, Rua 25 de Abril s/n, 2445-413 Pataias, Portugal

⁴ ALGAplus – Production and Trading of Seaweeds and Derived Products S.A., 3830-196, Ílhavo, Portugal

⁵ Mass Spectrometry Centre, LAQV-REQUIMTE, Department of Chemistry, University of Aveiro, Santiago University Campus, 3810-193 Aveiro, Portugal Institution, Address, Town, Country

Algae-derived lipids represent complex amphiphilic systems with potential to modulate interfacial phenomena in colloidal dispersions (Ahmad et al., 2025). In this study, a food-grade algal lipid extract (LE) was obtained from a commercial algae blend (Algaessence®) using ultrasound-assisted extraction with ethyl acetate. The extract was characterized in terms of phospholipid and glycolipid content, as well as pigment composition, revealing the presence of surface-active and amphiphilic constituents relevant for interfacial assembly. The LE was incorporated into oil-in-water nanoemulsions (NEs) formulated with either medium-chain triglycerides (MCT) or sunflower (SUN) oil (1 wt%) and stabilized using rhamnolipids (0.05 wt%) derived from the bacterium *Pseudomonas aeruginosa* as biosurfactant. Nanoemulsions (NEs) were produced via a two-step process involving pre-homogenization followed by high-energy ultrasonication, and compared with unloaded systems to assess interfacial effects induced by LE. LE-loaded NEs exhibited droplet sizes below 200 nm (MCT: 137.4±2.2 nm; SUN: 163.8±2.9 nm), low polydispersity (MCT: 0.21±0.03; SUN: 0.24±0.01), and highly negative zeta potentials (MCT: -70.9±3.2 mV; SUN: -70.2±3.3 mV), indicating strong electrostatic stabilization. Transmission electron microscopy (TEM) confirmed the formation of well-dispersed spherical droplets, consistent with dynamic light scattering measurements. The presence of LE reduced droplet size compared to control systems, suggesting interfacial stability driven by amphiphilic components of the extract. Furthermore, LE-NEs showed enhanced resistance to pH variations (pH 2.5–9), compared with unloaded NEs, indicating robust interfacial films likely reinforced by mixed adsorption of rhamnolipids and algal surface-active lipids. Overall, these results highlight the synergistic role of biosurfactants and naturally occurring amphiphilic lipids in controlling nanoemulsion formation and stability. This work provides insights into surfactant–lipid interfacial interactions and demonstrates the potential of combining microbial biosurfactants with algae-derived lipid fractions to engineer stable colloidal systems.

Acknowledgements Francisca Marques is grateful to FCT for the PhD Grant (2022.12131.BD; <https://doi.org/10.54499/2022.12131.BD>). This work is funded by national funds through FCT – Fundação para a Ciência e a Tecnologia I.P., under the project/grant UID/50006 + LA/P/0094/2020 (Centro de Estudos do Ambiente e Mar (CESAM)) and UID/50006 - Laboratório Associado para a Química Verde - Tecnologias e Processos Limpos. The authors acknowledge the University of Aveiro and the Portuguese Mass Spectrometry Network – RNEM (LISBOA-01-0145-FEDER-402-022125). The authors acknowledge the support of the Nanophotonics and Bioimaging Facility at the International Iberian Nanotechnology Laboratory.

References

Ahmad, S., Singh, A., Akram, W., Upadhyay, A., & Abrol, G. S. (2025). Algal lipids: A review on current status and future prospects in food processing. *Journal of Food Science*, 90(1), e17618. <https://doi.org/10.1111/1750-3841.17618>

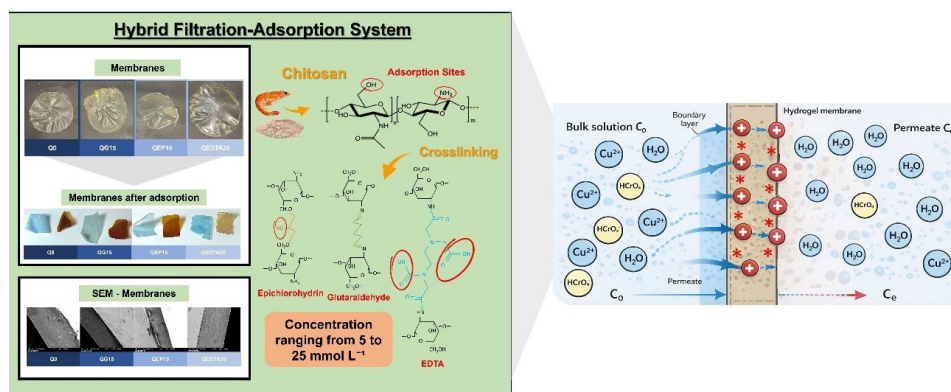
P.10: Effect of Crosslinker Type and Concentration on Chitosan Hydrogel-Membranes for Selective Removal of Cr^{6+} and Cu^{2+}

Lucas R. Goncalves, Rafaela R. Ferreira, Derval S. Rosa

Federal University of ABC, Avenida dos Estados 5001, Santo André - SP, Brazil.

Potentially toxic elements (PTEs) such as Cu^{2+} , Ni^{2+} , Zn^{2+} , Mn^{2+} , Cd^{2+} , and Cr^{6+} in aquatic systems, mainly from industrial activities, pose significant environmental risks. While some are essential at trace levels, their accumulation leads to toxicity and ecological imbalance¹. Adsorption combined with membrane filtration has emerged as an effective and sustainable treatment approach. Chitosan stands out for its amino ($-\text{NH}_2$) and hydroxyl ($-\text{OH}$) groups, which enable both chemical modification and interactions with metal ions. In this work, chitosan hydrogel-membranes² were prepared via solution casting method and crosslinked with different agents (glutaraldehyde (G), epichlorohydrin (EP) and ethylenediaminetetraacetic acid (EDTA)) to evaluate the effects of crosslinker type and concentration ($5\text{--}25\text{ mmol L}^{-1}$) on their structural properties and adsorption performance. FTIR, swelling, and gel fraction analyses confirmed the formation of stable three-dimensional networks in all systems. Thermal analysis indicated increased stability for G- and EP-based membranes, while EDTA-crosslinked systems exhibited distinct degradation behavior. SEM images revealed dense and compact morphologies, suggesting that mass transport occurs predominantly by diffusion through the polymer matrix. A multielement selectivity test (0.1 mmol L^{-1} of each ion and pH 4) revealed that Cr^{6+} and Cu^{2+} exhibited the highest affinity for all membranes. Based on the simultaneous removal efficiency of these two ions, the best-performing formulations were identified as QG15 (15 mmol L^{-1} of G), QEP15 (15 mmol L^{-1} of EP) and QEDTA25 (25 mmol L^{-1} of EDTA), with average removal efficiencies of 91%, 85% and 89%, respectively. Subsequently, an in-depth adsorption study was conducted under mono-element conditions (0.5 mmol L^{-1}) for Cr^{6+} and Cu^{2+} . The optimal conditions evaluated were pH 3 and 1 g L^{-1} for both ions. Under these conditions, QG15 showed the highest Cr^{6+} removal (85%, $q_e = 0.482\text{ mmol g}^{-1}$), while QEDTA25 exhibited superior performance for Cu^{2+} (87%, $q_e = 0.431\text{ mmol g}^{-1}$). These results highlight the influence of the crosslinking agent on adsorption behavior, indicating a preferential affinity of glutaraldehyde-crosslinked membranes for Cr^{6+} and EDTA-crosslinked systems for Cu^{2+} , likely associated with differences in functional groups and interaction mechanisms.

Scheme: Representation of the hybrid filtration-adsorption system based on crosslinked chitosan hydrogel-membranes.



Acknowledgements

We acknowledge FAPESP (2020/13703-3, 2021/14714-1, 2022/01382-3 and 2024/21298-2) and CNPq (132681/2024-2) for financial support, and UFABC and CEM-UFABC for institutional support.

References

- [1] Chen, L.; Fang, L.; Yang, X.; Luo, X.; Qiu, T.; Zeng, Y.; Huang, F.; Dong, F.; White, J. C.; Bolan, N.; Rinklebe, J. Environ. Int. 2024, 187, 108708. <https://doi.org/10.1016/j.envint.2024.108708>.
- [2] Yazdi, M. K.; Vatanpour, V.; Taghizadeh, A.; Taghizadeh, M.; Ganjali, M. R.; Munir, M. T.; Habibzadeh, S.; Saeb, M. R.; Ghaedi, M. Mater. Sci. Eng. C 2020, 114, 111023. <https://doi.org/10.1016/j.msec.2020.111023>.

P.11: Structure–Performance Relationship of β -Cyclodextrin–Clay Hybrid Composites for Metal Ion Removal

Rafaela R. Ferreira¹, Pedro M. C. Matias², Dina M. B. Murtinho², Artur J. M. Valente², Derval S. Rosa¹

¹ Engineering, Modeling and Applied Social Sciences Center (CECS), Federal University of ABC, Av dos Estados, 5001, Bairro Bangu, 09210-580 Santo André, SP, Brazil

² University of Coimbra, CQC-IMS, Department of Chemistry, Rua Larga, 3004-535 Coimbra, Portugal

The contamination of water by metal ions represents a significant environmental challenge, driving the development of efficient adsorbent materials. In this work, hybrid composites were prepared by crosslinking β -cyclodextrin (β -CD) with citric acid through polycondensation [1], followed by the incorporation of 5 wt.% of Brazilian clays, Brasgel (B) and Chocobofo (C), in their natural and thermally activated forms (Bt and Ct). The adsorptive performance of these composites was subsequently evaluated for the removal of Cu^{2+} , Mn^{2+} , and Ni^{2+} from aqueous systems (Figure 1). FTIR analyses confirmed the formation of ester bonds between citric acid and β -CD, evidenced by the characteristic C=O stretching band at 1720 cm^{-1} . The incorporation of clay did not significantly alter the main spectral bands, indicating the absence of covalent bonds formation between the clay functional groups and the polymer matrix (PCD). Thermogravimetric analysis (TGA) showed increased thermal stability after the addition of clay, highlighting its role as a structural reinforcement. Adsorption experiments revealed that the PCD-clay composites exhibited superior performance compared to the pure polymer and isolated clays, achieving removal efficiencies of up to 62% (Cu^{2+}), 42% (Mn^{2+}), and 49% (Ni^{2+}), with PCD-B showing the best performance. The kinetics were best described by the pseudo-second-order model, indicating chemisorption-controlled processes, while the dual-site Langmuir model provided the best fit to the equilibrium data, suggesting the presence of two distinct populations of active sites guiding adsorption. The maximum adsorption capacities (q_{max}) reached 0.58 mmol g^{-1} for Cu^{2+} (PCD-Bt), 0.82 mmol g^{-1} for Ni^{2+} (PCD-Bt), and 0.66 mmol g^{-1} for Mn^{2+} (PCD-C). Overall, the results indicated a synergistic effect between the polymer matrix and the clays, enhancing adsorption capacity and accelerating removal kinetics (15 min) compared to PCD or clays individually. These findings highlight the potential of β -CD/clay hybrid composites (particularly PCD-B) as sustainable and efficient materials for treating metal-contaminated wastewater.

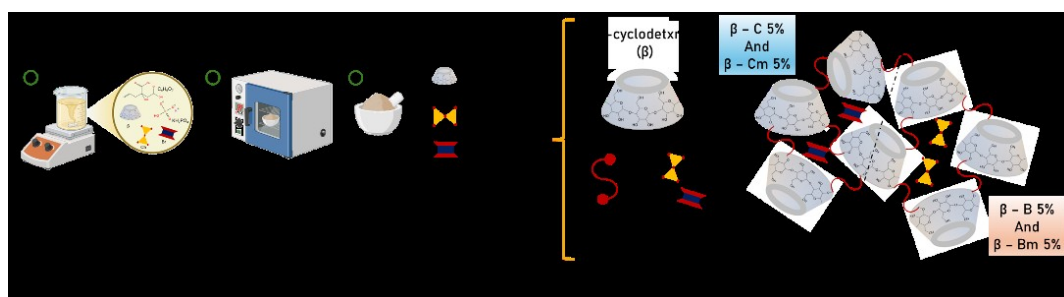


Figure 1. Schematic representation of the synthesis procedure of PCD containing Brazilian clays.

Acknowledgements

We acknowledge FAPESP for financial support through the thematic project (2020/13703-3 and 2021/14714-1) and grants (2024/08105-0 and 2022/01382-3). We also acknowledge CNPq for the grant (132681/2024-2). The authors thank UFABC and CEM-UFABC for institutional support. The work was also funded by the Coimbra Chemistry Centre, which is supported by the Fundação para a Ciência e a Tecnologia (FCT, Portugal), through the programs UIDB/00313/2025, UIDP/00313/2025 and LA/P/0056/2020. Pedro M. C. Matias acknowledges FCT, Portugal for the PhD Grant 2022.12425.BD.

References

[1] Silva, Emilly C., et al. "Carbon quantum dots-containing poly (β -cyclodextrin) for simultaneous removal and detection of metal ions from water." *Carbohydrate Polymers* 323 (2024): 121464.

P.12: Plasma treatment on electrospun membranes containing plasma-treated nanoclays: structure and adsorption performance

P. H. Camani¹, T. S. Steffen², D. Becker², G. Pitarelli³, S. Sahoo⁴, A. Yadav⁴, K. Rezvanian⁴, D. S. Rosa³, V. K. Rangari⁴, L. H. I. Mei¹

¹ School of Chemical Engineering, Department of Materials Engineering and Bioprocess (DEMBio), State University of Campinas (Unicamp), Albert Einstein Avenue, 13083-852, Campinas, Brazil

² Lab of Plasmas, Films and Surfaces, State University of Santa Catarina (UDESC), Florianópolis, Brazil

³ Center for Engineering, Modeling, and Applied Social Sciences (CECs), Federal University of ABC (UFABC), dos Estados Avenue, 09280-560, Santo André, Brazil

⁴ Department of Materials Science and Engineering, Tuskegee University (TU), Tuskegee, Alabama, USA

Polymeric membranes have been widely used in water treatment for their ease of operation and ability to retain contaminants. However, some hindrances, such as poor hydrophilicity, low selectivity, membrane fouling, and weak transport performance, still need to be overcome¹. In this context, cold plasma treatment can be used to introduce functional groups on the membrane's surface, thereby avoiding surface degradation of the membranes, depending on the conditions used². Thus, we fabricated electrospun PLA membranes containing plasma-treated nanoclays with different contact times (5, 17, and 30 min) and using SF₆ as a gas, followed by cold plasma treatment on the membrane's surface using O₂ as a precursor gas, plasma power of 18 W, and 5 min of contact time for each side of the membrane to evaluate the effect of plasma irradiation on the membrane's surface and their adsorptive performance to remove hexavalent chromium [Cr(VI)]. From the FTIR spectra, the carbonyl index (CI) was calculated for PLA, PLA containing C20A at 5 wt.%, and plasma-treated nanoclays with different contact times of SF₆ plasma, followed by O₂ plasma. The CI was 0.62, 0.65, 0.63, 0.65, and 0.78 for these electrospun membranes. In other words, higher degradation under plasma irradiation will occur in plasma-treated membranes with nanoparticles that have longer contact times. Morphologically, a clear degradation of the PLA membrane's surface was found due to plasma irradiation, thereby corroborating the FTIR spectra and the carbonyl index, following the same trend. Then, reducing plasma contact time on the nanoparticle's surface could reduce polymer degradation. Additionally, the adsorptive performance for removing Cr(VI) was evaluated for all plasma-treated membranes, with C₀ = 0.05 mMol/L and C₀ = 0.8 mMol/L, maintaining the medium pH at 2, the temperature at around 25 and 30 °C, and constant stirring at 150 rpm. Plasma-treated PLA membranes without fillers yielded the best results (especially in the relationship between removal efficiency and removal capacity). For electrospun membranes containing plasma-treated C20A nanoclays, there was a slight reduction in adsorptive values, with a slight increase for the membrane containing C20A treated with 30 min of SF₆ plasma (PLA+T-C20A/SF₆/t_{30min} 5%). However, for all plasma-treated membranes, solubility in the contaminated solution under constant stirring for 24 h was worse, with the membranes losing weight after 24 h, indicating poor mechanical resistance when used as filtration membranes. Therefore, plasma-treated nanoparticles incorporated into a polymer matrix can slow membrane degradation but reduce the availability of active sites, thereby decreasing hexavalent chromium removal performance and ultimately reducing the mechanical strength of the membranes.

Acknowledgements This research was financed by São Paulo Research Foundation (FAPESP) (grant #2023/11229-0, grant #2024/15696-5, grant #2022/11133-0, grant #2023/11783-8, grant #2022/01382-3, #2024/08105-0, grant #2020/13703-3, Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq) (grant #308053/2021-4, grant #403934/2021-4), and Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) (Finance Code 001). The authors would also like to acknowledge the NSF-CREST# 1735971. The authors thank the technical support of the Multiuser Experimental Center of UFABC (CEM-UFABC), CECS (UFABC).

References

1. Ebrahimi, M. (2026) Innovative Physical and Chemical Strategies for the Modification and Development of Polymeric Microfiltration Membranes—A Review. *Polymers* (Basel), 18 (3), 311.
2. Bertin, M., Leitao, E.M., Bickerton, S., and Verbeek, C.J.R. (2024) A review of polymer surface modification by cold plasmas toward bulk functionalization. *Plasma Processes and Polymers*, 21 (5).

P.13: Controlled Growth of Iridium Shells on Colloidal Gold Nanocrystals

S. Triviño-Sánchez¹, H. Geiss², A. Guerrero-Martínez¹, G. Gonzalez-Rubio¹

¹ Departamento de Química Física, Universidad Complutense de Madrid, Avenida Complutense s/n, 28040 Madrid, Spain.

² Physical Chemistry, University of Konstanz, Universitätsstraße 10, Box 714, 78457 Konstanz, Germany.

Colloidal multimetallic nanocrystals of noble metals possess novel physicochemical properties that make them highly attractive for energy harvesting and advanced catalysis^{1,2,3}. Specifically, it is of great interest to obtain nanocrystals that combine metals such as gold and iridium, as this can yield nanocrystals with strong optical properties (localized surface plasmon resonance of gold) and the exceptional catalytic activity of iridium. Their practical use depends heavily on our ability to precisely control their shape, size, composition, and elemental distribution. However, fabricating well-defined gold-iridium nanocrystals with desired dimensions and compositions remains a formidable challenge, primarily because iridium strongly favors homogeneous nucleation over heterogeneous deposition onto preformed seeds.

In this work, we have developed a bottom-up wet-chemical route to produce colloidal gold@iridium core@shell nanocrystals, using ethylene glycol as both solvent and reducing agent. To rigorously control the deposition process and suppress the homogeneous nucleation of iridium, a comprehensive study of the synthetic parameters was conducted, exploring the effects of temperature, the presence of oxygen in the reaction, reaction volume, and the concentration of key additives such as lead ions, hydrochloric acid, and stabilizing surface ligands. The optimization of these parameters enabled the investigation of the shell architecture's influence on the final physicochemical properties through the synthesis of three distinct Au:Ir molar ratios: 1:9, 1:3, and 1:1 (Fig. 1). This strategy guaranteed a conformal and controlled deposition of iridium onto the gold seeds, resulting in highly stable colloidal dispersions with well-defined core-shell morphologies.

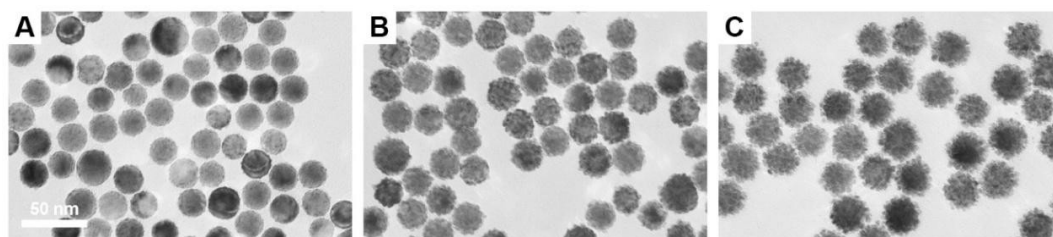


Figure 1: Electron microscopy images of Au@Ir nanocrystals with distinct Au:Ir ratios of (A) 1:1, (B) 3:1, and (C) 9:1.

