NEWBOUND

New boundary conditions for advanced electrocatalysis: from magnetic field effects to solventless configurations

Timeline | 09/2022 to 08/2025

ICIQ People | Galán-Mascarós Research Group

Budget | 314.600 €

Call | Proyectos I+D - Generación Conocimiento 2021

SUMMARY

Electrolysis is a promising technology to support the industrial decarbonization. Substitution of fossil by green fuels obtained from renewable energy and electrolyzers could transform the energy cycle, allowing for a rapid transition towards sustainable processes. Electrolysis advantages go even further. It could also contribute to the industrial electrosynthesis of chemical commodities. However, improved low-cost, fast and efficient processes are needed. And also highly selective to attempt the large scale electrosynthesis of chemical products.

Our research team has studied electrocatalysts for the oxygen evolution reaction (OER), the bottleneck for the production of green hydrogen from water. We have discovered low-cost OER electrocatalysts with excellent activity that were selected by European projects (CREATE or DECADE) to build industrial prototypes. From these collaborations with industry, we confirmed that working conditions are crucial to optimize a catalyst. There are too many differences between a glass reactor in the lab and an industrial device. Often the best catalysts in the lab is not the best performer in an industrial architecture, and this makes the transfer of knowledge more difficult.

For this project, we propose to shift the research paradigm in electrocatalysis, using the full cell design as a tool for discovery. This strategy allows for accurate control in reaction conditions, and in the fundamental parameters which determine productivity and selectivity.

We propose to study three model reactions:

1) OER under magnetic fields: This phenomenon can improve the productivity of water electrolyzers in alkaline conditions. Our objective is the identification of magnetic and electrochemical parameters to optimize this synergy, and to implement it into an industrial electrolyzer.

2) Selective oxidation of H2O to H2O2: This chemical reaction could offer added value to hydrogen production. The instability of the product, and the lower energy requirements of the dominant OER are the major challenges. Our objective is the development of an electrolytic cell to stabilize the product and to identify catalysts to run the reaction at optimum selectivity.

3) Selective oxidation of CH4 to CH3OH:Intermediate products during methane oxidation are even more reactive, so it is difficult to stop the reaction before the final CO2 and H2O products. Stopping the reaction at CH3OH would have multiple benefits: it would be a sustainable process for the obtention of methanol while producing green hydrogen. Our objective is the development of a gas-solid electrolytic cell to facilitate the catalysts optimization of selective, while avoiding overoxidation.

In summary, we propose a top-down approach to establish electrochemical working conditions to advance in the optimization of electrocatalytic solutions for applications in circular economy and sustainability.

Reference: PID2021-124796OB-I00