

## Internship from February 2022 to August 2022

### Integration of photochromic dyes in dye-sensitized solar cells and optimization of their photovoltaic and optical performances

#### *Characteristics of the position:*

Position	Master II Internship
Location	CEA-Grenoble
Discipline	Organic Chemistry, Materials Science
Laboratory	SyMMES-STEP
Supervisor	Dr. Renaud Demadrille

#### *Context and work environment*

The SyMMES laboratory aims to develop basic research on themes with strong societal issue: zero-carbon energy, information and communications technology (ICT), biotechnology and human health. The SyMMES hosts around 50 researchers and about 60 non-permanent researchers (students, PhD students and post-doctoral fellows). In the SyMMES unit, the STEP laboratory is an interdisciplinary team comprising chemists, physico-chemists, electrochemists and physicists. This team explores the design, synthesis and study of innovative functional materials for energy applications (photovoltaics, electrochemical energy conversion and storage, thermoelectricity). This project is in the framework of the ERC funded project PISCO.

#### *Background of the project:*

Among photovoltaic technologies, Dye-Sensitized Solar Cells (DSSC) represent a promising approach in terms of efficiency and production costs. They have already demonstrated power conversion efficiencies (PCEs) over 14%, but more interestingly, these devices can be colourful and semi-transparent. This technology is appealing for use in façades of buildings as demonstrated by the first large scale application in 2014 at EPFL Convention Centre. Like all other photovoltaic technologies, to convert efficiently energy from the Sun into electricity, DSSCs need to absorb radiations in the visible range. This is the reason why the best performing solar cells cannot show a good optical transparency: particularly, a compromise has to be found between transparency and efficiency when applications in façades of buildings are targeted.

State-of-the-art in photovoltaics only allows for the fabrication of semi-transparent devices with a given optical transmission, which is fixed during the fabrication process. In semi-transparent DSSCs, light transmission and photovoltaic efficiency are strongly dependent on the dye employed. For implementation of this technology in façades or even windows in buildings, the development of solar cells with a light transmission capable to self-adjust to the weather conditions could be very valuable. In this context, the STEP lab has developed an original approach consisting in the development of photochromic dye sensitized solar cells. Thanks to the design of push-pull dyes embedding a photochromic naphthopyran unit, photochromic solar cells with variable colours and optical transmission were obtained. This work was recently published in the journal "Nature Energy".

(See: <https://www.nature.com/articles/s41560-020-0624-7>)

***Main activities:***

This internship project is an interdisciplinary project combining chemistry, physical chemistry and device fabrication. The student will be in charge of the fabrication of dye-sensitized solar cells.

To start, He/She will fabricate devices using various photochromic dyes developed in the laboratory with the goal to select the best-performing materials. The solar cells will be characterized by UV-Vis spectroscopy, by electrical measurements and by impedance spectroscopy.

Then he/she will optimize the fabrication of opaque and semi-transparent solar cells with the goal to improve their optical and photovoltaic properties. To that end, He/she will investigate the fabrication of mesoporous electrodes using alternative metal oxide semiconductors. He/she will study the grafting of the dyes on the surface of these new electrodes and the effect on the photovoltaic parameters. Finally, he/she will develop and study novel electrolytes specifically designed for use with photochromic dyes. To improve the performances of the electrolytes, several redox couples and additives will be considered. During this internship, the candidate will also have the opportunity to be trained for the fabrication of solar mini-modules using printing techniques.

***Desired profile***

The candidate should be educated in organic chemistry or material science. He/she will have to show a real interest in working on a multidisciplinary subject and in the field of energy materials. A good background in organic chemistry and physical chemistry are expected. Good oral and written communication skills are a plus. We look for talented, motivated and creative students, capable to work with a good autonomy and to develop their project in synergy with the other members of the group.

***How to apply***

Applications (CV + letter of motivation + marks + letters of recommendation) should be sent to Renaud Demadrille ([renaud.demadrille@cea.fr](mailto:renaud.demadrille@cea.fr)) and Cyril Aumaitre ([Cyril.aumaitre@cea.fr](mailto:Cyril.aumaitre@cea.fr)).

Contact for the questions related to the position: Renaud DEMADRILLE

For More information: <https://www.demadrillegroup.com/>