Acknowledgements

This work has been supported by the ERC Starting Grant Time4Nano (101164205), the Spanish Ministry of Science, Innovation, and Universities (grants PID2021-123228NB-I00 and PID2024-159196NB-I00), and the International Research Network-IRN Nanoalloys. G.G-R. acknowledges the Atracción de Talento Fellowship from the Madrid Regional Government (Grant 2022-T1/IND-23908).

References

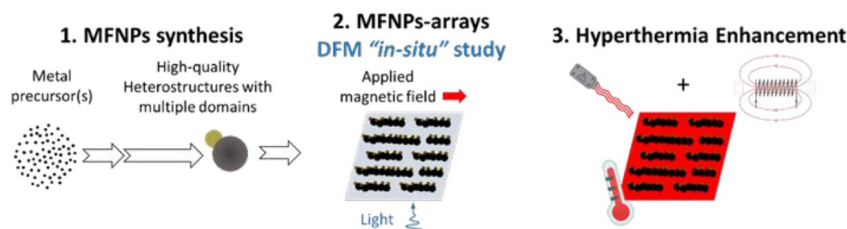
1. E. C. Dreaden; A. M. Alkilany; X. Huang; C. J. Murphy; M. A. El-Sayed; The golden age: gold nanoparticles for biomedicine, *Chem. Soc. Rev.* 2012, 41, 2740–2779.
2. R. Narayanan; M. A. El-Sayed; Shape-Dependent Catalytic Activity of Platinum Nanoparticles in Colloidal Solution. *Nano Letters*. 2004, 4, 1343–1348.
3. Y. Chen; H. Hung; M. H. Huang*. Seed-Mediated Synthesis of Palladium Nanorods and Branched Nanocrystals and Their Use as Recyclable Suzuki Coupling Reaction Catalysts. *J. Am. Chem. Soc.* 2009, 131, 25, 9114–9121.
- 4 K. D. Gilroy; A. Ruditskiy; H. Peng; D. Qin; Y. Xia*. Bimetallic Nanocrystals: Syntheses, Properties, and Applications. *Chem. Rev.* 2016, 116, 10414–10472.

P.14: Arrays of magnetic-plasmonic nanoparticles in viscous media monitored by dark-field optical microscopy

L. Labrador-Páez, M. Herrera-Serrano, A. Guerrero-Martínez, H. Gavilán

Physical Chemistry Department, Complutense University of Madrid, 28040, Madrid, Spain

Magnetic and plasmonic nanoparticles are widely utilized in nanomedicine for their capacity to generate localized heat when exposed to external electromagnetic fields. However, the heating efficiency of magnetic nanomaterials typically declines when they are transferred from aqueous dispersions into viscous biological-like media. To circumvent this limitation, magnetic nanoparticles can be arranged as arrays, forming long chains of nanoheaters¹. By integrating both magnetic and plasmonic materials into a single nanostructure, we have developed a multimodal heating platform responsive to both magnetic fields and light (Scheme). In this work, we take advantage of the diffraction-nonlimited resolution of dark-field microscopy to monitor the real-time the formation of these plasmonic-magnetic arrays². This approach allows to characterize the array formation kinetics and optimize its heating performance within complex biological environments. By controlling the spatial arrangement of the nanoheaters, this work provides a robust strategy for maintaining high heating efficiency in viscous media, facilitating more effective therapeutic applications.



Scheme: Steps in the optimization of arrays of plasmonic-magnetic nanoparticles.

Acknowledgements We thank the Spanish Ministry of Science, Innovation, and Universities (PID2023-150760NA-I00).

References

- Gavilán, H., ... & Pellegrino, T. (2021). Magnetic nanoparticles and clusters for magnetic hyperthermia: optimizing their heat performance and developing combinatorial therapies to tackle cancer. *Chemical Society Reviews*, 50(20), 11614-11667. <https://doi.org/10.1039/D1CS00427A>
- Labrador-Paez, L., Casanovas-Melián, A., Junquera, E., Guerrero-Martínez, A., & Ahijado-Guzmán, R. (2024). Optical dark-field spectroscopy of single plasmonic nanoparticles for molecular biosciences. *Nanoscale*, 16(41), 19192-19206. <https://doi.org/10.1039/D4NR03055A>

P.15: Polymorphic Transformations in Glass-Coated BiVO_4 Films

Bernardo Norte^{1,*}, Ana C. Estrada¹, Helena I. S. Nogueira¹, Tito Trindade¹

¹Department of Chemistry and CICECO-Aveiro Institute of Materials, University of Aveiro, Aveiro, Portugal

Bismuth(III) vanadate (BiVO_4) is a technologically relevant metal oxide whose performance depends on crystal structure, local order, and surface/interface properties. As a yellow pigment it has been employed as an alternative to cadmium and lead containing compounds, such as CdS and PbCrO_4 . Furthermore, BiVO_4 is also an important technological material for solar energy conversion and photocatalytic applications. Its performance depends on the polymorph present, which is in turn influenced by the synthesis method used. Therefore, accurate identification of the crystalline phases present in a sample is crucial. In this work, Raman spectroscopy was used to distinguish monoclinic scheelite BiVO_4 (ms- BiVO_4) from tetragonal scheelite BiVO_4 (ts- BiVO_4), while also addressing the effect of laser-induced polymorphism transformations during spectral acquisition using glass-coated films (Fig. 1)¹. Our studies demonstrate that the Raman response is sensitive to the local interaction between the incident beam and the BiVO_4 surface¹. Under these conditions, the interface may become a site of thermal accumulation, structural rearrangement, and phase conversion. Therefore, the experimental Raman spectra may show not only the original polymorph distribution, but also the dynamic evolution of the probed interface during characterization.

In this communication we discuss that reliable Raman phase assignment in glass-coated BiVO_4 samples requires careful control of acquisition conditions, especially laser power and exposure time, because both influence the stability of the probed interface and the likelihood of interface-mediated transformations. As an advancement in materials characterization, our research demonstrates that confocal Raman spectroscopy can be employed to obtain the spatial distribution of ms- BiVO_4 and ts- BiVO_4 within the same coated glass sample, hence providing an effective method for distinguishing between these polymorphs.

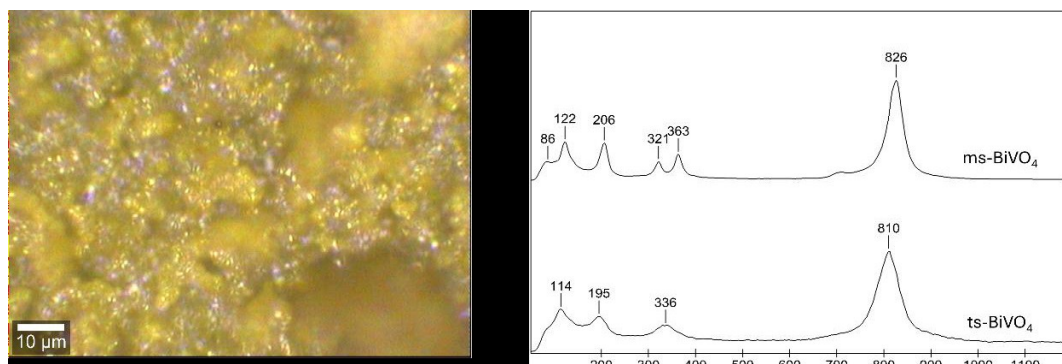


Figure 1: a) Optical microscopy image of a BiVO_4 sample and b) Raman spectra of the ms- BiVO_4 and ts- BiVO_4 polymorphs

Acknowledgements This work was developed within the scope of the project CICECO-Aveiro Institute of Materials, UID/50011/2025 (DOI 10.54499/UID/50011/2025) & LA/P/0006/2020 (DOI 10.54499/LA/P/0006/2020) & UID/PRR/50011/2025 (DOI 10.54499/UID/PRR/50011/2025), financed by national funds through the FCT/MCTES (PIDDAC).

References

Norte, B., Estrada, A.C., Nogueira, H.I.S., and Trindade, T. (2026) Implications of Laser-Induced Polymorphism Transformations in Bismuth(III) Vanadate Raman Spectroscopy Characterization. *Journal of Raman Spectroscopy*. <https://doi.org/10.1002/jrs.70104>

P.16: A Modular Polymeric Approach for the Self-Assembly of Plasmonic Nanoparticles via Acid-Base Interactions

I. Segura De Orta¹, M. J. Mancheño², J. Osío Barcina², A. Guerrero-Martínez¹, G. González-Rubio¹

¹ Departamento de Química Física, Universidad Complutense de Madrid, Avenida Complutense s/n, 28040 Madrid, Spain

² Departamento de Química Orgánica, Universidad Complutense de Madrid, Avenida Complutense s/n, 28040 Madrid, Spain

The precise control over the spatial organization of plasmonic metal nanocrystals remains a fundamental challenge in nanotechnology, as it dictates the emergence of unique collective optical properties¹. Despite the development of numerous strategies, achieving high colloidal stability and regioselective self-assembly through simple, reversible processes remains underexplored². The present work proposes a synthetic strategy for the controlled self-assembly of gold nanoparticles (AuNPs) using complementary responsive polymeric ligands.

The focal point of this investigation is the development of a "LEGO-type" platform based on a shared scaffold of pentafluorophenyl acrylate (PFPA), which facilitates versatile post-polymerization functionalization. This backbone is then functionalized with polystyrene and two distinct complementary copolymeric systems, containing 2-(dimethylamino)ethyl methacrylate (DMAEMA) or acrylic acid (AA) moieties. Thereby, the specific acid-base interactions between these complementary functional groups located on the surface of the AuNPs drive a controlled assembly process, while the polystyrene chains provide steric repulsions that prevent uncontrolled aggregation (Fig. 1). Preliminary laboratory tests are focused on ensuring the colloidal stability of the functionalized AuNPs in organic solvents and evaluating the initial stages of the assembly. The self-assembly process is monitored via UV-Vis-NIR spectroscopy, which can detect red shifts in the localized surface plasmon resonance (LSPR) bands arising from plasmonic coupling induced by nanoparticle assembly^{3,4}. This methodological approach aims to establish a robust framework for creating tailored nano-architectures with tunable optical activities^{5,6}.

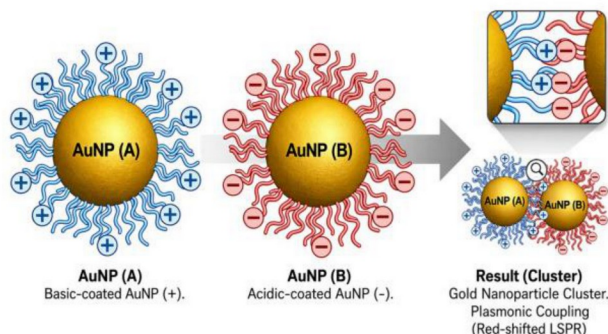


Figure 1: Scheme of the proposed self-assembly of AuNPs via complementary basic (+) and acidic (-) polymer coatings.

Acknowledgements Financial support from the Ministry of Science, Innovation and Universities (FPI fellowship PID-2024-159196NB-I00-B) and the ERC Starting Grant Time4Nano (101164205) is gratefully acknowledged.

References

1. A. Guerrero-Martínez et al. "From Individual Nanoparticles to Supramolecular Assemblies: Physical and Chemical Properties", *Angew. Chem. Int. Ed.* 2011, 50, 5499–5503. DOI: 10.1002/anie.201100557.
2. Z. Song et al. "Surface-Modified Gold Nanoparticles for Controlled Assembly in Organic Solvents", *ACS Appl. Opt. Mater.* 2024, DOI: 10.1021/acsaom.3c00465.
3. A. M. Kalsin et al. "Electrostatic Self-Assembly of Binary Nanoparticle Crystals with a Diamond Lattice", *Science* 2006, 312, 420–424. DOI: 10.1126/science.1125124.
4. N.-N. Zhang et al. "Acid-Base Interaction-Directed Self-Assembly of Nanoparticles in Nonpolar Solvents", *Nano Lett.* 2024, 24, 13027–13036. DOI: 10.1021/acs.nanolett.4c04207.
5. P. K. Jain et al. "On the Universal Scaling Behavior of the Distance Decay of Plasmon Coupling in Metal Nanoparticle Pairs: A Plasmon Ruler Equation", *Nano Lett.* 2007, 7, 2080–2088. DOI: 10.1021/nl071008a.
6. L. D. Barron, *Molecular Light Scattering and Optical Activity*, Cambridge University Press, Cambridge, 2004. DOI: 10.1017/CBO9780511535468.

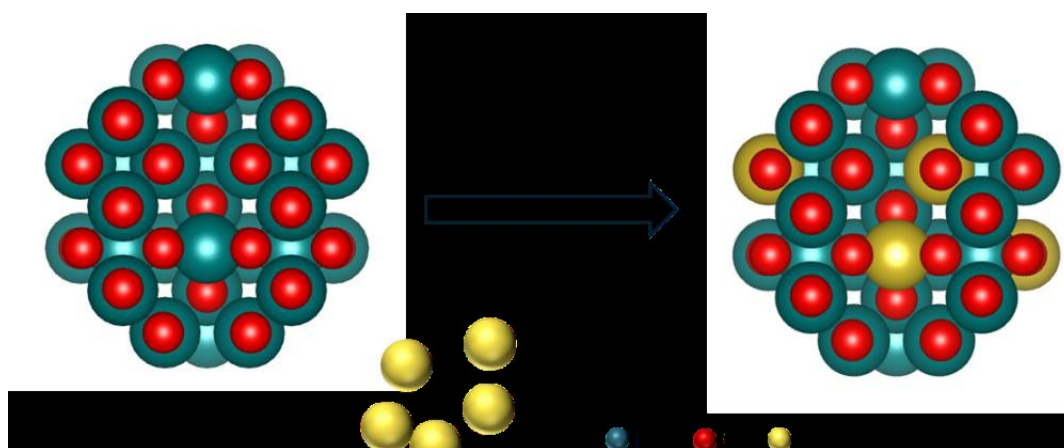
P.17: Pulsed Laser Excitation of Colloidal Ferrite Nanoparticles as a Strategy to Tune Magnetic Heating Properties

F. Martín, G. González-Rubio, H. Gavilán

Departamento de Química Física, Facultad de Ciencias Químicas, Universidad Complutense de Madrid, 28040, Madrid, Spain

Magnetic nanoparticles are versatile nanomaterials whose properties strongly depend on size, morphology, composition, and interfacial structure.¹ While colloidal synthesis enables precise control over core-shell architectures, post-synthetic strategies provide additional flexibility to tailor magnetic behavior.² In this context, pulsed laser irradiation emerges as a powerful approach to modify nanomaterials through localized energy deposition, triggering atomic redistribution phenomena (*Scheme 1*).³

Here, we explore the effect of pulsed laser excitation on the structural and magnetic properties of ferrite-based magnetic nanoparticles. Specifically, starting from Fe_3O_4 nanoparticles dispersed in the presence of transition metal precursors (e.g., Ni and Zn), controlled pulsed laser irradiation promotes precursor decomposition, cation diffusion, and incorporation into the crystal lattice, leading to the formation of $\text{M}_x\text{Fe}_{3-x}\text{O}_4$ ($\text{M} = \text{Ni}, \text{Zn}$) nanoparticles. This process modifies magnetic exchange interactions and affects the collective magnetic response.⁴ Structural, colloidal, and magnetic properties before and after irradiation were investigated using transmission electron microscopy, dynamic light scattering, and alternating current hysteresis measurements. Particular attention is given to magnetic heating efficiency, quantified by the specific absorption rate, which shows that laser-induced interfacial mixing and compositional homogenization provide an effective route to tune magnetic energy dissipation. These findings highlight the potential of combining bottom-up wet-chemical routes and pulsed laser irradiation to engineer magnetic properties, opening opportunities in biomedicine, sensing, and energy technologies.



Scheme 1: Laser-Induced Cation Incorporation and Alloying in Metal-Doped Ferrite Nanoparticles

Acknowledgements

This work has been supported by the ERC Starting Grant Time4Nano (101164205).

References

1. H. Gavilán et al. "Scale-up approach for the preparation of magnetic ferrite nanocubes and other shapes with benchmark performance for magnetic hyperthermia applications", *Nat. Protoc.* 2023, 18, 783–809.
2. T. Pellegrino et al. "Asymmetric Assembling of Iron Oxide Nanocubes for Improving Magnetic Hyperthermia Performance", *ACS Nano*. 2017, 11, 12121–12133.
3. G. González-Rubio et al. "Reshaping, Fragmentation, and Assembly of Gold Nanoparticles Assisted by Pulse Lasers", *Acc. Chem. Res.* 2016, 49, 678–686.
4. G. González-Rubio et al. "Controlled Alloying of Au@Ag Core-Shell Nanorods Induced by Femtosecond Laser Irradiation", *Adv. Optical Mater.* 2021, 9, 2101202.

P.18: Amphiphilic Azocalix[4]arenes as Photoresponsive Platforms for Controlled Self-Assembly and Molecular Recognition

J.R. Fernandes, H. Mahmoodi, N. Basilio

Laboratório Associado para a Química Verde (LAQV), Rede De Química e Tecnologia (REQUIMTE), Departamento De Química, Faculdade De Ciências e Tecnologia, Universidade NOVA De Lisboa, Caparica, Portugal.

Amphiphilic calixarene (CA) systems play a central role in colloidal and interface science, where self-assembly and aggregation govern the formation of structured soft matter¹. These macrocycles are well-established, conformationally defined scaffolds for multivalent molecular recognition, owing to their synthetic versatility and well-defined architectures^{1,2}. Incorporation of azobenzene functionality onto amphiphilic CA scaffolds has emerged as a promising strategy to introduce photochemical control, enabling reversible modulation of their molecular geometry and polarity. However, despite this potential, the photochemical behaviour of azocalixarene-based amphiphiles, particularly to binding and self-assembly, remains insufficiently characterised, with relatively few examples. In this communication, we present our work on the design and synthesis of anionic, amphiphilic, water-soluble azocalixarene derivatives aimed directly at developing their photoresponsive properties for molecular binding and self-assemblies in aqueous media. Starting from a commercially available CA scaffold, the synthetic strategy comprised of (1) lower rim alkylation, installation of propoxy chains to lock the conformation *in situ*; (2) controlled upper-rim nitration; (3) reduction to the corresponding amines; and (4) diazotization, providing access to the key azocalixarene core that was subsequently functionalised with sulfonate headgroups to afford highly soluble amphiphilic photoswitchable systems (Fig. 1). We show preliminary results on the photoresponsive binding properties and self-assembly. These findings *insofar* have demonstrated that azocalixarene-based amphiphiles serve as promising photoresponsive receptors and amphiphilic building blocks, supporting the broader concept of CAs as highly adaptable platforms for the design of tunable soft matter systems.

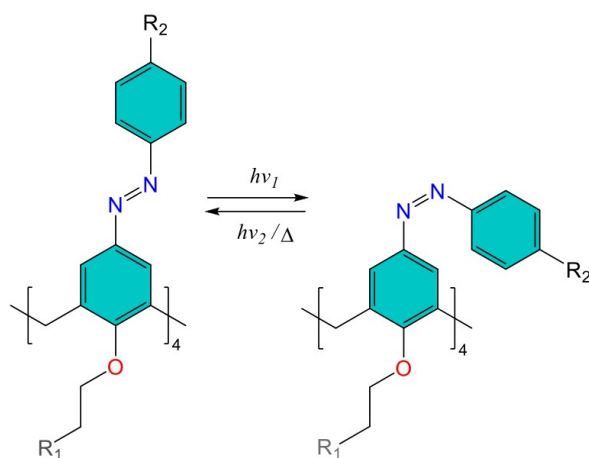


Figure 1: Schematic of reversible *E/Z* photoisomerisation of the azocalixarene scaffold, illustrating light-induced modulation of molecular geometry. R_1 : hydrophobic lower-rim propoxy chains. R_2 : hydrophilic upper-rim sulfonated groups, $\text{CH}_2(\text{CH}_2)_n\text{SO}_3^-$.

