Research and Development Project

Short term hiring contract (CDD) 12 months

Implementation of noble metal-free catalytic nanomaterials in water splitting electrolyzers

Fondamental Research Division, CEA-Grenoble
IRIG/Laboratoire de Chimie et Biologie des Métaux/SolHyCat team (www.solhycat.com)
Supervisor: Dr Vincent Artero

This research project will be developed in the framework of a collaborative project with Toyota Motor Europe

Vision

Hydrogen (H_2) generated from renewable energies, such as solar and wind, and water has a huge potential as a carbon-free energy vector which can be exploited on demand through fuel cell technologies. Proton-exchange membrane electrolysers (PEMEL) are a mature technology that can be coupled with intermittent renewable power sources. However their wide deployment still depends on innovative breakthroughs regarding the design of alternative catalysts avoiding the use of precious metals and fulfilling three main characteristics: sustainability, cost-effectiveness and stability.

Background

The SolHyCat group at CEA Grenoble has developed bio-inspired catalysts for H_2 evolution compatible with Nafion PEM technology (Le Goff et al. Science 2009, 326, 1384; Tran et al. Angew. Chem. Int. Ed. 2011, 50, 1371) and competing with Pt under such conditions (Huan et al. Energy Environ. Sci. 2016, 9, 940). The inspiration, hydrogenases, are unique metalloproteins that catalyse H_2 evolution as efficiently as platinum nanoparticles do and in particular with remarkably high reaction rates (1500-9000 s^{-1} at pH 7 and 37°C in water). The bio-inspired/coordination chemistry approach is so far one of the only reliable solution to use Earth-abundant metals as H_2-evolution catalysts under acidic conditions, since first-row metal particles are not stable under these conditions. Namely, we explored a coordination polymer structure for amorphous molybdenum sulfide (a-MoSx), refined the understanding of its catalytic mechanism (Artero and coll., Nature material 2016) and developed strategies to remedy reductive corrosion issues that so far limited the implementation of such earth-abundant H2 evolution catalysts in PEMEL.

Objectives

We aim at exploiting these new findings in PRODUCE-H2, an ERC Proof of Concept project which proposes to (1) optimize the formulation of these catalytic materials and assemble them in polymer-membranes, (2) assessing their performance and quantifying their stability during long-term tests performed under realistic operating conditions, (3) upscaling their production thanks to a newly developed synthetic process and (4) implementing them in a noble-metal-free PEMEL prototype. PRODUCE-H2 will exploit pre-existing and newly created intellectual property with the aim of proposing a cost-effective industrial solution for PV-coupled on-site hydrogen production.

The applicant will integrate original and innovative composite materials based on amorphous molybdenum sulfide as cathode materials of PEM electrolyzers, with either noble metal or non-noble metal anode catalyst and various membranes. Formulation optimization, as well as accelerated and long-term testing will be carried out.

Application

The position is open from September 2019. Selection will be made early July 2019 to allow for administrative work out by CEA administration. This position can be filled either at the engineer or PhD levels. An expertise in electrochemical techniques, device testing and materials formulation is required.

Applications should include a detailed CV (with exact starting and ending dates of each work contract and training positions), a motivation letter and two recommendation letters. They should be sent before June 30 to Adina Morozan (adina.morozan@cea.fr)