Imperial College London

Project: Novel photocathodes for hydrogen production

University: Imperial College London
Supervisor: Dr Salvador Eslava (s.eslava@imperial.ac.uk)
Industry partner: BP

Abstract: Solar fuels can be achieved cleanly splitting water in H_2 and O_2 using sunlight and semiconductor absorbing layers integrated in photoanodes and photocathodes of photoelectrochemical (PEC) cells (Fig. 1). However, PEC solar H_2 generation is limited by the recombination of charges in the semiconductor and poor catalytic properties of semiconductor surfaces.

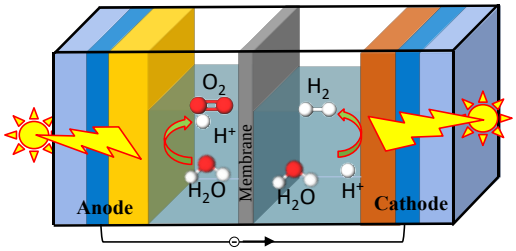

Fig. 1. *Water splitting photoelectrochemical cell*

The question is, how can we engineer the semiconductors and the semiconductor-electrolyte interface to enhance the charge transfer from the semiconductor to the electrolyte and avoid the electron- hole recombination?

Most research in PEC cells has been focused on n-type photoanodes of TiO_2, α-Fe_2O_3 and BiVO4 because water oxidation is more kinetically demanding than water or proton reduction. However, developing photocathodes is still crucial to take full advantage of the electrodes area and to achieve a higher cell photovoltage (>1.7 V) that accounts for the thermodynamic 1.23 V to split water and the overvoltages associated with the difficult kinetics. Most studied materials as photocathodes are p-type Si, Cu_2O and CuO, but corrosion during operation is a real problem in these. Stable semiconductors are needed to cover the photocathode side.

Copper ternary oxides such as $CuFe_2O_4$ can provide narrow bandgaps in the visible range and provide a conduction band above the hydrogen reduction potential, fulfilling thermodynamic requirements for hydrogen production. The overall aim of this project is to provide the needed characterization to reveal their properties that permits their rational design and development to achieve stable 10% solar-to-H_2 efficiency in photoelectrochemical cells.