Acknowledgements This work was financed by national funds from FCT - Fundação para a Ciência e a Tecnologia, I.P., under the scope of the project UID/50006/2023 of the Associate Laboratory for Green Chemistry- LAQV REQUIMTE. FCT is also acknowledged for the project 2023.16144.ICDT; cofinanced by FEDER through COMPETE 2023 with reference COMPETE2030-FEDER-00899900.

References

1. Baldini, L., Casnati, A., Sansone, F. & Ungaro, R. Calixarene-based multivalent ligands. *Chem. Soc. Rev.* 36, 254–266 (2007).
2. Pan, Y. C., Tian, J. H. & Guo, D. S. Molecular Recognition with Macrocyclic Receptors for Application in Precision Medicine. *Acc. Chem. Res.* 56, 3626–3639 (2023).

P.19: Multilayer biomimetic ungual model for transungual drug permeation studies

D. Fernandes¹, D. Santos¹, A. Ribeiro², C. M. Lopes³, M. Lúcio¹

¹ CF-UM-UP – Centre of Physics of University of Minho and Porto; LAPMET – Laboratory of Physics for Materials and Emerging Technologies, University of Minho, Braga, Portugal

² Centre of Biological Engineering, University of Minho, Braga, Portugal

³ Instituto de Investigação, Inovação e Desenvolvimento Fernando Pessoa (FP-I3ID), Fernando Pessoa University, Fernando Pessoa Teaching and Culture Foundation, Porto, Portugal; RISE-Health, Faculty of Health Sciences, Fernando Pessoa University, Fernando Pessoa Foundation for Education and Culture, Porto, Portugal; Associate Laboratory i4HB - Institute for Health and Bioeconomy; UCIBIO - Applied Molecular Biosciences Unit, MEDTECH, Laboratory of Pharmaceutical Technology, Dep. of Drug Sciences, Faculty of Pharmacy, University of Porto, Porto, Portugal

Low transungual permeability remains a major challenge in the topical treatment of nail disorders, limiting drug permeation and contributing to therapeutic failure ¹. Onychomycosis is a representative example, as it is highly prevalent and significantly affects patients' quality of life ^{2,3}. Current *in vitro* models based on human or animal nails are hindered by high variability, ethical constraints, and limited reproducibility, while synthetic alternatives often fail to replicate the complex structure and composition of the human nail plate ^{4,5}. Therefore, the development of biomimetic nail models that more accurately reproduce the physicochemical and structural features of the native barrier is essential to improve transungual delivery research.

This study aimed to develop and validate a multilayer biomimetic ungual model based on a nanofibrous scaffold combined with a lipid layer, in order to evaluate its permeation behaviour toward compounds with distinct physicochemical properties. The model was fabricated by sequential electrospinning of synthetic polymers blended with keratin extracted from human hair, mimicking the dorsal, intermediate, and ventral layers of the nail plate. A biomimetic lipid layer was incorporated to better reproduce the native lipid fraction.

Structural characterisation confirmed the formation of a stratified architecture with distinct fibre morphologies across layers, consistent with the hierarchical organisation of the human nail plate. Functional validation using Franz diffusion cells revealed distinct permeation profiles for the tested compounds. The multilayer model significantly reduced caffeine permeation compared to simpler structures, reinforcing its barrier function. In contrast, terbinafine exhibited increased permeation, indicating preferential interaction with the incorporated lipid domains. These findings highlight the ability of the model to capture differences in permeation behaviour associated with compound physicochemical properties.

Overall, the model reproduces key structural features of the human nail and demonstrates compound-dependent permeation behaviour. This biomimetic platform represents a reproducible and ethically sustainable *in vitro* alternative for transungual permeation studies, with potential to support the development of improved topical therapies.

Acknowledgements

This work was supported by the Portuguese Foundation for Science and Technology (FCT) in the framework of the Strategic Funding: UID/04650/2025 (DOI: 10.54499/UID/04650/2025) (CF-UM-UP); UID/04378/2025 (DOI: 10.54499/UID/04378/2025) and UID/PRR/04378/2025 (DOI: 10.54499/UID/PRR/04378/2025) (UCIBIO) and LA/P/0140/2020 (DOI identifier 10.54499/LA/P/0140/2020) (i4HB).

References

1. Thatai P, Sapra B. Structural and component mining of nails using bioengineering techniques. *Int J Cosmet Sci.* 2016;39(3):225–240.
2. Gupta AK, Wang T, Polla Ravi S, Mann A, Bamimore MA. Global prevalence of onychomycosis in general and special populations: An updated perspective. *Mycoses.* 2024;67:e13725.
3. Gupta AK, Economopoulos V, Wang T, Piguet V. Epidemiological trends and healthcare disparities in onychomycosis: An analysis of the All of Us research program. *PLoS One.* 2025;20(1):e0316681.
4. Thatai P, Sapra B. Transungual delivery: deliberations and creeds. *Int J Cosmet Sci.* 2014;36(5):398–411.
5. Laubé F, Poupon A, Zinck P, Müller-Goymann C, Reichl S, Nardello-Rataj V. Physicochemical investigations of native nails and synthetic models for a better understanding of surface adhesion of nail lacquers. *Eur J Pharm Sci.* 2019;131:208–217.

P.21: Biochar-based electrocatalysts for the oxygen reduction reaction: a step towards sustainable energy conversion

L. Bibic^{1,2}, I. S. Oliveira¹, A. S. Fernandes³, E. F. Marques¹, D. M. Fernandes²

¹ CIQUP/IMS, Departamento de Química e Bioquímica, Faculdade de Ciências da Universidade do Porto, Rua do Campo Alegre, 4169-007 Porto, Portugal

² LAQV/REQUIMTE, Departamento de Química e Bioquímica, Faculdade de Ciências da Universidade do Porto, Rua do Campo Alegre, 4169-007 Porto, Portugal

³ I3N, Departamento de Física, Universidade de Aveiro, Campus Universitário de Santiago, 3810-193 Aveiro, Portugal.

Electrochemical energy conversion technologies play a key role in the transition toward sustainable energy; however, their efficiency is limited by the inherently slow kinetics of the oxygen reduction reaction (ORR), particularly in alkaline fuel cells. While platinum-based catalysts are highly cost and scarcity motivate the search for alternative materials derived from abundant and renewable sources¹.

In this work, biochars derived from different parts of water hyacinth, an abundant invasive biomass, were synthesized and evaluated as ORR electrocatalysts. Among them, bulb-derived biochar (WHB) displayed the highest intrinsic activity, which was significantly enhanced by nitrogen doping, approaching the performance of Pt/C. Spectroscopic analyses (XPS and Raman) linked this improvement to favorable nitrogen functionalities, particularly graphitic N, and increased structural disorder, both of which are known to promote ORR activity.

Layer-by-layer (LbL) hybridization combining biochar with multi-walled carbon nanotubes (MWNTs), enabled by surfactant-assisted exfoliation and charge stabilization, was driven by amphiphile-mediated electrostatic interactions and provided further insight into structure–performance relationships (Fig. 1)^{2,3}. Hybridization improved ORR activity for pristine WHB, with optimal performance observed at a 3:1 WHB:N-MWNT ratio, due to synergistic integration of porosity and conductivity. In contrast, incorporation of MWNTs into already optimized N-WHB reduced activity, likely due to partial blockage or dilution of active sites and disruption of catalytic interfaces.

Overall, this work demonstrates the potential of invasive biomass as a sustainable precursor for high-performance, Pt-free ORR catalysts, while also delineating the conditions under which chemical modification or hybrid nano structuring provides the greatest benefit.

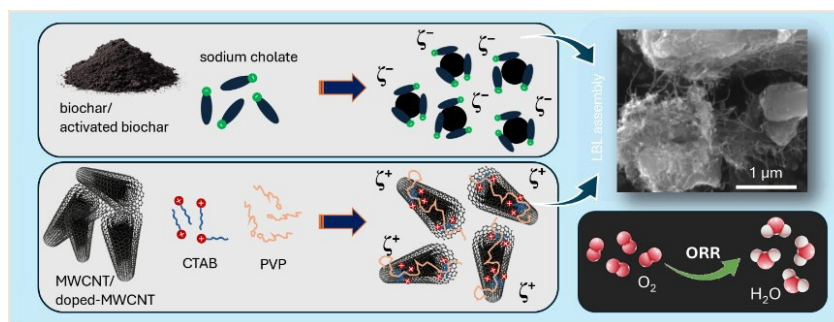


Figure 1: Schematic illustration of the preparation of biochar- and MWCNT-based composites via surfactant-assisted exfoliation and their application as ORR electrocatalysts.

Acknowledgements

We thank FCT for financial support through CIQUP via UID/QUI/0081/2020, IMS via LA/P/0056/2020 and LAQV via UID/50006/2025.

References

- 1- Li, Y.; Dai, H., Chem. Soc. Rev., 2014, 43, 5257, DOI:10.1039/C4CS00015C.
- 2- Abreu, B.; Montero, J.; Buzaglo, M.; Regev, O.; Marques, E.F., J. Mol. Liq., 2021, 333, 10, DOI: 10.1016/j.molliq.2021.116002.
- 3- Abreu, B.; Pires, A.; Guimarães, A.; Fernandes, R.; Oliveira, I.S.; Marques, E.F., J. Mol. Liq. 2022, 347, 118338, DOI: 10.1016/j.molliq.2021.118338.

P.22: Understanding the Collective Behaviour of Thermoresponsive Microgels by Theory and Simulation

A. Moncho-Jordá^{1,2}, A. Cuetos³, M. Á. Fernández-Rodríguez¹, J. Dzubiella⁴, A. Patti^{1,2}

¹ Department of Applied Physics, University of Granada, Campus Fuentenueva S/N, 18071 Granada, Spain

² Institute Carlos I for Theoretical and Computational Physics, University of Granada, Campus Fuentenueva S/N, 18071 Granada, Spain

³ Center for Nanoscience and Sustainable Technologies (CNATS), and Department of Physical, Chemical and Natural Systems, Universidad Pablo de Olavide, 41013 Sevilla, Spain

⁴ Physikalisches Institut, Albert-Ludwigs-Universität Freiburg, Hermann-Herder Straße 3, D-79104 Freiburg, Germany

We introduce a coarse-grained theoretical and computational framework to describe the compression and assembly of thermoresponsive core-shell microgels in good solvent conditions¹. The approach explicitly accounts for internal morphological heterogeneity by decomposing the particle free energy into core and shell contributions, each governed by a Flory-Rehner-type description with distinct elastic and swelling characteristics. Mechanical equilibrium between these regions is imposed to obtain a self-consistent description of particle size and internal restructuring. Interparticle interactions are represented through a size-dependent multi-Hertzian pair potential that captures the differential compressibility and mechanical response of the core and corona. Model parameters are calibrated against dynamic light scattering measurements of PNIPAM microgels across temperatures spanning the lower critical solution temperature, enabling a quantitative description of thermally induced swelling and collapse, including variations in core size. Monte Carlo simulations based on these effective interactions are used to investigate concentrated suspensions under compression, focusing on structural and thermodynamic properties such as size distribution, effective packing fraction, spatial correlations, and phase behavior. Our results demonstrate that particle softness, responsiveness, and internal heterogeneity collectively govern the organization and state behavior of dense microgel systems, providing a direct link between single-particle properties and emergent collective phenomena.

Acknowledgements A.M.J. and A.P. thank grant no. PID2022-136540NB-I00 awarded by MICIU/AEI/10.13039/501100011033 and ERDF, a way of making Europe. A.M.J. also acknowledges the program Visiting Scholars funded by the Plan Propio of the University of Granada (Project PPVS2018-08). M.A.F.R. acknowledges funding from PID2020-116615RA-I00, PID2023-149387OB-I00, and PID2023-147135OB-I00 funded by MICIU/AEI/10.13039/501100011033 and by FEDER, EU, an EMERGIA grant with reference EMC21_00008 and project C-ING-208-UGR23 funded by Consejería de Universidad, Investigación e Innovación de la Junta de Andalucía, and by FEDER “Andalucía 2021-2027”. A.P. acknowledges grant no. W911NF-23-1-0099 awarded by the U.S. Army Research Office and grant P21_00015 funded by Junta de Andalucía - Consejería de Universidad, Investigación e Innovación. A.P. was supported by a “María Zambrano Senior” research fellowship, financed by the European Union within the NextGenerationEU program and the Spanish Ministry of Universities. The authors thank Servicio de Supercomputación UGR and PROTEUS, the supercomputing center of the Institute Carlos I for Theoretical and Computational Physics, for the computational time provided. The authors also thank C3UPO of the Universidad Pablo de Olavide for the support with HPC facilities.

References

[1] A. Moncho et al., *Macromolecules* 58, 19, 10659, 2025.

P.23: Multiscale Computational Insights into Nanoparticle Functionalization and Drug Incorporation

Sandra Nunes¹, Maria Mendes^{1,2}, Bárbara Marques^{1,2}, Tânia Cova¹, João Simões^{1,2}, Teresa Pinho e Melo¹, Carla Vitorino^{1,2}, Alberto Pais¹

¹ Coimbra Chemistry Center (CQC-IMS), Institute of Molecular Sciences, University of Coimbra, Coimbra, Portugal

² Faculty of Pharmacy, University of Coimbra, Coimbra, Portugal

The rational design of solid lipid nanoparticle-based systems for biomedical applications requires a detailed understanding of the molecular interactions governing both surface functionalization and drug incorporation. Computational simulations provide a powerful framework to address these challenges across multiple length and time scales.

In this work, we present a multiscale computational study combining coarse-grained Monte Carlo and atomistic Molecular Dynamics simulations, applied to two distinct solid lipid nanoparticle systems targeting complementary aspects of nanocarrier design.

At the mesoscopic level, coarse-grained Monte Carlo simulations are employed to investigate the adsorption of cell-penetrating peptides onto functionalized nanoparticle surfaces. By varying the peptide characteristics such as length, overall charge density and positioning of the charged groups, these simulations provided mechanistic insight into experimental observations and help rationalize the role of peptide–nanoparticle interactions in the functionalization of nanocarriers for brain tumour targeting.

In another system, atomistic MD simulations are used to study nanoparticle formulations incorporating chemically modified variants of a standard therapeutic compound. The focus is on how structural modifications of the drug influence its interactions with the lipid nanoparticle matrix, its degree of incorporation, and its spatial distribution within the aggregate. These simulations provide detailed insight into the relationship between molecular structure and drug localization, with implications for optimizing loading efficiency and therapeutic performance.

Overall, this work demonstrates how multiscale computational approaches can address distinct yet complementary mechanisms in nanoparticle design, from surface functionalization to drug incorporation. The results contribute to a deeper understanding of structure-property relationships and support the rational development of more effective nanostructured delivery systems.

Acknowledgements We thank to Fundação para a Ciência e a Tecnologia (FCT) for funding project 2022.06174.PTDC. We also acknowledge funding from the Coimbra Chemistry Centre – Institute of Molecular Sciences (CQC-IMS) which is supported by FCT. CQC is funded by FCT through projects UID/PRR/00313/2025 (<https://doi.org/10.54499/UID/PRR/00313/2025>), UID/PRR2/00313/2025 (<https://doi.org/10.54499/UID/PRR2/00313/2025>) and UID/00313/2025 (<https://doi.org/10.54499/UID/00313/2025>) and IMS through special complementary funds provided by FCT (project LA/P/0056/2020).

P.24: Bacteriophage-Loaded Oleic Acid-Modified Oligochitosan Nanoparticles for Potential Application in Cystic Fibrosis Lung Infections

Joselyn Aime García-Mar¹, Patricia Dolores Martínez-Flores¹, David Encinas¹, Gerardo García-González², Gerardo Erbey Rodea-Montealegre³, Refugio Pérez-González¹, Viviana Reyes-Márquez¹, Marco Antonio López-Mata¹, Natalia Hassan⁴, Antonio Topete⁵, Josué Juárez¹

¹ Universidad de Sonora, Hermosillo CP 83000, México.

² Facultad de Medicina y Hospital Universitario "Dr. José Eleuterio González", Universidad Autónoma de Nuevo León, Monterrey 64460, México.

³ Hospital infantil de México, Federico Gómez, Ciudad de México, 06720, Mexico. 7Programa Institucional de Fomento a la Investigación, Desarrollo e Innovación, Universidad Tecnológica Metropolitana, Santiago, Chile. 5Departamento de Física de Partículas, Instituto de Materiales (iMATUS) e Instituto de Investigación Sanitaria (IDIS), Universidad de Santiago de Compostela, 15782, España.

Cystic fibrosis (CF) lung infections are recurrent and frequently involve multidrug-resistant bacteria, which limits the effectiveness of conventional antibiotic therapy. Bacteriophages represent a promising alternative, although their therapeutic application is challenged by poor stability and inefficient delivery in the airway microenvironment. In this work, oleic acid-modified oligochitosan (OCS-OA) nanoparticles were developed as bacteriophage nanocarriers for potential use in CF lung infections. Three formulations with different degrees of oleic acid substitution (10%, 20%, and 30%) were synthesized by amidation and confirmed by ATR-FTIR. Surface tension measurements supported the amphiphilic character of the modified oligochitosan and its ability to self-assemble into nanostructures. Bacteriophage vB_Eco_K-01 was encapsulated with high efficiency (>90%), and the formulations were characterized by STEM, AFM, DLS, and zeta potential. Notably, nanoparticles containing 10% and 20% OCS-OA preserved phage lytic activity against a clinical *Escherichia coli* strain isolated from CF patients, whereas the 30% formulation showed reduced antibacterial activity. These findings suggest that increasing hydrophobic substitution beyond an optimal range may negatively affect phage release, highlighting the importance of tuning polymer hydrophobicity to preserve bacteriophage functionality.

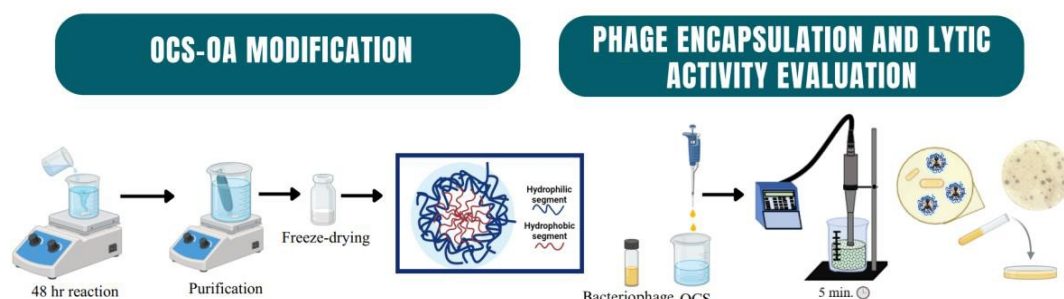


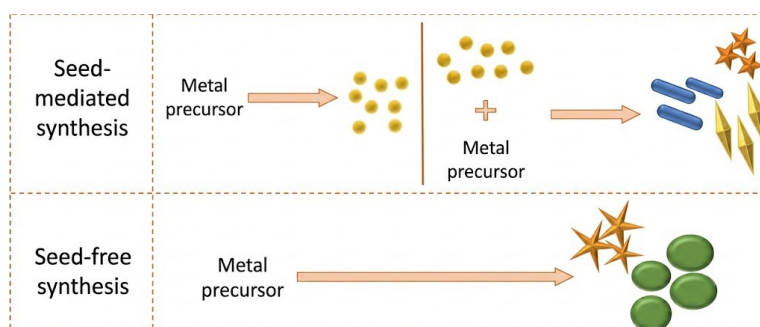
Figure 1: Esquematic representation of OA-modified Oligochitosan nanoparticles

P.25: Controlled Synthesis and Morphological Characterization of Gold Nanoparticles

Miguel González-Luque, Manuel Cano, Antonio J. Fernández Romero, Juan J. Giner-Casares, Pablo G. Argudo, Valentín García-Caballero

Departamento de Química Física y T. Aplicada, Facultad de Ciencias, Universidad de Córdoba (UCO), IQUEMA, Campus de Rabanales, Ed. Marie Curie, Córdoba 14071, Spain

Owing to their remarkable optical, electronic, and physicochemical traits, gold nanoparticles (AuNPs) have emerged as premier technology in materials science. They are utilized across diverse disciplines, including catalysis, biomedicine, and nanoelectronics, where their strong chemical stability and highly adaptable surface chemistry make them perfect for applications demanding extreme sensitivity. Their effectiveness is primarily powered by Localized Surface Plasmon Resonance (LSPR), a phenomenon occurring when incident electromagnetic waves cause the conduction electrons on the nanoparticle's surface to oscillate collectively. To tune this LSPR across a broad spectrum, from visible light down to the near-infrared (NIR), adjusting the particles' aspect ratio is the most crucial factor. While standard spherical AuNPs serve as a reliable baseline with resonance bands generally between 520 and 550 nm, they do not generate the intense field enhancements needed for highly demanding analytical methods. Consequently, more complex shapes like nanorods, nanobipyramids, and nanostars have become widely preferred for their advanced plasmonic qualities. For example, bipyramids and nanorods feature two distinct resonance modes, while the sharp tips of nanostars produce intense regions of signal amplification commonly referred to as "hotspots."



