Surface potential determination by Kelvin Probe Force Microscopy of transition metal oxyhydroxides catalysts, M-OOH, with M = Fe, Cu, Ni, Cu, Zn

M2 internship offer 2026 (6 months)

Abstract:

Production of clean hydrogen by solar water splitting can be improved by controlling charge transfer at the electrode – electrolyte interface. At the interface, the photoanode's surface potential is responsible for band alignments and bending, and thus for charge separation during the photoelectrochemical reaction. During this internship we propose to growth hetero-structured photoanodes (α-Fe_2O_3/FTO and M-OOH/ α-Fe_2O_3/FTO with M = Fe, Co, Ni, Cu or Zn), to measure their surface potential and to correlate these findings with macroscopic photoelectrochemical activity.

Subject description:

Hydrogen production by solar water splitting (SWS) is a very noteworthy concept because it permits the direct storage of solar energy in the H_2 chemical bonds. Moreover, it is a clean method and it uses abundant and not-expensive materials as electrodes. The optimization of materials used as photoelectrodes for this reaction represents an important challenge. The interface between the electrodes and the aqueous electrolyte is responsible for the charge transfer efficiency during SWS. Charge transfer at the interface is subject to the alignment between energy bands both in electrode and electrolyte side, and parameter such as surface potential plays a major role on the final band bendings and charge separation.

This study focuses on the interface between photoelectrode and electrolyte by measuring the surface topography and potential of different heterostructures proposed as photoanodes using an Atomic Force Microscope (AFM) coupled to Kelvin Probe Force Microscope (KPFM) on the near field microscopy platform at the SPEC laboratory (IMAFMP). The samples consist of films of transition metal oxyhydroxide (M-OOH with M = Fe, Co, Ni, Cu or Zn) obtained by electrodeposition, deposited both on FTO substrate and α-Fe_2O_3/FTO photoanode.

The intern will carry out: i) the growth of Fe_2O_3 photoanodes and catalysts films by aqueous chemical growth and electrodeposition; ii) Photoelectrochemical characterization of photoanodes (photocurrent and EIS) using the solar water splitting dedicated setup; iii) AFM and KPFM measurements. This study will allow us to correlate the local aspects (nanorods morphology, surface potential) with the macroscopic ones (photocurrent, interface characterization by EIS). Complementary physico-chemical characterizations (MEB, DRX, XPS) are also envisaged. The intern's work is part of the ANR project OERKOP.

Techniques:

AFM, KPFM, MEB, DRX, XPS, EIS, (photo-) voltammetry, aqueous chemical growth

Qualities and skills required for the candidate:

M2 student, knowledge of (photo-)electrochemistry, condensed matter, semiconductor physics.
For data processing and redaction of the internship report: python, office.

Environment:

The intern will work in SPEC, the Condensed Matter Physics Laboratory (SPEC: UMR 3680 CEA-CNRS) of CEA Saclay, located at L'Orme des Merisiers. A CEA bus system provides easy access to L'Orme des Merisiers from various locations in Ile-de-France.

Further information and to apply:

Please send your CV and motivation letter to Cindy L. Rountree (cindy.rountree@cea.fr) and Dana Stanescu (dana.stanescu@cea.fr).