Spin manipulation in electrochemistry: From Catalyst design to energy applications

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Recent breakthroughs demonstrate that spin manipulation, whether through external magnetic fields or chiral spin-filtering molecules, markedly enhances kinetics and selectivity in the oxygen evolution reaction (OER) and CO2 reduction (CO2RR). Building on this, we developed new strategies to synthesize robust, intrinsically chiral electrocatalysts, including Fe-doped NiO and CuO, which retain their stability under demanding conditions. Operando circular dichroism, in-situ XAS, and spectroelectrochemistry confirm that chirality dictates intermediate adsorption: in OER, the chiral surface stabilizes radicals for enhanced performance, while in CO2RR, an entropic surface oxygen lattice facilitates reduction and promotes C-C coupling to boost C2+ Faradaic efficiencies. To translate these fundamental insights into practical industrial solutions, we are actively designing and fabricating Anion Exchange Membrane Electrolyzers (AEMEL). Parallel to these fundamental mechanistic studies, our research also addresses the practical challenges of applied electrochemical technologies. We are actively designing and fabricating Anion Exchange Membrane Electrolyzers (AEMEL) to mitigate the real-world scalability and operational bottlenecks currently facing the industry, providing comprehensive solutions from intrinsic interface design to applied renewable energy systems.



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Dr. Felipe Andrés Garcés Pineda obtained his PhD in Chemistry at Universidad Nacional del Litoral (Argentina- 2013), he was working on transport properties of semiconducting materials for sensing and energy harvesting applications. In 2014, he joined the group of Prof. Haroldo Cavalcanti at USP (Brazil) with a FIPAI fellowship, where he participated in the BNDES-MAHLE FUNTEC project in collaboration with MAHLE-Leve company. Focusing on advanced sputtering techniques (HiPIMS), applied to improve tribological properties.

In 2015, he moved to ICIQ (Spain) as a Marie Skłodowska-Curie COFUND Fellow (2015-2016), leading the development of ultra-durable seawater electrolysers. His research centered on the design and characterization of robust anodic electrodes for the oxygen evolution reaction in harsh environments. Since 2017, he has been Senior Researcher in the Galán-Mascarós group, where he leads the research line in electrochemistry for energy materials. His work focuses on developing, characterizing, and correlating novel catalysts through innovative protocols and pioneering techniques, with applications in AEMEL and PEM devices.

Dr. Garcés Pineda has also established a new line in magnetoelectrochemistry and renewable fuels, demonstrating the potential of ferromagnetic and chiral catalysts for oxygen evolution, with significant impact on the electrochemistry community. He has been the coordinator of BREATH-CO2 project (2024-2025), work package coordinator in European projects as: A-LEAF (2017-2021), CREATE (2017-2020), DECADE (2020-2025) and SUPERVAL (2024-2026). Currently, he got a Ramon y Cajal fellowship, to work in the development of spin filter materials for electro-catalysis. Besides, he is leading the scaling-up of alkaline electrolyser technology in the H2SIN project at ICIQ.