Driven by the need to exploit these morphology-dependent plasmonic properties, this work focuses on the controlled synthesis of a diverse variety of gold nanomaterials (Figure 1). Specifically, we report the successful fabrication of gold nanospheres¹, nanorods², nanostars³, and nanobipyramids⁴. By developing these four distinct architectures under reproducible conditions, this study aims to systematically compare their Localized Surface Plasmon Resonance (LSPR) behaviors, their field enhancement capabilities, and their overall suitability for highly sensitive analytical applications.

Figure 1: Illustration of methods for synthesizing nanoparticles using a bottom-up approach.

Acknowledgements

We thank to the research group FQM-204. AJFR for the PID2022-139191OB-C32 project and excellent network E3TECH-PLUS.

References

- [1] V. García-Caballero, H. K. Mohammed-Ibrahim, J. J. Giner-Casares, M. Cano, *Electrochem. Commun.* 2022, 142, 107364.
- [2] L. Scarabelli, A. Sánchez-Iglesias, J. Pérez-Juste, L. M. Liz-Marzán, *J. Phys. Chem. Lett.* 2015, 6, 4270-4279.
- [3] A. Guerrero-Martínez, S. Barbosa, I. Pastoriza-Santos, L. M. Liz-Marzán, *Curr. Opin. Colloid Interface Sci.* 2011, 16, 118-127.
- [4] D. Alba-Molina, M. Cano, M. Blanco-Blanco, L. Ortega-Llamas, Y. Jiménez-Gómez, A. Gonzalez-Lopez, et al., *J. Mater. Chem. B.* 2025, 13, 3000-3010.

P.26: Induction of Raft-Like Nanodomains through Glucosylceramide as a Structural Modulator in Biomimetic Membranes

P. Cea, S. Martín, S. Chiodini, R. Soto-Ayala

Institute of Nanoscience and Materials of Aragón (INMA) C/Mariano Esquilor s/n. 50018 Zaragoza, Spain

The lateral organization of cell membranes into dynamic, raft-like nanodomains is a fundamental regulator of biological functions, such as signal transduction and membrane trafficking. Understanding the molecular determinants of these domains is crucial for the development of advanced drug delivery systems and biomimetic interfaces. This study explores the induction of raft-like nanodomains using a synthetic glycosphingolipid, glucosylceramide (GSL1), as a structural modulator in supported lipid membranes (SLMs).

By using a nanoarchitectonic approach,¹ we investigated the phase behavior and topography of a model system composed of DPPC (1,2-dipalmitoyl-*sn*-glycero-3-phosphocholine) and CHOL (cholesterol) in a 1:1 ratio, doped with varying molar fractions of GSL1. The integration of thermodynamic analysis at the air-water interface with Atomic Force Microscopy (AFM) of Langmuir-Blodgett films revealed a dual molecular behavior of GSL1: a significant poor miscibility with DPPC and a preferential, strong attractive interaction with cholesterol.²

Our findings demonstrate that GSL1 promotes the segregation of CHOL-rich regions, leading to the emergence of stable, well-defined raft-like nanodomains. AFM height-trace analysis confirmed that GSL1 dictates the internal order and height mismatch within the membrane, inducing the formation of multilayered patches at specific concentrations. This work provides a versatile toolkit for engineering complex biomimetic membranes, offering new insights for biopharmaceutical applications and the design of targeted colloidal platforms for medical diagnosis and therapy.

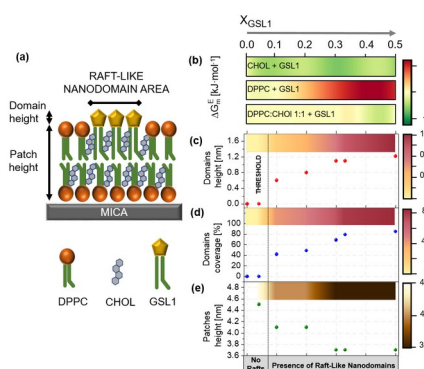


Figure 1. a) Schematic representation of the bilayer structure with the GSL1-enriched raft embedded in the top leaflet. b) Excess Gibbs energy of mixing, ΔG_m^E , for the binary systems (CHOL+GSL1) and (DPPC+GSL1), and the pseudobinary (DPPC:CHOL 1:1+GSL1) mixture, shown as a 1D color-coded profile as a function of the GSL1 mole fraction (x_{GSL1}). c) Raft height as a function of x_{GSL1} . Heights were calculated relative to the main top surface of the patch (see panel a). A 1D color-coded profile of the raft height is also included for clarity. d) Raft coverage versus x_{GSL1} , together with the corresponding 1D color-coded profile. Coverage was calculated relative to the corresponding patch area. e) Patch height as a function of x_{GSL1} together, accompanied by its corresponding 1D color-coded profile. For panels (c)-(e), values represent the average from three AFM images of the same scanned area.

References

(1) L. Dotor et al., *Nanoscale* 2023, 15, 2891; (2) S. Chiodini et al., *COLSUA* 2026, 739, 140096.

Acknowledgements

Authors are grateful for funding from DGA and fondos FEDER (E31_23) and financial support from the Spanish Ministry of Science and Innovation and the Spanish State Research Agency (AEI) through the Severo Ochoa Programme of Excellence for Research Units, with grant CEX2023-001286-S funded by MICIU/AEI/10.13039/501100011033.

P.27: Development of lipid nanoparticles as delivery systems for mRNA transport and delivery for the treatment of atherosclerosis

M.E. Anguiano-Lizárraga^{1,2}, Juárez-Josue², S. Barboza¹, P. Taboada¹

¹ Colloids and Polymer Physics Group (GFCP), Department of Particle Physics, Faculty of Physics and Institute of Materials (IMATUS), Campus Vida, Universidade de Santiago de Compostela, 15782 Santiago de Compostela, Spain.

² Department of Physics, Nanotechnology Doctoral Program, University of Sonora, Hermosillo Campus, Blvd. Luis Encinas y Rosales S/N, Col. Centro, 83000 Hermosillo, Sonora, Mexico.

Cardiovascular diseases (CVDs) are the leading cause of morbidity and mortality worldwide, with atherosclerosis (AS) being one of their main manifestations. AS is a systemic, chronic, inflammatory, and multifactorial disease associated with genetic predisposition, metabolic disorders and lifestyle factors. It is characterized by the formation of atheromatous plaques within the arterial wall, leading to narrowing of the vascular lumen, impaired blood flow, and potential thrombus formation, which may trigger severe clinical events such as acute myocardial infarction and stroke¹. In this context, gene modulation therapies based on messenger RNA (mRNA) have emerged as a promising strategy for the treatment of AS by enabling the expression of proteins involved in the regulation of pathological processes². However, their clinical application remains limited due to the inherent instability of mRNA and low cellular internalization efficiency. To overcome these limitations, lipid nanoparticles (LNPs) have been proposed as biocompatible and biodegradable delivery systems capable of protecting mRNA, enhancing its biodistribution, and improving cellular uptake. These systems are typically composed of phospholipids, cholesterol, and PEGylated lipids, which provide structural stability and functional versatility³. In this study, four types of synthesized LNPs were obtained by varying the ionizable lipid, which is responsible for enabling mRNA encapsulation. All formulations exhibited a spherical morphology, with an average particle size of approximately 140 nm and a zeta potential ranging from -4.5 to 6 mV. Furthermore, their functionality was evaluated in HeLa cells using GFP-encoding mRNA, where green fluorescence protein expression was observed, confirming efficient mRNA internalization and translation. These findings demonstrate the potential of LNPs as nanocarriers for mRNA delivery in gene therapy applications targeting cardiovascular diseases.

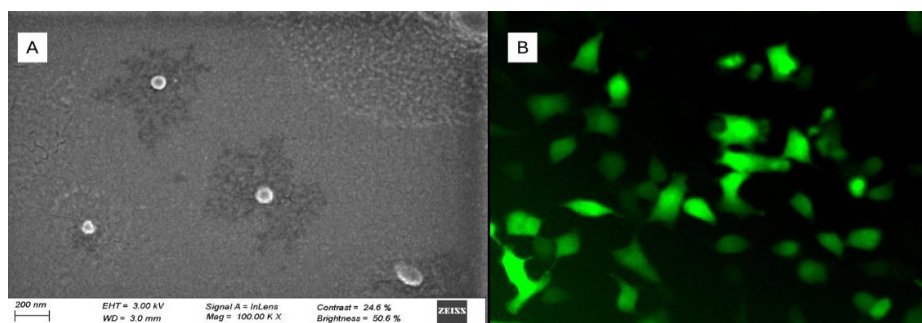


Figure 1. A) Images of lipid nanoparticles (LNPs) obtained by scanning electron microscopy (SEM), showing a spherical morphology. B) GFP protein expression in HeLa cells after 24 h of incubation with mRNA-loaded LNPs, demonstrating the internalization and functionality of the delivery system.

Acknowledgements

The authors gratefully acknowledge the financial support provided by the Agencia Estatal de Investigación (PID2022-142682OB-I00). M.E.A.-L. also gratefully acknowledges the Secretaría de Ciencia, Humanidades, Tecnología e Innovación (SECIHTI) for the scholarship support S190. The authors further acknowledge the assistance provided by the Scanning Electron Microscopy Technical Services during the development of this research.

References

1. Dimas et al. (2024). The ABC of Cardiology 2018, 87.
2. Cho, H. M et al. (2020). Molecular Therapy Nucleic Acids, 19, 1186-1197.
3. Wang, X., et al. (2023). Nature protocols, 18(1), 265-291.

P.28: Microencapsulation of Vitamins A and E: Production and Stability Evaluation

Carla Varela¹, Maria Graça Rasteiro¹, Luís Alves¹, Bruno Medronho^{2,3}, Solange Magalhães^{1,3}, Manel Jiménez⁴, Joaquim Jover⁴

¹ Chemical Engineering and Renewable Resources for Sustainability Research Center (CERES), Department of Chemical Engineering, University of Coimbra

² University of Algarve, MED Institute, Faro, Portugal

³ University of Mid Sweden, FSCN Research Center, Sundsvall, Sweden

⁴ Research & Development laboratory, Jover Labtech, Terrassa, Spain

Nowadays, consumers are more tuned to the quality of food products they consume. In this regard, food industry has also been focused on developing products that will contribute to ensure people's health. Adding some functional ingredients, such as vitamins, minerals and probiotics, will lead to a functional food that will allow to prevent and/or ameliorate some nutrition's deficiencies.

A solution to decrease the insufficiency in vitamins A and E is by fortifying bread, a very common daily food. However, these liposoluble vitamins are poorly stable under some conditions, such as high temperature, light and moisture. In this sense, encapsulation techniques have been employed to enhance their stability and bioavailability, because emulsion-based systems are quite adequate to ensure bio-actives' encapsulation and transport.[1,2]

The nature of the encapsulating agent to ensure a continuous film is an important point, and currently the interest in natural polymers, like polysaccharides and proteins, is very high given their biocompatibility and biodegradability. In this work, vitamin A and E were co-encapsulated via emulsion using three different wall materials: sodium alginate, gelatin and isolated pea protein. A second layer of chitosan was added to these microcapsules to afford an acid-resistant shell-matrix, suitable to protect vitamins from suffering stomach acidic degradation.[3] Briefly, a mixture of vitamin A (retinyl palmitate) and E (alpha-tocopheryl acetate) in vegetable oil was prepared by stirring, followed by addition of soy lecithin. This mixture was allowed to stir for 1h after which it was poured dropwise to an aqueous solution of the biopolymer, at full speed of the magnetic stirrer. This homogenous mixture was then turned pulverized into water with stirring (500 rpm), a white clear emulsion being formed. This mixture was later added to a pH4 controlled aqueous solution of chitosan, also with stirring (500 rpm), concluding the formulation preparation.

The prepared microparticles formulations were afterwards characterized regarding zeta potential via electrophoretic light scattering using a Malvern Zetasizer NanoZS equipment (ZN 3500) and size via laser diffraction spectroscopy using a Malvern Mastersizer 2000 and via STEP technology using a LUMiSIZER. Images were also acquired using an inverted microscope (Olympus BH2 equipped with a digital camera). Rheological behavior was also analyzed using a Haake Mars rheometer. Suspension stability was also evaluated using STEP technology by performing accelerated stability tests with a LUMiSIZER.

For the encapsulation procedure to adequately enhance aqueous solubility, prevent the degradation of the bio-actives and fulfill its application, it is important for the emulsions to be stable. This evaluation is, therefore, crucial in the development of new formulations. With this in mind, a study was performed during 7 days where the prepared formulations were submitted to 24h-intermittent cycles of cold (4°C) and heat (40°C). Besides the already mentioned evaluations, the accelerated stability testing was also made.[4]

Acknowledgements

This work was financed by Fundação La Caixa and FCT via the research project "Plantas aromáticas do Alentejo, probióticos e farinha de bolota no desenvolvimento de pão funcional" (PD23-0025) and through the Strategic Research Center Project UIDB/00102/2020 (DOI: doi.org/10.54499/UIDB/00102/2025 and DOI: doi.org/10.54499/UID/PRR/00102/2025).

References

- [1] Patil, R. et al. Emerging encapsulation strategies for vitamin A fortification in food sector: an overview. Food Science and Biotechnology (2024). doi.org/10.1007/s10068-024-01635-8
- [2] Ribeiro, A. M. et al. Improvement of vitamin E microencapsulation and release using different biopolymers as encapsulating agents. Food and Bioproducts Processing (2021). doi.org/10.1016/j.fbp.2021.08.008
- [3] Yu, C. et al. Composite microparticle drug delivery systems based on chitosan, alginate and pectin with improved pH sensitive drug release property. Colloids and Surfaces B: Biointerfaces (2009). doi.org/10.1016/j.colsurfb.2008.10.013

- [4] Stobba, B.K. et al. Critical review of techniques for food emulsion characterization. *Applied Sciences* (2024). doi.org/10.3390/app14031069
- [5] ISO/TR 13097: 2013. Guidelines for characterization of dispersion stability.
- [6] ISO 13318-2: 2017 Determination of particle size distribution by centrifugal liquid sedimentation methods.
- [7] Lerche D. & Sobisch T., Direct and accelerated Characterization of Formulation Stability. *Journal of dispersion Science and Technology*. 2011, 32 pp 1799-1811

P.29: Functional Bread Enriched with Acorn Flour and Encapsulated Essential Oils

Hugo Duarte^{1,2}, Rita Jorge², Luísa Corrêa², Isabela Vera², Margarida Oliveira², Solange Magalhães^{1,4}, Anabela Romano², Marta Laranjo³, Bruno Medronho^{2,4}, Luís Alves¹

¹ University of Coimbra, Chemical Engineering and Renewable Resources for Sustainability (CERES), Department of Chemical Engineering, Rua Sílvio Lima, Pólo II, Pinhal de Marrocos, 3030-790 Coimbra, Portugal

² MED (Mediterranean Institute for Agriculture, Environment and Development) CHANGE (Global Change and Sustainability Institute), Universidade do Algarve, Faculdade de Ciências e Tecnologia, Campus de Gambelas, Ed. 8, 8005-139 Faro, Portugal

³ MED (Mediterranean Institute for Agriculture, Environment and Development) & CHANGE – Global Change and Sustainability Institute, IIFA (Instituto de Investigação e Formação Avançada), Universidade de Évora, Pólo da Mitra, Ap. 94, 7002-554 Évora, Portugal

⁴ FSCN, Surface and Colloid Engineering, Mid Sweden University, SE-851 70 Sundsvall, Sweden

Bread remains a staple food worldwide, and recent consumer trends have driven the development of functional products enriched with bioactive ingredients. This study explores the creation of innovative gluten-free bread by incorporating acorn flour and essential oils encapsulated within polymer mixtures comprising bacterial cellulose fibres. The encapsulation process aims to enhance the stability, solubility, and controlled release of essential oils, addressing challenges such as volatility and degradation during baking. Essential oils from *Thymus mastichina* and other medicinal plants, sourced from distinct regions, were characterized for their bioactive profiles using gas chromatography-mass spectrometry (GC-MS). Bacterial cellulose obtained from vinegar production and locust bean gum were employed as a natural carriers to encapsulate these oils, leveraging its biocompatibility and ability to form protective matrices. With the aim of introducing the encapsulated essential oils into bread formulations, several flours were tested on the stability of the emulsion systems. Marked differences were observed depending on the type of flour, from which acorn flour showed higher affinity towards the oil. This approach allowed to increase oil stability in an aqueous system, with the potential for the gradual release of key antimicrobial and antioxidant compounds, contributing to extended bread shelf life and enhanced functional properties. This approach not only augments the health benefits of gluten-free bread but also supports the valorisation and sustainability of the Montado ecosystem by utilizing underexploited resources such as acorns and medicinal plants.

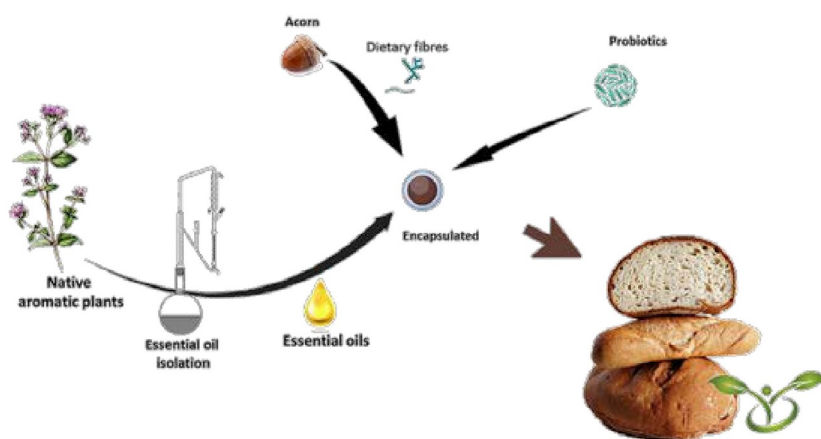


Figure 1: Schematic picture of the work

Acknowledgements The authors want to acknowledge Fundação la Caixa and FCT for the financial support through the project “Plantas aromáticas do Alentejo, probióticos e farinha de bolota no desenvolvimento de pão funcional” (PD23-0025). FCT is also acknowledged for its financial support through the Strategic Research Centre Project UIDB/00102/2020 and UIDB/05183/2020.

