

Electro-optical and structural characterizations of III-V/Si photo-electrodes for the production of green hydrogen

PhD position opened at Institut FOTON / OHM research team, INSA de RENNES

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Topic:

The production and storage of clean, renewable and low-cost energy is one of the most important technological challenges of this beginning of the century. The photo-electrolysis of water promises the direct conversion of solar energy into hydrogen. Hydrogen can be stored and electrical or thermal energy can be produced on demand, without greenhouse gas emissions.

In the recent years, the OHM team of the Institut FOTON, located at INSA Rennes, has been developing a new architecture of photoelectrochemical cells (PEC), combining the high performance of cells based on III-V compounds and a cost reduced manufacturing through the use of silicon substrates. These results have already been the subject of several significant recent publications, [1-5] and have enabled the team to start the "NAUTILUS" research project, which finances this thesis, around decarbonated hydrogen financed in the framework of priority research programs and facilities (PEPR), part of the "France 2030" national strategy.

In this context, the objective of this thesis will be to determine the structural and electro-optical properties of III-V/Si materials developed at the Institut FOTON and in partner laboratories, using advanced optical characterization techniques (luminescence, ellipsometry & absorption), electro-optical (Hall, C(V), DLTS, PEC characs), and structural (DRX, SEM, AFM, C-AFM), in order to propose the complete design of a photoelectrochemical cell autonomous, robust and cost-efficient, allowing realistic hydrogen production. This work will benefit from the equipment and know-how of the OHM team at the Institut FOTON (III-V/Si development, optoelectronics, structure and simulations), and will be carried out in constant collaboration with the partner laboratories (ISCR-Rennes-catalysis, CINaM-Marseille-protection/corrosion, C2N-Paris-Saclay-microscopy/EBIC, IEM-Montpellier-2D catalysis).

[1] Alqahtani *et al.*, Sustainable Energy & Fuels, Royal Society of Chemistry, 3, 1720 (2019).

[2] I. Lucci *et al.*, Advanced Functional Materials 28, 1801585 (2018).

[3] L. Chen *et al.*, Solar Energy Materials and Solar Cells 221, 110888 (2021).

[4] L. Chen *et al.*, Advanced Science 9, 2101661, (2022).

[5] M. Piriyevev *et al.*, Solar Energy Materials and Solar Cells 251, 112138 (2023).

About the applicant:

The candidate must have a master's degree, or an engineering degree, with, if possible, a basis in solid state physics, and characterization of materials. The applicant must have a strong interest in experimental work in an interdisciplinary environment between chemistry and physics. Fluency in English is required (both written and spoken). Good notions of French are desirable.

Host laboratory:

The Institut FOTON is a mixed research unit (UMR 6082) associating the CNRS, the University of Rennes, and INSA Rennes. The unit is structured around three thematic axes and three teams, spread over two sites: two teams in Rennes, (OHM, INSA-Rennes) and (DOP, UR); a team in Lannion (SP, Enssat-Lannion). The specificity of the Institut FOTON is to bring together around common programs three teams and three platforms covering areas targeted around photonics (optical sensors, lasers, instrumentation for photonics) and energy (photovoltaic and photo-electrochemical solar cells), around regional and European priorities (Key Enabling Technologies). The doctoral student will initially be hosted on the INSA Rennes site within the OHM team (Opto-electronics, Hetero-epitaxy and Materials), to develop their experimental and simulation activities.

Other information:

Start of thesis: between September 1, 2023 and November 1, 2023

Thesis supervision: Charles Cornet, Nicolas Bertru, Yoan Léger

Funding: ANR PEPR NAUTILUS – France 2030

Estimated gross salary: 2100-2200 € /month

Keywords: photo-electro-chemistry, III-V semiconductors, silicon, structural, electrical and optical characterizations.

Application :

It is strongly recommended to contact the supervisors as soon as possible to indicate your interest in the subject.

All applications must include the following elements:

- Cover letter
- Detailed resume
- Copy of diplomas obtained
- Report cards

And optionally:

- List of publications if applicable
- Letters of recommendation