

Valorization of biomass-waste and plastic-waste via electro-catalysis for the production of pure H₂



Context

The overall objective of this work is to develop, characterize and understand a “proof-of-concept” of a sustainable, economic and environmentally friendly technology to produce pure H₂ by the electrolysis of lignin and plastic-waste.

Currently, water electrolysis is used for large scale H₂ production. The main drawback of this technology is related to its high electrical energy requirements, which makes the process economically unattractive. In this sense, the electrolysis of organic molecules has been proposed as a promising method for onsite pure H₂ production with lower power demands (1-2 orders of magnitude). For instance, it has been reported that pure H₂ can be produced by the electrolysis of methanol¹ and ethanol² as well as bio-ethanol³ solutions.

In this project we will focus on the valorization of waste materials for sustainable H₂ production. In this sense, “lignin” is one of the most abundant bio-polymers in nature. Nowadays, about 50 million tons of lignin are produced annually as a waste stream of the Kraft pulping industry for cellulose production. The Kraft lignin is characterized by its inertness and robustness towards degradation, making tricky its selective degradation into fine chemicals. Therefore, lignin is currently incinerated for energy applications.

On the other hand, plastic-waste constitutes 10 % of household waste. Around 80 % of plastic waste is found polluting beaches or floating in the ocean.

In order to valorize the lignin and the plastic-waste, in this project we aim to produce pure H₂ via electrolysis in Polymer Electrolyte Membrane (PEM) reactors.

Work description

The Ph.D. will be performed at the CARE team (Caractérisation et remédiation des polluants dans l'air et l'eau) at the *Institut de Recherches sur la Catalyse et l'Environnement de Lyon* (IRCELYON, <http://www.ircelyon.univ-lyon1.fr/>).

During the first stage of the Ph.D., the work will be focused on the “proof-of-concept” for the electrolysis of lignin and plastic-waste in order to produce pure H₂. Commercial electrodes and alkaline membranes will be used for that purpose.

In the next stage, we will focus on the understanding of the electrolysis process. The liquid products obtained together with H₂ will be analyzed by HPLC coupled with High Resolution Mass Spectroscopy (HRMS).

Finally, novel materials will be developed for the electrodes in order to enhance the activity and economy of the electrolysis process.

In this project we will use a wide variety of characterization techniques, both ex-situ (XRD, XPS, TEM, SEM, etc) and in-situ/operando (DRIFTS, Electrochemical-Impedance Spectroscopy, Environmental SEM/TEM, etc.).

References

¹ G. Sasikumar et al., *IJHE*, 2008, 33, 5905

² **A. Caravaca et al., *IJHE*, 2012, 37, 9504**

³ **A. Caravaca et al., *Appl. Catal. B*, 2013, 134-135, 302**

PhD Candidates

Candidates with a background in chemistry, electrochemistry, chemical engineering, materials science, and environmental science are encouraged to send their CV.

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