P.30: Hybrid biomimetic systems as drug nanocarriers

A. Costa-Santos¹, M. Luna², O. Abelenda¹, A. Pardo¹, A. Topete¹, S. Barbosa¹, P. Taboada¹

¹ Grupo de Física de Coloides y Polímeros, Departamento de Física de Partículas, Universidad de Santiago de Compostela, Santiago de Compostela 15782, España

² Posgrado en Nanotecnología, Departamento de Física, Universidad de Sonora, Unidad Centro, Apdo Postal 83000 Hermosillo, Sonora, Mexico

In recent years, the use of cell membranes as drug delivery systems is getting increasing attention. Although their use as simple drug delivery systems (DDS), their application as coating to develop biomimetic hybrid systems is even more promising. These hybrid systems combine the advantages of the biomimetic coating such as active targeting, enhanced biocompatibility, immune evasion and prolonged circulation times¹, with the intrinsic properties of the core material. The use of nanoparticles of different nature as a core can endow the hybrid system with a huge variety of properties such as improved therapeutic cargo loading and controlled releasing profiles, the ability to perform phototherapies or the capacity to combine imaging-based diagnosis with therapy.

This work is focused on the synthesis and physicochemical characterization of two hybrid DDS and their comparison with the bare membrane-derived vesicles. In this sense, one of the hybrid systems is based on poly (lactic-co-glycol) acid (PLGA) spherical cores, as PLGA is one of the most extensively used polymers in DDS. It presents good aqueous stability and ability to encapsulate both hydrophobic and hydrophilic compounds². In a second hybrid systems, a zeolitic Metal Organic Framework, ZIF-8, was selected as a nucleus due to its intrinsic porosity with hydrophobic cavities, which enables higher loading capacities than others systems, high specific surface area and great chemical and thermal stability with pH responsiveness³. Finally, the physicochemical characteristics and the potential of these hybrid systems as DSS was evaluated *in vitro*, showing their improved performance compared with bare cell membrane vesicles.

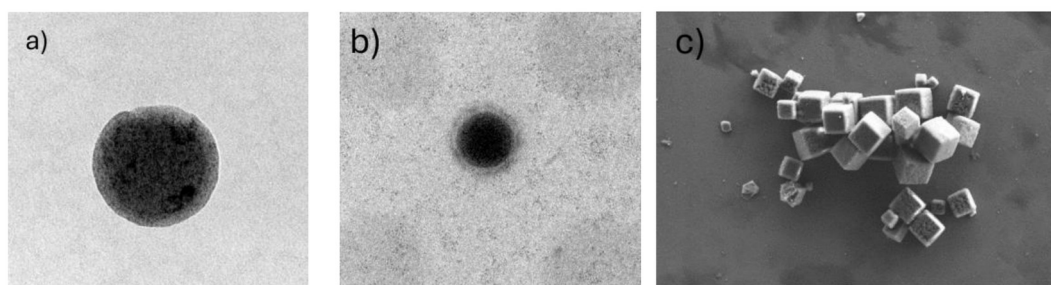


Figure 1. a) TEM picture of the membrane-derived vesicles, b) TEM picture of biomimetic PLGA, c) SEM picture of biomimetic ZIF-8.

Acknowledgements The authors thank financial support from grant PID2022-142682OB-I00 funded by MICIU/AEI/10.13039/501100011033 and by the European Union Next-generation EU/PRTR. The authors also thank support from grants PID2023-152062OA-I00 funded by MICIU/AEI/10.13039/501100011033 and ED431F2025/14 funded by Xunta de Galicia.

References

- 1Gao, W.; Han, X.; Li, L.; Xu, Y.; Xu, M.; Gao, Z.; Wang, C. Journal of Materials Chemistry B 2025, 13, 3758_3785.
- 2Alsaab, H. O., Alharbi, F. D., Alhibs, A. S., Alanazi, N. B., Alshehri, B. Y., Saleh, M. A, Pharmaceutics 2022., 14, 12, 2728.
- 3Wei, X.; Wang, Y.; Liu, Y.; Ji, K.; Li, K.; Wang, J.; Gu, Z. Matter 2024, 7, 826_854.

P.31: Inversely coupled thermogelation in hybrid hydrogels as a novel mechanistic strategy for smart topical drug delivery

R.L. Machado¹, E.C. Loureiro¹, S.G. Silva², I.S. Oliveira¹, A.C. Gomes³, E.F. Marques¹

¹ CIQUP, Department of Chemistry and Biochemistry, Faculty of Sciences, University of Porto, Rua do Campo Alegre, 4169-007, Porto, Portugal

² LAQV-REQUIMTE, Department of Chemistry and Biochemistry, Faculty of Sciences, University of Porto, Rua do Campo Alegre, 4169-007, Porto, Portugal

³ CBMA, School of Sciences, University of Minho, Campus of Gualtar, 4710-057, Braga, Portugal

Advances in colloidal science, particularly in smart drug delivery, have allowed the development of nanocarriers capable of efficiently transporting encapsulated cargo to target sites. Hydrogels, owing to their high biocompatibility and tissue-like properties, are promising platforms for local therapeutic applications. Block copolymers, such as Pluronic F127, can form thermosensitive hydrogels via self-assembly, enabling temperature-triggered gelation under mild conditions¹. In parallel, surfactants can spontaneously self-assemble into a range of nanostructures, including micelles, vesicles and tube aggregates, some of which undergo stimuli-responsive structural transitions². In this work, we combine these two components in a hybrid platform and systematically investigate its structural, rheological, and functional properties. Lysine-derived surfactants (14Lys10 and 10Lys14), which undergo reversible tube-to-vesicle or tube-to-micelle transitions, are incorporated into a F127 hydrogel matrix (Fig. 1). This system operates through an inversely coupled thermogelation (ICT) mechanism, in which polymer gelation is coupled to the structural transition of the surfactant aggregates. Despite strong F127/surfactant interactions, confirmed by thermal and rheological studies, both tube formation and the thermally induced transitions are preserved within the hybrid systems. The hybrid hydrogels exhibit desirable rheological properties, including shear-thinning and self-healing behavior, supporting their applicability in topical administration. Surfactant tubes can entrap a model fluorescent probe (CBF), while the hydrogel scaffold promotes a slower and more sustained release compared to neat surfactant systems. *In-vitro* studies demonstrate excellent biocompatibility in L929 cells, along with enhanced cellular internalization compared with neat F127³. These results highlight the potential of ICT-based hybrid hydrogels as versatile platforms for controlled and efficient topical drug delivery.

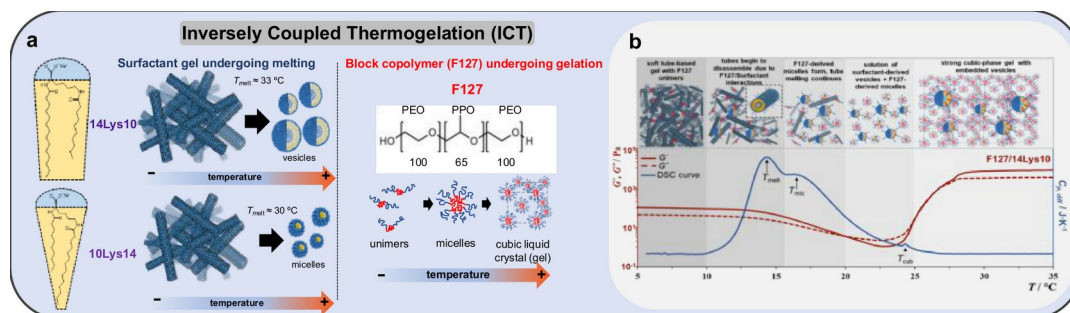


Figure 1: a) composition of the hybrid block copolymer/surfactant tube hydrogel and illustrative mechanism of the inversely coupled thermogelation (ICT) mechanism; b) correlation of ICT with thermal and rheological findings.

Acknowledgements We thank Fundação para a Ciência e Tecnologia for financial support through project 2022.05543.PTDC-Smart4Vir, through CIQUP via grant UID/QUI/0081/2020, IMS via grant LA/P/0056/2020 and CBMA via grant UID/BIA/04050/2020.

References

1. Russo, E. and Villa, C., *Pharmaceutics*, 2019, 11, 671, DOI: 10.3390/pharmaceutics11120671.
2. Oliveira, I.S., Machado, R.L., Araújo, M.J., Gomes, A.C. and Marques, E.F., *Chem. Eur. J.*, 2021, 27, DOI: 10.1002/chem.202003320.
3. Machado, R.L., Loureiro, E.C., Silva, S.G., Oliveira, I.S., Gomes, A.C. and Marques, E.F., *Mater. Today. Chem*, 2026, 52, 103362. DOI: 10.1016/j.mtchem.2026.103362.

P.32: From Waste to Value: Green Conversion of Agricultural Waste into Graphene Quantum Dots for Advanced Theranostic Applications

PV. Teixeira^{1,2,3}, R. Branquinho², CM. Lopes³, M. Lúcio^{1,2}

¹ Centre of Physics of the Universities of Minho and Porto (CF-UM-UP), School of Sciences, Gualtar Campus, University of Minho, 4710-057, Braga, Portugal

² Armamar Scientific Capital Promotion Network (ARMA-Sci), 5110-128, Armamar, Portugal

³ Instituto de Investigação, Inovação e Desenvolvimento Fernando Pessoa (FP-I3ID), Fernando Pessoa University, Fernando Pessoa Teaching and Culture Foundation, Praça de 9 de Abril 349, 4249-004 Porto, Portugal; RISE-Health, Faculty of Health Sciences, Fernando Pessoa University, Fernando Pessoa Foundation for Education and Culture, Rua Carlos da Maia 296, 4200-150, Porto, Portugal; Associate Laboratory i4HB - Institute for Health and Bioeconomy; UCIBIO - Applied Molecular Biosciences Unit, MEDTECH, Laboratory of Pharmaceutical Technology, Department of Drug Sciences, Faculty of Pharmacy, University of Porto, Rua Jorge Viterbo Ferreira 228, 4050-313 Porto, Portugal

The continuous generation of agricultural waste poses environmental, economic and societal challenges, highlighting the need for sustainable valorization strategies. This waste is a renewable carbon source, and its valorization is strategic to produce high-value nanomaterials within a circular economy framework^{1,2}. In this context, green synthesis offers a promising route to transform low-value waste into cost-efficient carbon-based nanostructures with low toxicity and tunable physicochemical properties³.

Concurrently, theranostic has revolutionized cancer treatment by integrating diagnosis and therapy into single platforms. Graphene oxide quantum dots (GQDs) are ideal theranostic carriers due to their biocompatibility and unique optical properties for bioimaging⁴. Their nanoscale dimensions and surface chemistry are also decisive for their interaction with biological interfaces, such as cell membranes and tumor microenvironments, where interfacial processes govern cellular uptake, bioimaging performance and drug release. However, conventional GQD synthesis relies on non-renewable, toxic, and energy-intensive methods, limiting their sustainable production⁵. This work develops eco-friendly strategies to produce second-generation graphene quantum dots (2G-QDs) from vineyard residues. As a preliminary step, nanometric graphene oxide (NGO) was synthesized via conventional chemical methods, functionalized, and conjugated with anticancer drug doxorubicin (NGO@DOX). Results show that NGO possesses excellent drug-loading capacity and optical properties. NGO@DOX remains stable at physiological pH but releases the drug in acidic environments, supporting its potential for targeted responsive therapy. These conjugates enhance therapeutic selectivity by a pH-triggered drug release in acidic tumor microenvironments.

In conclusion, this work highlights the potential of quantum dot-anticancer drug conjugates as effective systems for controlled drug delivery and bioimaging applications. The transition from conventional chemical synthesis to green synthesis using agricultural waste as a precursor represents a promising strategy to produce eco-friendly quantum dots while contributing to circular economy and the advancement of next generation theranostic platforms designed to interact efficiently with biological interfaces.

Acknowledgements

This work was supported by the Portuguese Foundation for Science and Technology (FCT) in the framework of the Strategic Funding: UID/04650/2025" DOI <https://doi.org/10.54499/UID/04650/2025> (CF-UM-UP); UID/04378/2025 (DOI identifier 10.54499/UID/04378/2025) and UID/PRR/04378/2025 (DOI identifier 10.54499/UID/PRR/04378/2025) (UCIBIO) and LA/P/0140/2020 (DOI identifier 10.54499/LA/P/0140/2020) (i4HB). PV. Teixeira acknowledges the financial support of the PhD research grant with reference 2025.01831.BDANA.

References

- 1 Silva, O.; Mafra, A. K. C.; Pelissari, F. M.; Lemos, L.; Molina, G. (2025). *Microorganisms*, 13, 1789. <https://doi.org/10.3390/microorganisms13081789>.
- 2 Vilariño, M. V.; Franco, C.; Quarrington, C. (2017). *Frontiers in Environmental Science*, 5, 21. <https://doi.org/10.3389/fenvs.2017.00021>.
- 3 Martins, B.; Lopes, C.; Gomes, A.; Lúcio, M. (2025). *Materials Today Nano*, 32, 100697. <https://doi.org/10.1016/j.mtnano.2025.100697>.
- 4 Lúcio, M.; Fernandes, E.; Gonçalves, H. (2021). *Advanced Drug Delivery Reviews*, 85.
- 5 Shaari, N.; Kamarudin, S. K.; Bahru, R. (2021). *International Journal of Energy Research*, 45, 1396–1424. <https://doi.org/10.1002/er.5889>.

P.33: Gemini Cationic Lipid/MOG-Based Lipoplexes: Self-Assembly and Biological Activity

Natalia Sánchez-Arribas¹, Brenda Velasco-Rodríguez², Emilio Aicart¹, Silvia Barbosa², Gerardo Prieto², Andrés Guerrero-Martínez¹, Pablo Taboada², Elena Junquera¹

¹ Departamento de Química Física, Universidad Complutense de Madrid, Madrid, Spain

² Departamento de Física de Partículas e Instituto de Materiales (IMATUS), Universidade de Santiago de Compostela, Santiago de Compostela, Spain

Efficient intracellular delivery remains a major challenge for the therapeutic application of small interfering RNAs (siRNAs). These biomolecules can selectively silence target genes and inhibit the expression of associated proteins, offering a powerful approach for treating inherited and acquired diseases, including cancer, cardiovascular, and inflammatory disorders [1]. However, their clinical translation requires the development of suitable nanocarriers capable of protecting siRNA and facilitating its cellular uptake. In this context, gemini cationic lipids (GCLs) have emerged as promising non-viral delivery systems due to their ability to self-assemble in aqueous media and electrostatically condense nucleic acids into supramolecular structures known as lipoplexes. The incorporation of helper lipids can further modulate the structural organization, stability, and biological performance of these assemblies [2].

In this work, lipoplexes were formulated using mixed lipid systems composed of: (i) a synthetic gemini cationic lipid bearing imidazole headgroups and an alkyl spacer, and (ii) the neutral helper lipid 1-(cis-9-octadecenoyl)-rac-glycerol (MOG). These systems effectively bound and condensed a siRNA targeting green fluorescent protein (GFP). The physicochemical properties of the resulting complexes were thoroughly characterized using complementary experimental techniques. Their cytotoxicity was initially evaluated in 2D cell cultures, revealing low levels of cell mortality across a wide concentration range. Furthermore, cellular uptake and gene silencing efficiency were assessed in GFP-expressing tumor cell lines by flow cytometry and fluorescence microscopy, both in 2D monolayers and in 3D multicellular spheroids, a more physiologically relevant model of solid tumors.

Overall, the results demonstrate that this lipid formulation enables efficient siRNA delivery and gene knockdown, highlighting its potential as a nanocarrier for therapeutic applications.

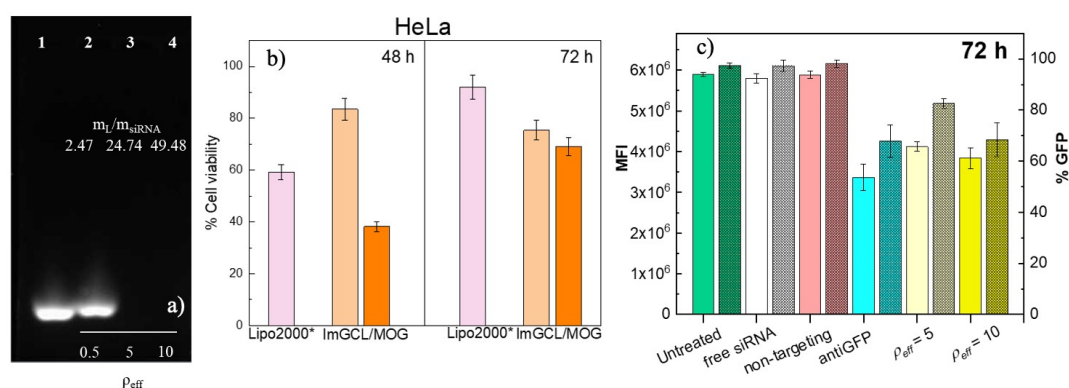


Figure 1: a) Gel electrophoresis; and b) cell viability and c) GFP silencing efficiency in GFP-expressing T731 cells of GCL/MOG-siRNA lipoplexes.

Acknowledgements Authors thanks AEI for projects: PID2021-123228NB-I00, PID2022-142682OB-I00, PCI2022-134981-2, and PID2024-159196NB-I00 funded by MICIU/AEI/ 10.13039/501100011033. ERDF/EU and European Union NextGenerationEU/PRTR funds are also greatly acknowledged.

References

- [1] F. Liu, C.F. Wang, Y.T. Gao, X. Li, F. Tian, Y.T. Zhang, M.Y. Fu, P.F. Li, Y.L. Wang, F. Wang, Current transport systems and clinical applications for small interfering RNA (siRNA) drugs, *Mol. Diagn. Ther.* 22 (2018) 551–569.
- [2] P.R. Cullis, M.J. Hope, Lipid nanoparticle systems for enabling gene therapies, *Mol. Ther.* 25 (2017) 1467–1475.

P.34: Exosome-Mimetic Liposomes for siRNA Delivery

Joana Ribeiro^{1,2}, Renata Mundim^{1,2}, Mário Fernandes^{1,2}, Rosana Simón-Vazquez³, Ivo Lopes¹, Andreia C. Gomes^{1,2}

¹Centre of Molecular and Environmental Biology (CBMA) / Aquatic Research Network (ARNET) Associate Laboratory, Universidade do Minho, Campus de Gualtar, 4710-057, Braga, Portugal

²Institute of Science and Innovation for Sustainability (IB-S), Universidade do Minho, Campus de Gualtar, 4710-057, Braga, Portugal

³CINBIO, Immunology Group, Universidade de Vigo 36310 Vigo, Spain

Testing delivery systems within biological interfaces is essential to accurately predict their behaviour *in vivo*, as interactions with complex biological environments can profoundly influence their stability, functionality and therapeutic efficacy. Evaluating nanocarriers in biologically relevant conditions is critical to bridge the gap between *in vitro* performance and clinical translation¹.

The therapeutic potential of small interfering RNA (siRNA) lies in its ability to selectively silence disease-related genes, offering promising strategies for treating conditions ranging from cancer to neurodegenerative disorders². However, its clinical application is limited by inherent instability and susceptibility to degradation². To address these challenges, we developed an exosome-mimetic liposomal platform incorporating an ionizable lipid, designed to enhance siRNA encapsulation, endosomal escape, and intracellular delivery (Fig.1). These exosome-like liposome-siRNA complexes (Exo-Lip/siRNA) exhibited favourable physicochemical properties, high encapsulation efficiency (90%), stability under physiological conditions, and strong gene silencing (~89%) with minimal cytotoxicity. Furthermore, the behaviour of Exo-Lip/siRNA was evaluated in human serum to investigate protein corona formation and its biological impact³. Proteomic and DLS analyses revealed changes in nanoparticle identity, while hemocompatibility and immune system activation were assessed on erythrocytes and peripheral blood mononuclear cells, respectively. These findings highlight the importance of biological interface testing in optimizing safe and effective siRNA delivery systems.

Figure 1: Cryo-TEM images of siRNA-containing exosome-like liposome.

