Far Red and Near Infra-Red Dyes in Dye-Sensitized Solar Cells: key ingredients for both panchromatic absorption and transparent solar windows

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Nowadays, low-cost solar energy harvesting technologies able to provide enhanced performance under low or weak irradiation and possessing aesthetically pleasing/functional features (BIVP) are requested as complementary renewable sources to Si-based photovoltaics (PV). Among them, dye-sensitized solar cells (DSSCs) are one of the most interesting alternatives [1–2]

Moreover, most PV technologies absorb the visible domain of the light spectrum that is why these devices are not transparent or no less than semi-transparent. However, far-red/near infra-red (NIR) light is indubitably interesting to widen solar harvesting corresponding to 25% of overall solar light available on earth's surface. Of course, the photoconversion expected by the exploitation of these frequencies (700-1000 nm) is lower with respect to the visible region. But, NIR sensitizers allow to tune the colours of final devices from green to blue, even to transparent. Transparent cells without any coloration would allow the visible light to pass through unhampered reaching a fully integration of PV devices in building-integrated applications. [3]

The photosensitizer has a crucial role in a NIR-DSSC system. Different families of NIR chromophores have been investigated for applications in DSSCs with relatively low success in terms of transparency and power conversion efficiency. At present, NIR-based DSSCs exhibited at best 2.3% PCE with very thick electrodes sensitized with a cyanine dye absorbing at 805 nm. [4]. Our group have already developed several squaraine dyes for DSSC absorbing in the NIR region. [5,6]

A few series of new efficient organic sensitizers based on squaraine [7], cyanine and croconine core-units (Figure 1) with a shifted absorption as high as 830 nm have been synthesized and fully characterized. DSSCs based on these new efficient sensitizers are able to convert up to 36% IPCE until 850 nm. Their light-to-electricity performances have been optimized by using highly diluted dye solution to promote the formation of a free self-assembled monolayer.

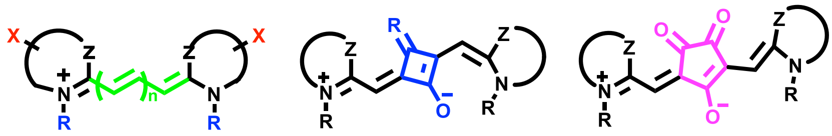

Figure 1. Examples of structures of polymethine dyes.

Finally, application of these novel sensitizers also in water based DSSC [8-9] and their optimization will be discussed.

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