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Molecular engineering of organic photosensitizers, structure-properties relationships and use in photovoltaic devices and semi-transparent solar panels

Quentin Huaulmé[1], Valid M. Mwalukuku[1], Johan Liotier[1], Damien Joly[1], Maxime Godfroy[1], Cyril Aumaitre[1], Yann Kervella[1], Stephanie Narbey[2], Frédéric Oswald[2], Emilio Palomares[3], Renaud Demadrille[1]*

[1] *CEA-Univ. Grenoble Alpes-CNRS, IRIG, SyMMES, 38000 Grenoble, France.*
[2] *Solaronix SA, Rue de l'Ouriette 129, 1170 Aubonne, Switzerland.*
[3] *Institute of Chemical Research of Catalonia (ICIQ), Tarragona, ICREA Barcelona, Spain.*
* renaud.demadrille@cea.fr

In the last decades, the efforts dedicated to the development of next-generation solar cells, especially the ones based on organic materials, have been incredibly increased. Several research axis aiming at improving the performances and stability of these technologies, while decreasing their environmental impact and their cost, have been prospected. Among emerging photovoltaic (PV) technologies, dye-sensitized solar cells (DSSCs) demonstrate a strong potential for applications since they have already achieved power conversion efficiencies close to 14% at laboratory-scale. [1] They are serious candidates for building-integrated photovoltaics because they can be based on low-cost materials and be produced by simple and versatile manufacturing process, they can perform under various light environments, and more importantly, they offer a higher stability compared to other emerging PV technologies. Another unique advantage relies on the possibility to fabricate semi-transparent and colourful DSSCs modules. [2]

In this communication, we will introduce our latest developments focusing on the synthesis, the characterization and the use of organic photosensitizers based on various units such as benzothiadazole or iso-indigo units. [3-5] We will show that minor variations of the chemical structures of these compounds not only induce spectacular changes in their optoelectronic properties but also in their performances in solar cells. With the help of photo-physical and/or impedance spectroscopy techniques, we will unravel electronic interfacial process, and elucidate some of the factors that influence negatively the performances of these new photosensitizers.

We will propose improvements of their chemical structures and demonstrate that some of the new dyes, or combinations of these dyes, lead to solar cells exhibiting high current densities of up to 20 mA/cm² and power conversion efficiencies over 10% under standard irradiation conditions when an iodine-iodide-based electrolyte is employed.

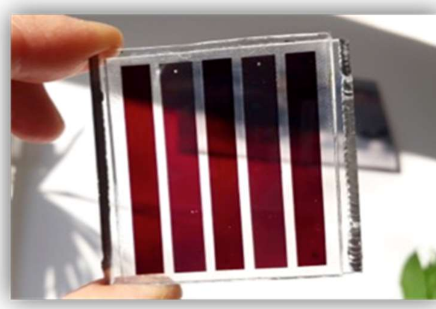

Figure 1: Mini-module (active surface area: 14 cm²) prepared with an organic dye synthesized in this work.

In the last part of this lecture, we will present the performances of these compounds when they are implemented in semi-transparent solar cells and in solar modules. Finally, we will introduce a new concept in the field by describing a new class of photosensitizers allowing to obtain semi-transparent solar cells with variable and self-adaptable optical transmission.

Références

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