Acknowledgements We acknowledge Fundação para a Ciência e a Tecnologia (FCT, I.P.) for funding project EXOPATH - Biomimetic artificial exosomes for nose-to-brain delivery (2024.17197.PEX) and “Contrato-Programa” UID/04050/2025 (<https://doi.org/10.54499/UID/04050/2025>). J Ribeiro holds a scholarship from FCT, I.P.: (2024.00627.BD).

References

1. Blanco, E., Shen, H. & Ferrari, M. Nat. Biotechnol. 33, 941–951 (2015).
2. Ali Zaidi, S. S. et al. J. Nanobiotechnology 21, 381 (2023).
3. Mahmoudi, M., Landry, M. P., Moore, A. & Coreas, R. Nat. Rev. Mater. 8, 422–438 (2023).

P.35: Microgel monolayers for precise and localized biomolecule capture: toward diagnostic and biosensing platforms

G. Sánchez-Balderas^{1,2}, C.L. Moraila-Martínez^{3,4}, J.G. Guerrero-Félix^{2,3}, M. Hurtado-López⁵, A. Dorigo², Sarita Montañó^{1,6}, M. Bramini⁷, P. Sánchez-Moreno², M.A. Fernández-Rodríguez²

¹ Faculty of Chemical-Biological Sciences, Autonomous University of Sinaloa, Culiacán, 80030, Sinaloa, México

² Department of Applied Physics, Faculty of Sciences, University of Granada, Granada, 18071, Granada, Spain

³ Faculty of Biology, Autonomous University of Sinaloa, Culiacán, 80040, Sinaloa, México

⁴ Department of Electronics and Computer Technology, Faculty of Sciences, University of Granada, Granada, 18071, Granada, Spain

⁵ Institute of Parasitology and Biomedicine Lopez-Neyra, CSIC, Granada, 18016, Granada, Spain

⁶ Department of Pathology, University of Michigan, Ann Arbor, 48109, Michigan, USA

⁷ Department of Cell Biology, Faculty of Sciences, University of Granada, Granada, 18071, Granada, Spain

Thermoresponsive microgels based on poly(N-isopropylacrylamide) (pNIPAM) and poly(N-vinylcaprolactam) (pVCL) were self-assembled into ordered monolayers at fluid interfaces and transferred onto glass substrates via Langmuir-Blodgett deposition, enabling controlled investigation of microgel behavior under confinement. Their stability and swelling response were evaluated in phosphate-buffered saline (PBS), Dulbecco's Modified Eagle Medium (DMEM), supplemented DMEM (cDMEM), and HEK-293 cell culture using in situ fluid-cell atomic force microscopy (AFM). While both microgels show biocompatibility, only the softer pVCL ones remain structurally stable after incubations, whereas pNIPAM-based coatings show limited stability. pVCL microgel monolayers display time-dependent and partially irreversible biomolecular uptake, including proteins and extracellular vesicles, as confirmed by AFM, fluorescence microscopy (Fig. 1), and FTIR spectroscopy. The combination of AFM-based volumetric analysis, fluorescence imaging, and UV-vis microplate reader measurements provides a multi-technique framework for evaluating protein adsorption, enabling low-cost methods to be calibrated against high-resolution approaches. The results highlight low-crosslinked pVCL monolayers as robust bioactive interfaces with high biomolecular uptake capacity, with potential relevance for biosensing, diagnostic platforms, and biomedical surface engineering.

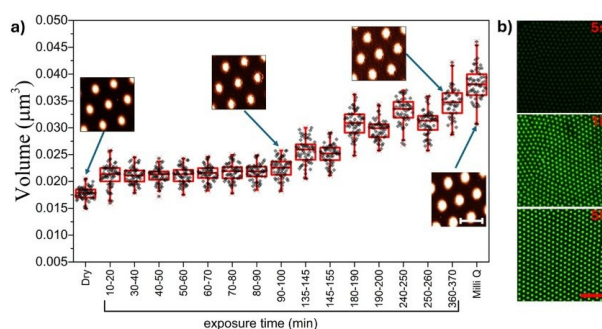


Figure 1: pVCL microgel volume evolution during exposure to a BSA dispersion in PBS (4.5 mg/mL) measured by **a)** in-situ AFM in a fluid cell, and **b)** epifluorescence microscopy thanks to a fluorescent-labeled BSA protein.

Acknowledgements

This work was supported by projects PID2020-116615RA-I00, PCI2020-112045, and RYC 2019-027692-I, funded by MCIN/AEI/10.13039/501100011033, EU Next Generation EU/ PRTR, and the European Social Found "El FSE invierte en tu futuro". MAFR acknowledges support from the EMERGIA grant EMC21_00008 and project C-ING-208-UGR23 funded by Consejería de Universidad, Investigación e Innovación de la Junta de Andalucía, and by FEDER "Andalucía 2021-2027". Also, by projects PID2023-149387OB-I00 and PID2023-147135OB-I00 funded by MICIU/AEI/10.13039/501100011033 and by FEDER, EU. CLMM acknowledges support from project B-RNM-486-UGR20 funded by Consejería de Universidad, Investigación e Innovación de la Junta de Andalucía, and "ERDF A way of making Europe". GSB acknowledge support from SECIHTI México through postdoctoral grant associate to CVU 659625.

P.36: Characterising lipid interfaces with plasmonic nanosensors under dark-field microscopy

Alfredo Casasnovas-Melián, Rubén Ahijado-Guzmán, Lucía Labrador-Páez, Elena Junquera, Andrés Guerrero-Martínez

Universidad Complutense de Madrid, Facultad de Ciencias Químicas, Madrid, Spain

Traditional techniques for investigating lipid systems often rely on fluorescence-based probes. However, these methods can perturb membrane organization and influence lipid packing, even at low probe concentrations. Additional limitations such as photobleaching, blinking, and restricted temporal resolution further motivate the development of label-free approaches that avoid introducing artifacts.

This work explores single-nanoparticle plasmon spectroscopy as a label-free method to study lipid membranes. The approach uses gold nanorods (AuNRs), which exhibit localized surface plasmon resonances (LSPRs)¹. LSPRs produces strong optical scattering signals that are highly sensitive to changes in the local refractive index within a few nanometres of the nanoparticle surface². This sensitivity allows AuNRs to function as nanoscale sensors capable of detecting membrane structural changes and phase transitions in real time³ (Fig. 1).

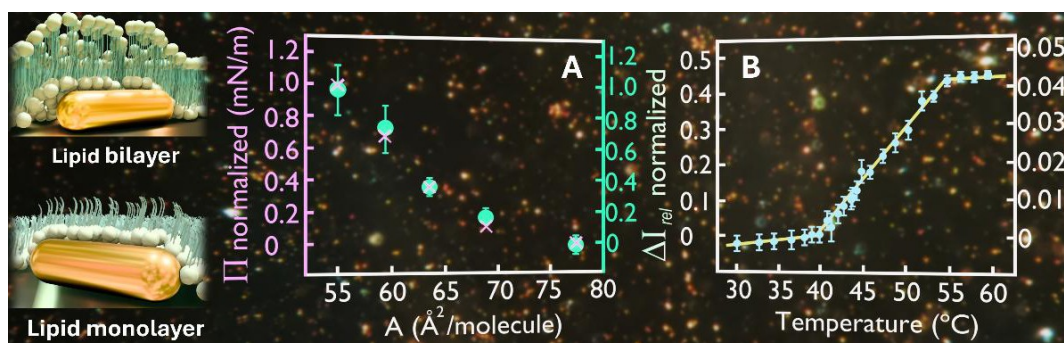


Figure 1: (A) Correlation between the normalized scattering intensity of nanosensors and surface pressure at different lipid packing densities on a lipid monolayer. (B) Normalized scattering intensity of plasmonic nanoparticles under a lipid bilayer at different temperatures.

Acknowledgements This work has been funded by the Spanish Ministry of Science and Innovation (MICINN) (Grants PID2021-123228NB-I00, PID2023-150760NA-I00 and PID2024-159196NB-I00) and the Madrid Regional Government (Grant ANTICIPA-UCM). A.C.-M. was funded by a predoctoral fellowship granted from the Universidad Complutense de Madrid-Banco Santander.

References

- 1 G. González-Rubio, P. Díaz-Núñez, A. Rivera, A. Prada, G. Tardajos, J. González-Izquierdo, L. Bañares, P. Llombart, L. G. Macdowell, M. Alcolea Palafox, L. M. Liz-Marzán, O. Peña-Rodríguez, A. Guerrero Martínez, *Science* 2008, 358, 6363, 640 – 644.
- 2 S. Celiksoy, W. Ye, K. Wandner, K. Kaefer, C. Sönnichsen, *Nano Lett.* 2021, 21, 5, 2053 – 2058.
- 3 A. Casasnovas-Melián, N. Robles-Anda, L. Labrador-Páez, F. D. Kofler, J. Hinojosa-Espinosa, E. Junquera, M. A. Sacristán, I. López-Montero, A. Collada, A. Cruz, J. Pérez-Gil, R. Ahijado-Guzmán, A. Guerrero-Martínez, *Adv. Optical Mater.* 2025 13, 34, e01356.

P.37: Effect of SO_4^{2-} and Sr^{2+} Ions at Oil and Emulsions–Brine Interfaces

J. M. S. Gonçalves^{1,2,3}, F. S. Serpa², C. Dariva^{1,2}, Artur J. M. Valente³, G. R. Borges^{1,2}

¹ Center for the Study of Colloidal Systems / Institute of Technology and Research, Av. Murilo Dantas, 300, Aracaju-SE, Brazil, CEP 49032-490

² Tiradentes University, Institute of Technology and Research, Aracaju, SE, Brazil, CEP 49032-490

³ University of Coimbra, CQC-IMS, Department of Chemistry, Rua Larga, 3004-535 Coimbra, Portugal

The interfacial behavior of oil-water systems is strongly influenced by the ionic composition of the aqueous phase, which affects the physicochemical properties of the interface and plays an important role in oil recovery processes. Understanding how specific ions affect these interfacial properties is therefore essential for interpreting the mechanisms associated with enhanced and advanced oil recovery processes¹. This study investigates how specific ions (SO_4^{2-} and Sr^{2+}) influence interfacial tension and the viscoelastic behavior of oil-brine systems, including emulsified systems. Synthetic brines were prepared using sodium sulfate (Na_2SO_4) and strontium chloride hexahydrate ($\text{SrCl}_2 \cdot 6\text{H}_2\text{O}$) as sources of SO_4^{2-} and Sr^{2+} , respectively, and the systems are described according to the ions of interest present in the aqueous phase. Interfacial tension was determined using the Du Noüy ring method. In addition, water-in-oil (W/O) emulsions were prepared and characterized by apparent viscosity and oscillatory rheology to evaluate their overall viscoelastic response and to relate interfacial behavior to bulk rheological response. More complex emulsified systems were also investigated, in which an inner aqueous phase containing Sr^{2+} was dispersed in oil and brought into contact with an outer aqueous phase containing SO_4^{2-} , enabling the assessment of interfacial effects in systems with multiple interfaces. The experiments were conducted at 25 °C using controlled ionic compositions based on concentrations found in actual produced waters, covering the range from 10 to 500 mg L⁻¹. The equilibrium interfacial tension of the oil/deionized water system was 23.48 ± 0.28 mN m⁻¹. Among the investigated conditions, the optimal ionic composition corresponded to the condition of minimum interfacial tension within the studied range, reaching 21.6 ± 0.11 mN m⁻¹ for sulfate-containing systems at 228 mg L⁻¹ and for mixed $\text{Sr}^{2+}/\text{SO}_4^{2-}$ systems at 252 mg L⁻¹. In emulsified systems composed of an inner aqueous phase containing Sr^{2+} , dispersed in oil and brought into contact with an external aqueous phase containing sulfate, the interfacial response suggests that the external aqueous phase governs the overall behavior of the system. Rheological results indicated predominantly viscous behavior and no marked changes in overall viscoelasticity, indicating that the ion-specific effects observed in these systems are primarily associated with interfacial properties rather than with the formation of rigid or gel-like structures in the emulsion bulk. Overall, the results revealed a nonlinear dependence of interfacial tension on ion identity and concentration, highlighting a pronounced ion-specific effect at the oil-water interface. This study advances the understanding of ion-specific effects by demonstrating that interfacial behavior in emulsified systems is governed by the composition of the external aqueous phase, providing a mechanistic basis for the design of formulated brines in enhanced oil recovery processes.

Acknowledgements We acknowledge CAPES (Coordination for the Improvement of Higher Education Personnel - Brazil) - Funding Code 001, CNPq (National Council for Scientific and Technological Development), FAPITEC/SE (Foundation for Research and Technological Innovation Support of the State of Sergipe), and ANP (National Agency for Petroleum, Natural Gas, and Biofuels) for their financial support and scholarships. This work was also funded by the Coimbra Chemistry Center (CQC-IMS), with support from the Foundation for Science and Technology (FCT, Portugal), through programs UIDB/00313/2025 and UIDP/00313/2025.

References

1 AKINDIPE, D.; SARAJI, S.; PIRI, M. Carbonated water injection in oil-wet carbonate rock samples: a pore-scale experimental investigation of the effect of brine composition. *Energy & Fuels*, v. 36, n. 9, p. 4847-4870, 2022.

P.38: Effect of crosslinking and drying on starch/alginate beads for effective removal of heavy metals from aqueous systems

Talles B. Costa^{1,2}, Pedro M.C. Matias¹, Dina M.B. Murtinho¹, Derval S. Rosa², Artur J.M. Valente¹

¹ Coimbra Chemistry Centre, Department of Chemistry, University of Coimbra, 3004-535 Coimbra, Portugal

² Center for Engineering, Modeling and Applied Social Sciences, Federal University of ABC, 09280-560, Santo André, São Paulo, Brazil

The presence of heavy metal in contaminated water from industrial activities has raised increasing concern due to their toxicity, persistence, and bioaccumulation potential. The removal of these elements from aqueous systems is essential for sustainable water management. Among available technologies, sorption has emerged as an efficient and low-cost strategy for removing metal ions, particularly when using bio-based materials containing oxygenated functional groups capable of coordinating metallic species¹. Polysaccharides such as starch and alginate are especially attractive due to their abundance, biodegradability, and high density of hydroxyl and carboxyl groups. Thus, this work describes the preparation of hybrid potato starch/sodium alginate beads covalently crosslinked with citric acid (6 and 15 g L⁻¹) for the removal of heavy metals from aqueous solutions. Two drying strategies were investigated to evaluate their influence on the structure and adsorption behavior of the materials: oven-drying (beads F3) and freeze-drying (beads F6) (Figure 1). FTIR spectra confirmed the formation of ester bonds between the polysaccharides and citric acid, evidenced by the progressive emergence of the carbonyl stretching band at 1725 cm⁻¹ and the C–O stretching band at 1158 cm⁻¹. Morphological and porosimetry characterization showed that freeze-drying generates a highly porous structure (F6) with higher swelling degree (2000%) and specific surface area (8.56 m² g⁻¹) than oven-drying, which produces more compact scaffolds (F3), with limited swelling (400–500%) and 25× lower surface area (0.33 m² g⁻¹). Adsorption experiments conducted with eight metal ions showed that highly crosslinked formulations exhibit strong selectivity for cationic metals following the trend Pb(II) > Cu(II) > Cr(III) > Cd(II) > Ni(II) > Zn(II) > Mn(II) >> Cr(VI). Equilibrium data were best described by the Sips isotherm model, with maximum adsorption capacities reaching (2.0 ± 0.2) mmol g⁻¹ (F3) and (1.79 ± 0.08) mmol g⁻¹ (F6) for Pb(II), exceeding those obtained for Cu(II), Cr(III), and Cd(II). Kinetic analysis revealed a pronounced structural–functional contrast between the materials: the porous F6 beads reached adsorption equilibrium within 120–180 min, whereas the compact F3 beads required up to 1440 min, corresponding to adsorption rates up to 12 times faster for the freeze-dried material. Reuse assays revealed excellent operational stability, with metal recovery efficiencies above 90–95% using 0.5 mol L⁻¹ nitric acid over five adsorption–desorption cycles. These results demonstrate that the combined covalent crosslinking and freeze-drying processes enables the development of high-performance and regenerable adsorbents for heavy metal remediation.

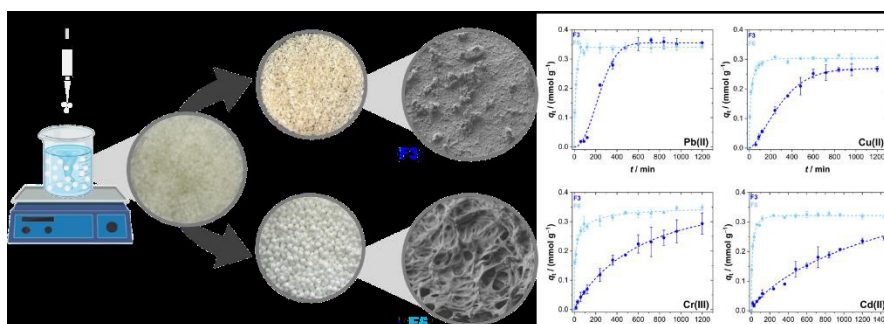


Figure 1: Schematic illustration of the preparation and application of starch/alginate beads crosslinked with citric acid for heavy metal removal from aqueous solutions.

Acknowledgements The work was funded by the Coimbra Chemistry Centre, which is supported by the Fundação para a Ciência e a Tecnologia (FCT, Portugal), through the programs UIDB/00313/2025, UIDP/00313/2025 and LA/P/0056/2020. Talles B. Costa thanks Fundação de Amparo à Pesquisa do Estado de São Paulo (FAPESP, Brazil) for the grants #2022/11133-0 and #2023/11783-8. Pedro M. C. Matias acknowledges FCT, Portugal for the PhD Grant 2022.12425.BD.

References

1. Crini, G.; Lichtfouse, E. Advantages and disadvantages of techniques used for wastewater treatment. *Environmental Chemistry Letters*, 2019, 17, 145–155.

P.39: Plasmonic-based Enhancement of Zn-Air Battery Performance

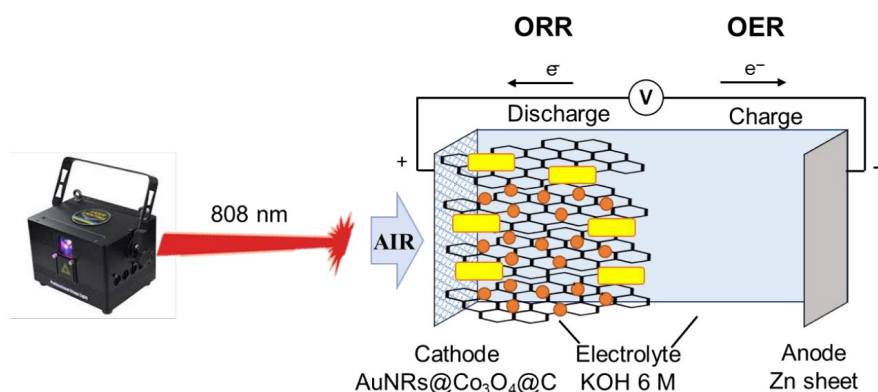
Domingo Salazar-Ordoñez, Valentín García-Caballero, Manuel Cano, Juan J. Giner-Casares, Antonio J. Fernández Romero

Departamento de Química Física y Termodinámica Aplicada, Instituto Químico para la Energía y el Medioambiente (IQUEMA), Universidad de Córdoba, E-14014 Córdoba, Spain

The transition toward high-density energy storage necessitates the development of bifunctional electrocatalysts capable of driving both the oxygen reduction and evolution reactions (ORR/OER) with minimal overpotentials. In this work, we present an advanced plasmonic-assisted Zinc-air battery (ZAB) utilizing a tailored cathode based on carbon (C) integrated with cobalt oxide (Co_3O_4) and gold nanorods (AuRods). This hybrid architecture leverages the conductive properties of the doped carbon matrix alongside the catalytic activity of transition metal oxides to bridge the gap between fundamental catalysis and practical device application.^{1,2}

Moreover, a key innovation of this system lies in its near-infrared (NIR) sensitivity. By exploiting the Localized Surface Plasmon Resonance (LSPR) of the embedded AuRods, the cathode captures NIR radiation to generate energetic hot carriers. This plasmonic enhancement accelerates the sluggish kinetics of oxygen intermediates at the Co_3O_4 active sites, effectively lowering the charge-discharge voltage gap when illuminated.

