Guillermo Díaz-Sainz seminar (January 14, 2026)

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Sustainability-Driven Process Scale-Up: Continuous CO_2 Electroreduction for Formic Acid and Formate Production

Carbon capture, utilization, and storage (CCUS) strategies are increasingly recognized as effective means to achieve carbon neutrality, while simultaneously enabling the conversion of CO_2 into value-added products. Among these approaches, electrochemical CO_2 reduction (CO_2RR) stands out due to its operation under mild temperature and pressure conditions and its potential to store intermittent renewable energy—such as solar or wind—in the form of chemical products like formic acid and formate. The Development of Chemical Processes and Pollution Control (DePRO) research group at the University of Cantabria (Spain) has been actively involved in advancing continuous CO_2 electroreduction to formate. Over the past years, the group has systematically investigated a wide range of cathodic and anodic electrocatalysts, as well as various electrode configurations, to optimize the performance and stability of the system.

This communication presents recent advances and persistent challenges in the development of efficient continuous-flow CO_2 electroreduction systems, with a particular focus on the influence of the cathodic electrocatalytic area, an aspect that has been scarcely explored to date. All experiments were conducted under a standardized setup and operating conditions, while varying key parameters such as cathodic electrocatalysts—including Sn-, Bi, and Sb-based materials and electrode architectures, such as planar electrodes, particulate electrodes (PE), gas diffusion electrodes (GDEs), catalyst-coated membrane electrodes (CCMEs), and membrane electrode assemblies (MEAs), operating in the gaseous-phase [6], using a geometric area of 10 cm^2. On the anodic side, different materials have been explored, including DSA/O_2 and Ni-based electrodes, with electrolysis typically coupled to the oxygen evolution reaction (OER). Both cation exchange membranes (CEM, e.g., Nafion) and anion exchange membranes (AEM, e.g., Sustainion) were tested, allowing for comparative performance analysis and identification of optimal cell configurations.

SHORT CV Guillermo Díaz-Sainz

Guillermo Díaz-Sainz received his Degree in Chemical Engineering (2015) from the University of Cantabria and his MSc. in Chemical Engineering (2017) delivered from the University of Cantabria (UC) and the University of the Basque Country. In 2021, he completed his Ph.D. in Chemical Engineering, Energy and Processes focused on the development of processes for CO_2 electrocatalytic reduction to formate. He is currently integrated into the Research Group DePRO (Development of Chemical Processes and Pollution Control), and at present, he is Associate Professor in the Chemical and Biomolecular Engineering Department. Currently, the research activity and mid/long term interests of Dr. Diaz-Sainz are mainly focused on the development of an innovative process for the CO_2 capture and photo/electrochemical conversion in products of interest, and at the same time, the production of green hydrogen by electrolyzers. He has co-supervised three doctoral theses on CO_2 (photo)electroreduction to value-added products and has participated in over 20 international, national, and regional research projects, serving as principal investigator in several. To date, he has authored more than 30 scientific articles in high-impact journals.