



UNIVERSITAT POLITÈCNICA
DE CATALUNYA
BARCELONATECH

UAB
Universitat Autònoma
de Barcelona

 UNIVERSITAT DE
BARCELONA

ICFO
The Institute
of Photonic
Sciences



Master in Photonics – “PHOTONICS BCN” Master ERASMUS Mundus “EuroPhotonics”

MASTER THESIS PROPOSAL

Dates: April 2021 - September 2022

Laboratory: Jordi Martorell, ONP Group
Institution: ICFO
City, Country: Barcelona

Title of the master thesis: Time-modulated LASER illumination to characterize the response of metal oxide photoelectrodes for photovoltaic and synthetic solar fuels applications.

Name of the master thesis supervisor and co-supervisor: Dr. Carles Ros and Prof. Dr. Jordi Martorell

(for external proposals a co-supervisor from the Master program is needed)

Email address: carles.ros@icfo.eu

Phone number: +34-935-53-40-02

Mail address: Mediterranean Technology Park, Avinguda Carl Friedrich Gauss, 3, 08860 Castelldefels, Barcelona

Keywords: LASER, Spectroscopy, Photovoltaics, Synthetic Solar Fuels

Summary of the subject (maximum 1 page):

Worldwide energy consumption requires energy vectors capable to store and distribute energy for many applications for which direct electrification or battery storage is not suitable. Solar synthetic fuels, based on conversion of solar illumination into electricity and direct formation of a chemical bond allows for long term storage and distribution. H₂ generation by direct water splitting or carbon dioxide recovery by CO₂ reduction back to synthetic fuels are fields gaining a lot of attention during last decade. Complex bimetallic oxides in contact with electrolytes have proven the formation of semiconductor-liquid junctions (SCLJ) and stable performance in photocurrent generation, although their performance is still a bottleneck for industrialization and the understanding of the internal absorption and recombination paths is limited. These large bandgap materials are used in tandem structures with Organic and Perovskite photovoltaics to efficiently convert large part of the solar spectra.

We propose to use time-modulated LASER illumination to characterize the response of large bandgap metal oxides (MO_x i.e. BiVO₄) or chalcogenides (i.e. SnS or SnS₂) during operation. Solid-state PV junctions will be formed, together with SCLJ, to better understand the



UNIVERSITAT POLITÈCNICA
DE CATALUNYA
BARCELONATECH

UAB
Universitat Autònoma
de Barcelona

 UNIVERSITAT DE
BARCELONA

ICFO
The Institute
of Photonic
Sciences



material. Intensity modulated photocurrent spectroscopy (IMPS) together with impedance spectroscopy (IS) will allow to distinguish the limiting factors and to correlate them with fabrication steps. Also, LASER will allow for superior resolution for under-direct-bandgap photoconversion identification, what could be key for a disruptive advance in the performance of these materials.

The candidate will join a multidisciplinary group at ICFO which will provide with expertise on computational simulation and experimental fabrication of 1D and 3D photonic structures for tandem devices (MO_x-organic-perovskite) for applications in PV and H₂ or CO₂RR. Femtosecond-pulsed LASERs, clean-room fabrication facilities, nanoscale characterization techniques and testing stations will also be provided.

Additional information (if needed):

- * Required skills: basic knowledge of optics, semiconductors and photovoltaic is valuable. Although, the group searches for highly motivated candidates and will provide training for the highly multidisciplinary field of spectroscopy for photovoltaics and photoelectrodes.
- * Miscellaneous :