M2 Internship: Study of electrocatalytic nanomaterials for the efficient and selective reduction of CO_2 inside a membrane-electrode assembly setup

Duration: 5 – 7 Months

Location: IRCELYON/CNRS (Villeurbanne, France)

Starting date: 1st quarter 2024

Grant: 614 €/month (gratification)

IRCELYON (Institut de Recherches sur la Catalyse et l'Environnement de Lyon, www.ircelyon.univ-lyon1.fr) is the largest CNRS department devoted to fundamental and applied research in catalysis. The work will be carried out in collaboration with a postdoc and two senior researchers from the laboratory, in the framework of a EU-coordinated project (www.nextccus.eu).

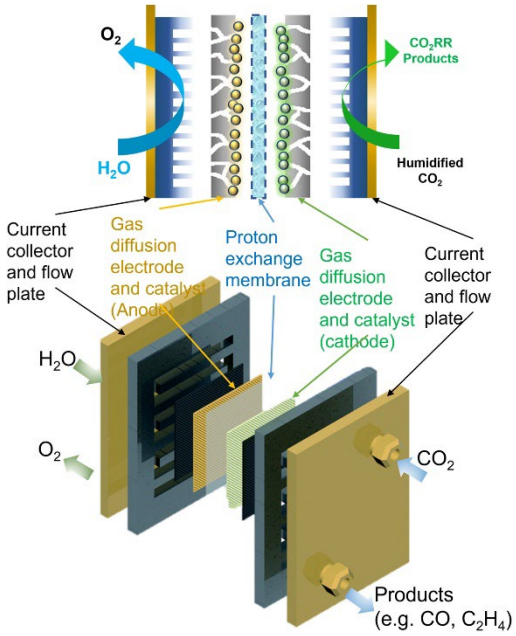

Figure 1 General architecture of a MEA electrolyzer

Context: Electrocatalytic CO_2 reduction (CO2RR) is a promising circular-economy approach to the electrification of the chemical industry. In this process, renewable electricity is used as a source of electrons to drive the reduction of CO_2 into more valuable chemicals such as CO, HCOOH, methanol, ethylene, ethanol, etc. To operate the CO2RR at high rates (i.e. high current densities) with minimal losses, a membrane-electrode assembly is typically employed (see Figure 1). Indeed, this design allows to reach current densities higher than 100 $mA.cm^{-2}$, which are relevant to industrial applications. One major challenge with the development of this technology concerns the development of active, selective and durable electrocatalysts for the CO2RR. Indeed, among the metals of the periodic table, only Cu is capable of driving the reduction of CO_2 towards high-value products (ethylene, ethanol, methanol), but with poor selectivity. Therefore, there is a great research effort to identify and design efficient electrocatalysts for the selective production of these molecules.

Work description: The intern will synthesize CO2RR electrocatalysts using established methods (e.g. impregnation, colloidal synthesis, exfoliation, hydrothermal synthesis) and characterize their structure with typical techniques (XRD, TEM, etc.). These electrocatalysts will then be processed as an ink and spray-coated onto a porous gas-diffusion layer to generate a gas-diffusion electrode (GDE). Each GDE will then be tested in a

MEA setup similar to the one pictured in Figure 1. Reaction products will be identified and quantified (by GC, NMR and HPLC) at different applied potentials to assess the performance of each electrocatalyst. The catalytic materials will base on late transition metals (e.g. Cu, Co) in the form of carbon-supported molecular complexes or nanoparticles.

Required profile: Master courses in physical chemistry or material chemistry, with basic knowledge in electrocatalysis and material characterization. Know-how in lab experimentation and routine analytical measurements (X-ray diffraction, electron microscopy, chromatography, etc.) is a plus.

Internship training: The intern will be trained in electrocatalytic material preparation and characterization as well as working on an advanced electrochemical system. Finally, the intern will acquire expertise in the precise assessment and benchmarking of electrocatalytic processes performances.

Perspectives: A PhD thesis scholarship will be potentially proposed to the student after the internship.

Contact: Send a CV and a cover letter to Mathieu Prévot (mathieu.prevot@ircelyon.univ-lyon1.fr) and Laurent Piccolo (laurent.piccolo@ircelyon.univ-lyon1.fr)

Why coming to IRCELYON:

- Largest research institute of heterogeneous catalysis in France
- Stimulating working environment, with students from all over the World
- Neighboring corporate restaurant proposing lunch at low cost
- Easy access by public transport + private car park
- Partial refund of transportation tickets + sustainable mobility bundle