Performance evaluation in a rechargeable Zn-air configuration demonstrates that NIR irradiation leads to a significant increase in energy and power density, energy efficiency, as well as improved cycling stability compared to dark conditions. This work underscores the potential of integrating plasmon-enhanced nanostructures into metal-air batteries, offering a robust strategy for light-assisted, high-efficiency energy storage devices.



Scheme 1: Schematic representation of Zinc-Air Battery used in this work.

Acknowledgements

We thank the support of the FQM-204 research group and AJFR for the PID2022-139191OB-C32 project and excellent network E3TECH-PLUS (ED2022-134552-T, MICINN/AEI).

References

- 1G. Ren, M. Zhou, P. Hu, J. F. Chen, H. Wang, *Nat. Commun.* 2024, 15, 2346.
- 2D. Yang, Y. Zhang, J. Sun, X. Zhang, Z. Gao, Sun, M. Feng, *Int. J. Hydrog. Energy* 2025, 116, 23.

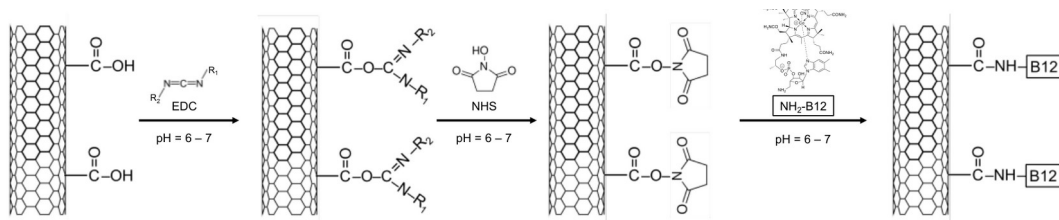
P.40: Bio-inspired catalysis: Vitamin B12 and SWCNTs for energy storage in zinc-air batteries

Valentín García-Caballero, Miguel López-León, José M. Rodríguez Mellado, Antonio J. Fernández Romero, Pablo G. Argudo, Manuel Cano Luna

Departamento de Química Física y Termodinámica Aplicada, Instituto Químico para la Energía y el Medioambiente (IQUEMA), Universidad de Córdoba, E-14014 Córdoba, Spain

The global transition toward renewable energy necessitates the development of advanced energy storage systems. Zinc-air batteries (ZABs) stand out as a highly sustainable and efficient solution, leveraging atmospheric oxygen as an active reactant. However, the practical viability of ZABs is hindered by the sluggish kinetics of the cathodic oxygen reduction reaction (ORR), which traditionally requires scarce and expensive noble metal catalysts. To address this bottleneck, biomolecules have emerged as a promising, eco-friendly alternative. While previous studies have demonstrated the catalytic potential of pyrolyzed or modified vitamin B12 for ORR and CO₂ reduction^{1,2}, its direct covalent integration into highly conductive carbon frameworks for battery applications remains relatively unexplored. Therefore, this work evaluates the electrocatalytic performance of vitamin B12 covalently anchored to single-walled carbon nanotubes (SWCNTs) as a novel cathode catalyst for ZABs.

The covalent anchoring of vitamin B12 onto SWCNTs was achieved via EDC/NHS coupling (Scheme 1), and successful conjugation was confirmed through X-ray photoelectron spectroscopy (XPS) and high-resolution transmission electron microscopy (HR-TEM). The electrocatalytic activity of the resulting nanohybrids toward ORR was thoroughly investigated using rotating ring-disk electrode (RRDE) voltammetry, applying the Koutecký-Levich method to determine the electron transfer number and elucidate the catalytic pathway. Furthermore, the electrochemically active surface area (ECSA) of the modified electrodes was quantified by evaluating the electrochemical double-layer capacitance, complemented by electrochemical impedance spectroscopy (EIS) to assess charge transfer dynamics. Finally, translating these fundamental findings into practical applications, the B12/SWCNT composite was successfully integrated into prototype zinc-air batteries. These preliminary device-level tests validate the catalytic efficacy of the nanohybrid, paving the way for the development of next-generation, biocompatible, and sustainable metal-air energy storage systems.



Scheme 1: Modification of SWCNTs with Vitamin B12 via carbodiimide.

Acknowledgements We thank to the research group FQM-204. M. L.-L. thanks the Ministry of Universities for a FPU fellowship (FPU24-03131). AJFR for the PID2022-139191OB-C32 project and excellent network E3TECH-PLUS.

References

- 1 Lee, D.-E.; Moru, S.; Jo, W.-K.; Tonda, S. J. *Alloys Compd.* 2022, 912, 165118.
- 2 Yesudas K., Y.; Balamurugan, M.; Nam, K. T.; Gopal, B.; Senthil Kumar, A. J. *Mater. Chem. A.* 2024, 12, 31135–31144

P.41: Synthesis and Characterization of Gold Nanostars Coated with Titanium Oxide for the Degradation of Organic Pollutants

A.M. Ochoa-Cardoza¹, J. Juárez¹, A. Topete², S. Barbosa², P. Taboada², D. Encinas-Basurto¹

¹ Department of Physics, Nanotechnology Doctoral Program, University of Sonora, Hermosillo Campus, Blvd. Luis Encinas y Rosales S/N, Col. Centro, 83000 Hermosillo, Sonora, Mexico.

² Colloids and Polymer Physics Group (GFCP), Department of Particle Physics, Campus Vida, Universidade de Santiago de Compostela, 15782 Santiago de Compostela, Spain.

In recent years, photocatalysis has emerged as a promising advanced oxidation process (AOP) for water remediation, enabling the degradation of organic contaminants through the generation of reactive oxygen species (ROS). Titanium dioxide (TiO_2) is a widely used photocatalyst due to its low cost, stability, and environmental compatibility; however, its practical application is limited by its wide bandgap and rapid electron-hole recombination, restricting its activity to the UV region. To overcome these limitations, AuNS@ TiO_2 hybrid nanostructures were developed by integrating gold nanostars (AuNS) with TiO_2 , aiming to exploit localized surface plasmon resonance (LSPR). The plasmonic properties of AuNS enable the generation of hot electrons under visible-NIR irradiation, which can be injected into the TiO_2 conduction band, enhancing charge separation and potentially improving photocatalytic performance. Thereby improving photocatalytic efficiency⁴. In this work, AuNS were synthesized via a seed-mediated method, yielding anisotropic structures (~100 nm) with broad LSPR absorption extending over the visible-NIR region (500–1000 nm). Subsequently, a layer of TiO_2 was deposited using titanium isopropoxide (TTIP), preserving both the morphology and the optical properties no changes were observed in the LSPR position, the size of the AuNS increased to ~120 nm, and a zeta potential of -38.7 mV was obtained, indicating that the system is stable. These findings suggest that plasmonic-semiconductor hybrid nanostructures represent a promising strategy for extending photocatalytic activity into the visible spectrum and improving the efficiency of systems designed to degrade pollutants such as methylene blue.

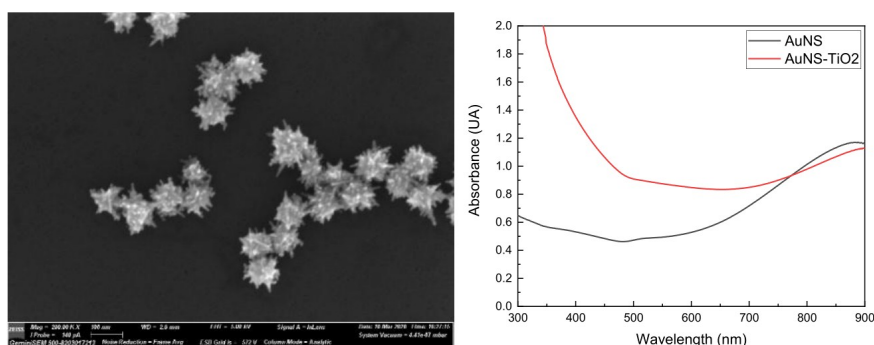


Figure 1: SEM micrograph of AuNS and UV-Vis absorbance spectra of the AuNS before and after coating with TiO_2

Acknowledgements The authors further acknowledge the assistance provided by the Scanning Electron Microscopy Technical Services during the development of this research. A.M.O.-C. also gratefully acknowledges the Secretaría de Ciencia, Humanidades, Tecnología e Innovación (SECIHTI) for the scholarship support S190.

References

1. Thuan, D. Van, Long, H., Pham, H., Thu, T. & Chu, H. Photodegradation of hazardous organic pollutants using titanium oxides-based photocatalytic : A review. *Environ. Res.* 229, 116000 (2023).
2. Sarina, S., Wacławik, E. R. & Zhu, H. irradiation. 1814–1833 (2013) doi:10.1039/c3gc40450a.
3. Ibrahim, U. & Halim, A. *Journal of Photochemistry and Photobiology C : Photochemistry Reviews* Heterogeneous photocatalytic degradation of organic contaminants over titanium dioxide : A review of fundamentals , progress and problems. 9, 1–12 (2008).
4. Atta, S. et al. TiO_2 on Gold Nanostars Enhances Photocatalytic Water Reduction in the Near-Infrared Regime TiO_2 on Gold Nanostars Enhances Photocatalytic Water Reduction in the Near-Infrared Regime. *CHEMPR* 4, 2140–2153 (2018).

P.42: Effect of Nafion on the Electrocatalytic Performance for ORR of Gold and Silver Nanoparticles

Teresa Mansilla-Cejas, Valentín García-Caballero, Miguel López-León, José M. Rodríguez Mellado, Antonio J. Fernández Romero, Juan J. Giner-Casares, Manuel Cano Luna

Department of Physical Chemistry, University of Córdoba (UCO), Institute of Chemistry for Energy and the Environment, University of Córdoba, E-14014 Córdoba.

Nafion is a synthetic ionomer based on a sulfonated tetrafluoroethylene copolymer, characterized by its exceptional chemical and thermal stability and high proton conductivity. In the field of heterogeneous electrocatalysis, it is mainly used as a binding agent for the preparation of catalytic inks^{1,2}. Its main function is to mechanically fix the catalyst materials on the surface of the electrode, creating an adherent and porous film that not only prevents leaching of the active material, but also facilitates the transport of reactants and products across the solid-liquid interface without compromising electron transfer. On the other hand, gold (AuNPs) and silver (AgNPs) nanoparticles have proven to be highly efficient electrocatalyst materials in oxygen reduction reaction (ORR), showing promise to replace Pt-based catalysts in alkaline fuel cells. At the nanoscale, these noble metals exhibit superior properties due to their large surface area and quantum effects.

In this work, the effect of Nafion on the electrocatalytic performance for ORR of AuNPs and AgNPs has been investigated. AuNPs and AgNPs were synthesized by simple and sustainable citrate reduction methods in aqueous medium. Subsequently, both were characterized by UV-visible spectroscopy, x-ray photoelectron spectroscopy (XPS), X-ray diffraction (XRD) and transmission electron microscopy (TEM) (**Figure 1**). Next, different electrochemical techniques, both static and dynamic conditions, were used to compare the electrocatalytic performance for ORR of AuNPs and AgNPs in the presence and in the absence of Nafion. Finally, lead underpotential deposition technique was performed to analyze the influence of Nafion on the existing facets both for AuNPs and AgNPs.

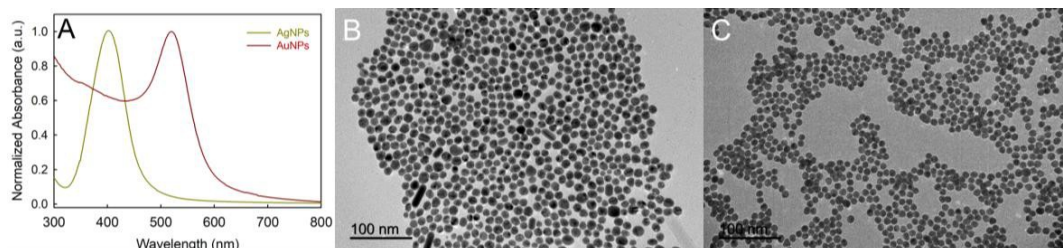


Figure 1: (A) Normalized UV-visible absorption spectra and TEM images of (B) AgNPs and (C) AuNPs.

Acknowledgements To the research group FQM-204. T. M.-C. thanks the UCO for a Predoctoral Contract associated with RYC2021-034702-I, funded by MCIN/AEI/10.13039/501100011033 and by the European Union “NextGenerationEU”/PRTR. M. L.-L. thanks the Ministry of Universities for a FPU fellowship (FPU24-03131).

References

- [1] N. Kakati, L. Anderson, G. Li, D. M. Sua-an, A. Karmakar, J. D. Ocon, P.-Y. A. Chuang, *ACS Appl. Mater. Interfaces* 2023, 15, 55559–55569.
- [2] S. Röher, L. L. Duarte, A. Apel, J. Grothe, S. Kaskel, I. M. Weidinger, *ChemCatChem* 2026, 18, e01435.

P.43: Multiple intralayer linkage of bulky organic spacers for enhancing stability and performance of quasi-2D perovskites in photovoltaics

E.M. Vargas-García¹, Gustavo de Miguel¹, E. Hernández-Balaguera²

¹ Departamento de Química Física y Termodinámica Aplicada, Instituto Químico para la Energía y el Medioambiente (IQUEMA), Universidad de Córdoba, Campus de Rabanales, Edificio Marie Curie, E-14071 Córdoba, Spain

² Escuela Superior de Ciencias Experimentales y Tecnología Universidad Rey Juan Carlos C/ Tulipán, s/n, Móstoles, Madrid 28933, Spain

Metal halide perovskites (MHPs) based solar devices are highly versatile. Three-dimensional (3D) perovskites have demonstrated high power conversion efficiencies but suffer from poor stability. In contrast, two-dimensional (2D) perovskites offer enhanced stability at the expense of reduced efficiency.

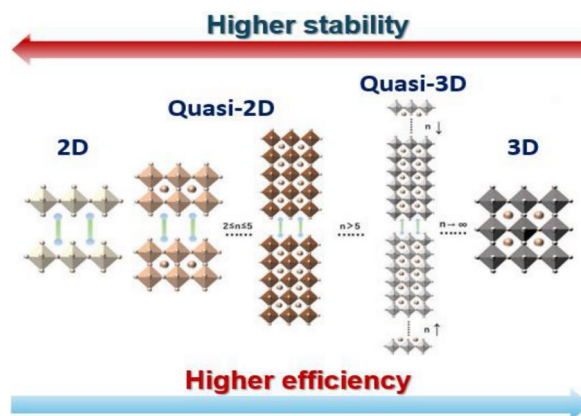


Figure 1: Dimensionality of the MHPs and relation to stability and efficiency of the solar cells.

The aim of this work is to fabricate and optimize photovoltaic devices using a thin layer of quasi-2D halide perovskite. This type of perovskite consists of a 3D perovskite layer—responsible for high efficiency—coupled with a 2D perovskite layer, which provides enhanced stability and contributes to material passivation¹. The interaction between these layers occurs through specific crystallographic planes composed of inorganic octahedral sheets assembled by bulky organic mono- or diammonium cations¹. In this study, three types of bulky tetraammonium organic spacers are proposed, both in the form of single crystals and thin films.

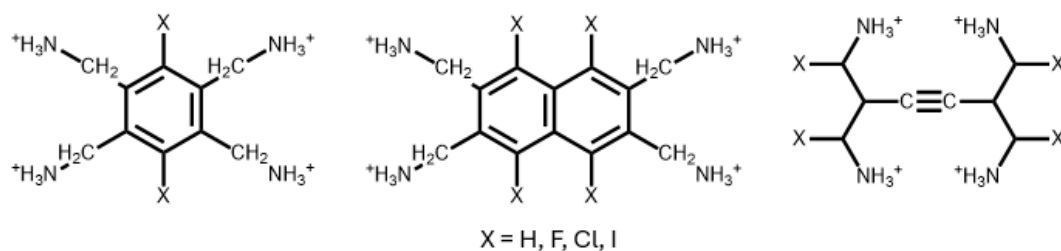


Figure 2: Chemical structure of the selected tetraammonium bulky spacers

Following synthesis, the optoelectronic properties of the fabricated prototypes are characterized to understand the charge transport properties of the synthesized materials, particularly in the out-of-plane direction. Additionally, degradation mechanisms of the synthesized prototypes are investigated under different stress conditions, including high humidity, continuous illumination, and elevated temperatures. The theoretical target for these solar cells is to achieve efficiencies exceeding 23%, with a degradation of only 20% after more than 6000 hours of continuous illumination.

Acknowledgements The authors gratefully acknowledge the financial support from the *Ministerio de Ciencia, Innovación y Universidades* (Ref: PID2024-161164OB-I00)

References

[1] S. Ramos-Terrón, L. Camacho, J.-P. Correa-Baena, C. A. R. Perini, G. de Miguel, 2025 *Materials Today*, 85, 60-68.

P.44: Development of a sustainable separator for batteries using aerogels

Raquel Bento¹, Cláudio M.R. Almeida¹, Artur Valente², Luísa Durães¹

¹ University of Coimbra, CERES, Dept. Chemical Engineering, Rua Sílvio Lima, 3030-790 Coimbra, Portugal

² University of Coimbra, CQC-IMS, Dept. Chemistry, Rua Larga, 3004-535 Coimbra, Portugal

The rapid growth of electric mobility, the expansion of renewable energy sources, and the increasing demand for efficient energy storage systems have reinforced the strategic role of batteries in the global energy transition. These systems are essential for ensuring grid stability, enabling energy storage during periods of surplus generation, and reducing dependence on fossil fuels, thereby contributing to the decarbonization of the energy sector. In parallel, the growing emphasis on sustainability has driven the development of environmentally friendly solutions aligned with circular economy principles, material reuse, and the reduction of environmental impact throughout the battery life cycle.¹

Despite their technological importance, battery production and use remain associated with significant environmental impacts, particularly during raw material extraction, material processing, manufacturing, and end-of-life management. Among battery components, the separator plays a critical role by ensuring physical separation between electrodes while allowing selective ion transport, directly influencing safety, electrochemical performance, and system durability. Currently, commercial separators are predominantly based on fossil-derived polymers such as polyethylene and polypropylene, which provide adequate electrochemical performance and mechanical strength but raise environmental concerns due to their low biodegradability, limited recyclability, and restricted thermal stability.¹

In this context, the present project aims to develop a sustainable battery separator based on silica aerogel derived from recycled glass, promoting waste valorization and the use of secondary raw materials in high-value applications. The aerogel will be reinforced with recycled cellulose textile fibers², namely cotton, to enhance mechanical properties such as flexibility, structural integrity, and resistance during charge-discharge cycles.

The work will include the chemical characterization of recycled glass as a silica source to evaluate its suitability for extraction and purification processes, for which a purity level of 91% has already been achieved. Different silica recovery methods will be explored, and the influence of impurities on the final aerogel properties, including porosity, density, and average pore size, will be analyzed. Following aerogel synthesis, thermal, mechanical, and electrolyte permeability properties will be assessed, as these parameters are critical for separator performance.

From an environmental perspective, the development of sustainable and thermally safer separators offers a promising pathway to reduce the ecological footprint of batteries while promoting circular economy strategies and waste reutilization. This project is expected to demonstrate the technical and environmental viability of silica aerogel-based separators as a sustainable alternative to conventional materials, contributing to the advancement of safer, high-performance, and environmentally responsible energy storage technologies.

