

Image not found

Felicidades a la nueva graduada de doctorado del ICFO

La Dra. Blanca Belsa se ha doctorado con una tesis titulada *Engineering Catalyst-Ionomer Interfaces for Carbon-Efficient CO₂ Electrolysis and Technology Prospects*

February 20, 2026

Felicidades a la Dra. Blanca Belsa que ha defendido su tesis esta mañana en el Auditorio del ICFO.

La Dra. Belsa obtuvo su Master en Multidisciplinary Research in Experimental Sciences por la Universitat Pompeu Fabra. Se unió al equipo de investigación de CO₂ Mitigation Accelerated by Photons dirigido por el profesor Dr. F. Pelayo García de Arquer. Su tesis titulada *Engineering Catalyst-Ionomer Interfaces for Carbon-Efficient CO₂ Electrolysis and Technology Prospects* fue supervisada por el profesor Dr. F. Pelayo García de Arquer.

RESUMEN:

The electrochemical reduction of CO₂ (CO₂E) offers a promising route to convert greenhouse gas emissions into value-added chemicals and fuels. However, achieving performance metrics that enable the techno-economic and sustainable viability of CO₂E remains challenging. This is especially acute in the case of multicarbon products (C₂+), important precursors for energy fuels and manufacturing, where achieving combined selectivity and carbon utilisation under industrially relevant conditions is challenged by undesired competing reactions. This thesis explores the design and implementation of new strategies to modulate electrochemical interfaces in CO₂E to overcome this barrier. These are based on the implementation of ionomer coatings that specifically address key reactants and intermediates in CO₂E.

A key contribution is the development and mechanistic elucidation of ion management channels (IMCs), formed by co-distributing cation and anion exchange ionomers (CEIs and AEIs) within the catalyst layer. This architecture enables local regulation of hydroxide and cation populations, mitigating *OH poisoning and enhancing *CO adsorption, critical steps for promoting C-C coupling and C₂+ product formation.

The ionomer-catalyst interface is comprehensively characterised using SEM-EDS, FTIR, XPS, KPFM, contact angle measurements, cyclic voltammetry, and EIS. In situ Raman spectroscopy reveals the dynamic evolution of surface species, confirming that excessive

*OH accumulation suppresses C₂⁺ selectivity, while IMCs restore favourable interfacial conditions. These insights are correlated with improved electrochemical performance, carbon efficiency, and stability across a wide range of operating conditions, including highly acidic environments.

The IMC concept is further implemented in membrane electrode assembly (MEA) devices operating under neutral pH. Preliminary results demonstrate improved performance and reduced cell voltages for IMC-based electrodes, indicating compatibility with scalable reactor platforms and commercially viable components.

The thesis concludes with a broader analysis of the challenges facing CO₂E at scale. Key bottlenecks, such as the reliance on iridium anodes and fluorinated membranes, are critically assessed, and material and performance targets for gigaton-scale deployment are proposed. A techno-economic and life-cycle analysis outlines trade-off between performance, cost, and sustainability, while global scaling efforts are reviewed. Benchmarking protocols are proposed to bridge the gap between laboratory research and industrial implementation. Together, this work advances a cohesive framework for interfacial engineering in CO₂E, linking molecular-level understanding to device-scale integration, and providing pathways toward industrial deployment.

Tribunal de Tesis:

Prof. Dr. Teresa Andreu Arbella, Universitat de Barcelona

Prof. Dr. Nicoletta Liguori, ICFO

Prof. Dr. Jose Solla Gullon, Universitat d'Alacant

Image not found

Tribunal de Tesis