Acknowledgements The work developed at CERES and CQC research units was supported by FCT (Portugal) and the European Union - NextGenerationEU, through PRR and Equipar+2, under the scope of projects:

<https://doi.org/10.54499/UID/00102/2025>, <https://doi.org/10.54499/UID/PRR/00102/2025>,
<https://doi.org/10.54499/UID/PRR2/00102/2025>, <https://doi.org/10.54499/UID/00313/2025>,
<https://doi.org/10.54499/UID/PRR/00313/2025> and <https://doi.org/10.54499/UID/PRR2/00313/2025>.

References

- [1] C.R. Chowdhury, A. Biswas, M.G. Kibria and M. Mourshed, "Battery waste management: Tackling environmental, health, and resource challenges from growing waste", *Chemical Engineering Journal Advances*, 25 (2026): 101033, <https://doi.org/10.1016/j.ceja.2026.101033>
- [2] T. Linhares, V.H. Carneiro, M.T. Pessoa de Amorim, L. Durães, "A Comparative Thermoacoustic Insulation Study of Silica Aerogels Reinforced with Reclaimed Textile Fibres: Cotton, Polyester and Wool", *Gels*, 9 (2023): 548, <https://doi.org/10.3390/gels9070548>

Author Index

482 authors · Alphabetical by surname · Page numbers refer to this book

A

Abalde-Cela, Sara²⁹
 Abelenda, O.¹⁰⁵
 Abelenda, Óscar⁴⁵
 Abou-Hassan, Ali^{22, 31, 32}
 Abreu, M. H.⁸³
 Abreu, P. E.⁵⁵
 Adam-Cervera, Inés^{11, 15}
 Aguilar-Ramírez, A.²⁰
 Aguilera-Garrido, Aixa¹⁸
 Ahijado-Guzmán, Rubén¹¹¹
 Aicart, Emilio¹⁰⁸
 Almeida, Cláudio M.R.¹¹⁹
 Alves, Luís^{102, 104}
 Amaral, Leonardo⁷⁶
 Amaya, Ana Jiménez^{65, 67}
 Anguiano-Lizárraga, M.E.¹⁰¹
 Araújo, João P.⁹⁴
 Arcos, Belén¹⁷
 Arenas-Esteban, Daniel²³
 Argudo, P.G.⁶⁴
 Argudo, Pablo G.^{99, 115}
 Assubuji, A.D.³⁸
 Azevedo, Ana Gabriela⁴²

B

Balalta, Deema²³
 Ballard, N.⁹
 Bals, Sara²³
 Bañares-Morcillo, Luis³⁹
 Bañobre-López, M.⁵⁴
 Barbosa, S.^{20, 26, 54, 105, 116}
 Barbosa, Silvia^{47, 58, 108}
 Barboza, S.¹⁰¹
 Barcina, J. Osío⁹⁰
 Barradas, Paulo D. Nunes⁶⁰
 Barriga, Miriam Feijoo³⁰
 Barros, P.¹⁶
 Basílio, N.⁸²
 Basilio, N.⁹²
 Becker, D.⁸⁶
 Bello, Davide³⁰
 Bento, Raquel¹¹⁹
 Bettini, S.^{19, 75}
 Bibic, L.⁹⁵

Blanco-Pérez, Martí78
 Bodelón, G.28
 Bodelon, Gustavo29
 Bodelón, Gustavo35
 Bonastre, Jose María14
 Borges, G. R.112
 Bouju, Cyprien78
 Bramini, M.110
 Branco, F.66
 Branquinho, R.107
 Brzezinski, M.64

C

Caballero, V. García19, 75
 Cabrerizo-Vílchez, Miguel Ángel68
 Calero, Carles71
 Camani, P. H.40, 86
 Cambón, Adriana58
 Candela, M. T.50
 Canepa, Ester73
 Cano, Manuel99, 114
 Cara-Galdeano, C.9
 Cardoso, H.83
 Carracedo, G.41
 Carril, Mónica30
 Casal, Ana Carolina77
 Casasnovas-Melián, Alfredo111
 Casteleiro, B.53
 Cea, P.13, 100
 Cea, Pilar14
 Cerqueira, M. A.83
 Cerqueira, Miguel A.42
 Chandrasegaran, S.25
 Chaouachi, Myriam32
 Charreyre, M.-T.53
 Chen, W.64
 Chicharo, Alexandre29
 Chiodini, S.100
 Clare, G.16
 Clemente, Pablo Díaz47
 Corrêa, Luísa104
 Costa, Alba45
 Costa, T.B.38
 Costa, Talles B.113
 Costa-Santos, A.105
 Costas-Ríos, Lara29, 35
 Couselo-Carreira, Marcos45
 Cova, Tânia97
 Crivillers, Núria14
 Cruz-Yusta, M.46

Cuenca, Julio Marco³³
 Cuetos, A.⁹⁶
 Culebras, M.¹⁰
 Culebras, Mario¹⁵
 Cunha, D.³⁴
 Currás, Leyre⁵⁷
 Currás-Barreiro, Leyre⁶⁹

D

da Costa, T. B.⁴⁰
 da Silva, M. B.⁸⁰
 Daffé, Niéli³²
 Daneri-Navarro, Adrián²⁶
 Daniel-da-Silva, Ana L.^{48, 76}
 Dariva, C.¹¹²
 Dawson, Kenneth⁷³
 De Beule, P. A.A.³⁴
 de Melo, J. Sérgio Seixas⁶⁰
 de Miguel, Gustavo¹¹⁸
 de Oliveira, É. Ramin⁸⁰
 De Orta, I. Segura⁹⁰
 de Rada-Piñeiro, Xavier Manuel³⁵
 de Sousa, Beatriz P.⁷⁶
 Dieguez, Lorena²⁹
 do Vale, M. L.⁴³
 do Vale, M. Luísa C.⁶³
 Domingues, M. R.⁸³
 Domínguez-Arca, V.²⁵
 Domínguez-Arca, Vicente⁷²
 Dorigo, A.¹¹⁰
 Doughty-Domínguez, Edwin¹⁷
 Duarte, Hugo¹⁰⁴
 Durães, L.¹⁶
 Durães, Luísa¹¹⁹
 Dúzs, B.⁶⁴
 Dzubiella, J.⁹⁶

E

Ehrlich, Victor³²
 Encinas, David⁹⁸
 Encinas-Basurto, D.¹¹⁶
 Enciso, Eduardo²³
 Escañuela-Copado, Adri⁷⁰
 Escobar, Ane³⁰
 Escorihuela, E.¹³
 España, Alma González⁴⁴
 Esquena, Jordi⁷⁸
 Estévez-Varela, C.³⁴
 Estrada, Ana C.⁸⁹
 Estrella-Guisado, G.^{37, 46, 62}

F

Falconi, Y.13
 Faria, M.J.41
 Farinha, J. P. S.53
 Fateixa, Sara76
 Faulon, Jean-Loup29
 Favier, A.53
 Fernandes, A. S.95
 Fernandes, D.93
 Fernandes, D. M.95
 Fernandes, J.R.92
 Fernandes, Mário109
 Fernández, Luis Angel29
 Fernández-Lodeiro, Carlos57, 69
 Fernández-Rodríguez, M. Á.96
 Fernández-Rodríguez, M.A.110
 Ferrández, A.37
 Ferrari, B.37
 Ferreira, R. R.40
 Ferreira, Rafaela R.84, 85
 Fiuza-Maneiro, Nadesh69
 Fresnais, Jérôme32
 Fusco, Schon59

G

Galán-Mascarós, Jose Ramón51
 Galisteo-González, Francisco18
 Gallego, L.37
 Gálvez-Ruiz, María José18
 Gama, J. N.34
 García-Acevedo, P.54
 García-Caballero, Valentín99, 114, 115, 117
 García-González, Gerardo98
 García-Lojo, Daniel29
 García-Mar, Joselyn Aime98
 García-Pardo, M.34
 Gavilán, H.88, 91
 Gavilán, Helena33
 Geiss, H.87
 Giancane, G.19, 75
 Giglio, Maria Elisabetta14
 Gil-Bea, Francisco Javier30
 Giner-Casares, J.J.19, 75
 Giner-Casares, Juan77
 Giner-Casares, Juan J.31, 99, 114, 117
 Godínez-Rubí, J.M.26
 Gomes, A. C.36
 Gomes, A.C.43, 106
 Gomes, Andreia C.63, 77, 109
 Gómez, C.10

Gómez, Clara M.15
 Gómez-González, A.13
 Gómez-Graña, Sergio24, 57, 69
 Gonçalves, Gil76
 Gonçalves, J. M. S.112
 Goncalves, Lucas R.84
 González, Z.37, 46, 62
 González-Béjar, María11
 González-Cabaleiro, L.28
 González-Luque, Miguel99
 González-Rubio, G.50, 90, 91
 Gonzalez-Rubio, G.87
 Gonzalez-Rubio, Guillermo39
 Graván, Pablo18, 73
 Grzelczak, Marek30
 Guerrero-Félix, J.G.110
 Guerrero-Martínez, A.87, 88, 90
 Guerrero-Martínez, Andrés23, 39, 108, 111
 Guzmán, Eduardo17

H

Hassan, Natalia98
 Hernández-Balaguera, E.118
 Herrera-Serrano, M.88
 Hill, Eric H.65, 67
 Honrado, Carlos29
 Hurtado-López, M.110

I

Insua, Mónica Andrea Paz52

J

Jiménez, Manel102
 Jiménez-Hernández, L. F.10
 Jiménez-Hernández, Luis F.15
 Jorge, Rita104
 Jover, Joaquim102
 Juárez, J.26, 116
 Juárez, Josué98
 Juarez-Josue101
 Junquera, Elena108, 111

K

Kanduč, Matej18
 Krüger, Jannis72
 Kublashvili, Nineli Abramidze12

L

Labrador-Páez, L.88
 Labrador-Páez, Lucía111

Lama, Manuel72
 Landázuri-Gómez, G.20
 Landi, Caterina33
 Laranjo, Marta104
 Legentil, Camille73
 Lekshmi, Neenu94
 Lillo, Vanesa51
 Lin, Yuchen73
 Liz-Marzán, L.28
 Lopes, Armandina M.L.94
 Lopes, C. M.93
 Lopes, CM.107
 Lopes, Ivo109
 López-Fernández, Iago24
 Lopez-García, M.34
 López-González, M. Carmen34
 López-León, Miguel115, 117
 López-Mata, Marco Antonio98
 López-Sicilia, Irene31
 Lorite-Méndez, Guillermo59
 Loureiro, E.C.43, 106
 Loureiro, Elsa C.94
 Lucia, Alejandro17
 Lúcio, M.41, 93, 107
 Lúcio, Marlene77
 Luna, M.105
 Luna, M. Cano19, 75
 Luna, Manuel Cano115, 117
 Luna, Mariangel45
 Luque, J.M.37, 46, 62

M

Machado, R. L.36, 81
 Machado, R.L.106
 Macías-Balleza, E. R.20
 Magalhães, Solange102, 104
 Mahmoodi, H.82, 92
 Maldonado-Valderrama, J.9
 Maldonado-Valderrama, Julia18
 Manca, G.19, 75
 Mancheño, M. J.90
 Mansilla-Cejas, Teresa117
 Marcantonigni, Andrea73
 Marcos, Altair Victoria47
 Marques, Bárbara97
 Marques, E. F.81, 95
 Marques, E.F.36, 43, 106
 Marques, Eduardo F.63, 94
 Marques, F.83
 Marques, J. M. C.55

Martín, F.91
 Martín, S.13, 100
 Martín, Santiago14
 Martín-Molina, A.9
 Martín-Molina, A.56
 Martín-Molina, Alberto70
 Martín-Roca, José71
 Martínez-Ascensión, Alex30
 Martínez-Flores, Patricia Dolores98
 Martínez-Pedrero, Fernando33
 Martínez-Quimbiulco, A.10
 Martinho, J.M.G.53
 Mas-Torrent, Marta14
 Matias, P.M.C.38
 Matias, Pedro M. C.85
 Matias, Pedro M.C.113
 Medronho, Bruno102, 104
 Mei, L. H. I.40, 86
 Mellado, José M. Rodríguez115, 117
 Mendes, M.66
 Mendes, Maria97
 Menguy, Nicolas22, 32
 Michel-Tourgis, Aude32
 Michot, Laurent32
 Mihi, Agustín29, 57
 Miranda, A.34
 Miras, Jonathan78
 Moncho-Jordá, A.96
 Moncho-Jordá, Arturo18
 Montaña, Sarita110
 Montenegro, R.46, 62
 Moraila-Martínez, C.L.110
 Moreira, D.81
 Moreira, Diogo29
 Mosquera, Jesús52
 Mota, C.16
 Motta, Breno Moura73
 Mundim, Renata109
 Muñoz-Espí, R.10
 Muñoz-Espí, Rafael11, 15
 Murtinho, D.38
 Murtinho, Dina M. B.85
 Murtinho, Dina M.B.113

N

Navarro-Real, M.26
 Nogueira, Helena I. S.89
 Norte, Bernardo89
 Nuekaew, Anupong22
 Nunes, S.C.C.38

Nunes, Sandra⁹⁷
 Núñez-Sánchez, S.³⁴
 Núñez-Sánchez, Sara⁴⁹

O

Ochoa-Cardoza, A.M.¹¹⁶
 Ogando, Alejandro⁵⁸
 Oliveira, E. R.⁷⁹
 Oliveira, I. S.^{36, 81, 95}
 Oliveira, I.S.^{43, 106}
 Oliveira, Isabel S.^{63, 94}
 Oliveira, M.E.C.D. Real⁴¹
 Oliveira, Margarida¹⁰⁴
 Ortega, Francisco^{17, 71}
 Otaegui-Bichot, David³⁰

P

Pagonabarraga, Ignacio⁷¹
 Pais, A.⁶⁶
 Pais, A.A.C.C.³⁸
 Pais, Alberto⁹⁷
 Pardo, A.^{26, 105}
 Parekh, S.H.⁶⁴
 Pastoriza-Santos, I.^{28, 34}
 Pastoriza-Santos, Isabel^{29, 35, 49, 51, 69}
 Pastrana, L.⁸³
 Pastrana, Lorenzo M.⁴²
 Patti, A.⁹⁶
 Patti, Alessandro⁷⁰
 Pedreira, P.³⁴
 Pedrero, Fernando Martínez⁷¹
 Pedro, Carolina D.⁹⁴
 Pedrosa, María¹⁸
 Pelaz, B.⁵⁴
 Peña-Martín, Jesús¹⁸
 Pereira, José M.⁹⁴
 Pérez, Luis Alberto⁵⁷
 Perez, M. Quesada⁵⁶
 Pérez-Garrido, Rosa³³
 Pérez-González, Refugio⁹⁸
 Pérez-Juste, J.²⁸
 Pérez-Juste, Jorge^{24, 29, 35, 51, 69}
 Pina, João⁶⁰
 Pinho e Melo, Teresa⁹⁷
 Pitareli, G.⁸⁶
 Piton, Alexandre²²
 Polavarapu, Lakshminarayana^{24, 57, 69}
 Prieto, G.²⁶
 Prieto, Gerardo^{72, 108}
 Pukala, T.²⁵

Q

Qi, Xiaoyu57

R

Ramos-Tejada, M. M. del M.56
 Rangari, V. K.40, 86
 Rasteiro, Maria Graça102
 Renero-Lecuna, C.28
 Rey, R. Iglesias54
 Reyes-Márquez, Viviana98
 Rezvanian, K.40, 86
 Riaño, D.13
 Ribeiro, A.93
 Ribeiro, Joana109
 Rizzi, Cécile22
 Rocha, R.66
 Rodal-Cedeira, Sergio69
 Rodea-Montealegre, Gerardo Erbey98
 Rodrigues, A.C.B.38
 Rodrigues, Ana Clara B.60
 Rodríguez, A.46, 62
 Rodríguez-Abreu, Carlos78
 Rodríguez-Boscà, Christian11
 Rodríguez-Da-Silva, Sara51
 Rodríguez-Gómez, Laura30
 Rodríguez-Valverde, Miguel Ángel59
 Romano, Anabela104
 Romero, Antonio J. Fernández99, 114, 115, 117
 Ros-Espinal, Marc78
 Rosa, D. S.40, 79, 86
 Rosa, D.S.38, 80
 Rosa, Derval S.84, 85, 113
 Rubio, Guillermo González23
 Rubio, Ramón G.17
 Rubio, Ramón González71
 Rueda, Pau Vilches52
 Ruivo, J.P.16

S

Sabin, J.25
 Sabín, Juan72
 Sahoo, S.40, 86
 Salazar-Ordoñez, Domingo114
 Samanta, A.64
 Samantha, Subarna57
 Sánchez, L.46
 Sánchez-Arribas, Natalia108
 Sánchez-Balderas, G.110
 Sánchez-Iglesias, Ana30
 Sánchez-Moreno, P.110

Sanmartín-Rodríguez, Paula⁴⁹
 Santaella, Teresa del Castillo⁶⁸
 Santisteban-Veiga, Andrea^{25, 72}
 Santos, Carolina⁵⁸
 Santos, D.⁹³
 Santos, P.¹⁶
 Scarabelli, Leonardo^{12, 44, 52}
 Serna, R.³⁴
 Serpa, F. S.¹¹²
 Sicilia, Irene⁷⁷
 Silva, B.⁴³
 Silva, Bruna^{63, 77}
 Silva, M. B. O.⁷⁹
 Silva, S.G.¹⁰⁶
 Silva, Sandra G.⁶³
 Silva, T.¹⁶
 Simões, João⁹⁷
 Simões, Susana⁵⁸
 Simón-Vazquez, Rosana¹⁰⁹
 Soares, Sofia F.⁴⁸
 Solano, E.³⁴
 Soltero-Martínez, J. F. A.²⁰
 Soto-Ayala, R.¹⁰⁰
 Sousa, J. F. M.⁵⁵
 Steffen, T. S.⁸⁶

T

Taboada, P.^{20, 26, 101, 105, 116}
 Taboada, Pablo^{45, 47, 58, 108}
 Tajuelo, Javier³³
 Talbot, Delphine³²
 Tavares, J.¹⁶
 Teixeira, PV.¹⁰⁷
 Terriza, Juan Antonio Holgado⁶⁸
 Tirado-Miranda, María⁵⁹
 Toba-Pérez, Artai²⁹
 Topete, A.^{26, 105, 116}
 Topete, Antonio^{72, 98}
 Trindade, Tito^{48, 76, 89}
 Triviño-Sánchez, S.^{50, 87}
 Triviño-Sánchez, Sergio²³

V

Valderrama, Julia Maldonado⁶⁸
 Vale, B.⁵³
 Valente, A. J. M.^{38, 55}
 Valente, Artur¹¹⁹
 Valente, Artur J. M.^{85, 112}
 Valente, Artur J.M.¹¹³
 Valeriani, Chantal³³

Valero, Daniel70
Vallejo-Bay, Álvaro72
Valli, L.19, 75
Varela, Alejandro47
Varela, Carla102
Vargas-García, E.M.118
Vasilevskiy, M.34
Vaz, Raquel42
Vázquez-Iglesias, L.28
Vela, Yael Gutiérrez12
Velasco-Rodríguez, B.20, 54
Velasco-Rodríguez, Brenda108
Vera, Isabela104
Vila-Funqueiriño, José M.47
Vílchez, Susana78
Vitorino, C.66
Vitorino, Carla97

W

Walther, A.64

X

Xu, Ren.39

Y

Yadav, A.40, 86
Yan, Yan73
Ye, Yanqiu73

Z

Zavala-López, J.O.26
Zhang, Wanting73
Zhao, Zixu73
Zoco, A.36

RICI XI

JUNE | 22, 23 AND 24 | 2026 | CÓRDOBA | SPAIN

ORGANIZER:



UNIVERSIDAD
DE
CÓRDOBA

CONTRIBUTORS



Cátedra
Enresa



SPONSORS:



PLATINUM

L'ORÉAL



GOLD

RSSEQ
Real Sociedad Española de Química

GECI

iquema
INSTITUTO QUÍMICO PARA LA ENERGÍA Y EL MEDIOAMBIENTE



BRONZE

LASING

ricixi.com