Synthesis of Near Infrared Quaterrylene-based Dyes for Colourless Dye-sensitized Solar Cells

Marco Giordano,[a] A. Fin,[b] M. Bonomo,[a] N. Barbero,[a] C. Barolo,[a] G. Viscardi[a]

[a] *Dipartimento di Chimica, NIS Interdepartmental and INSTM Reference Centre, Università di Torino, Torino, Italy*

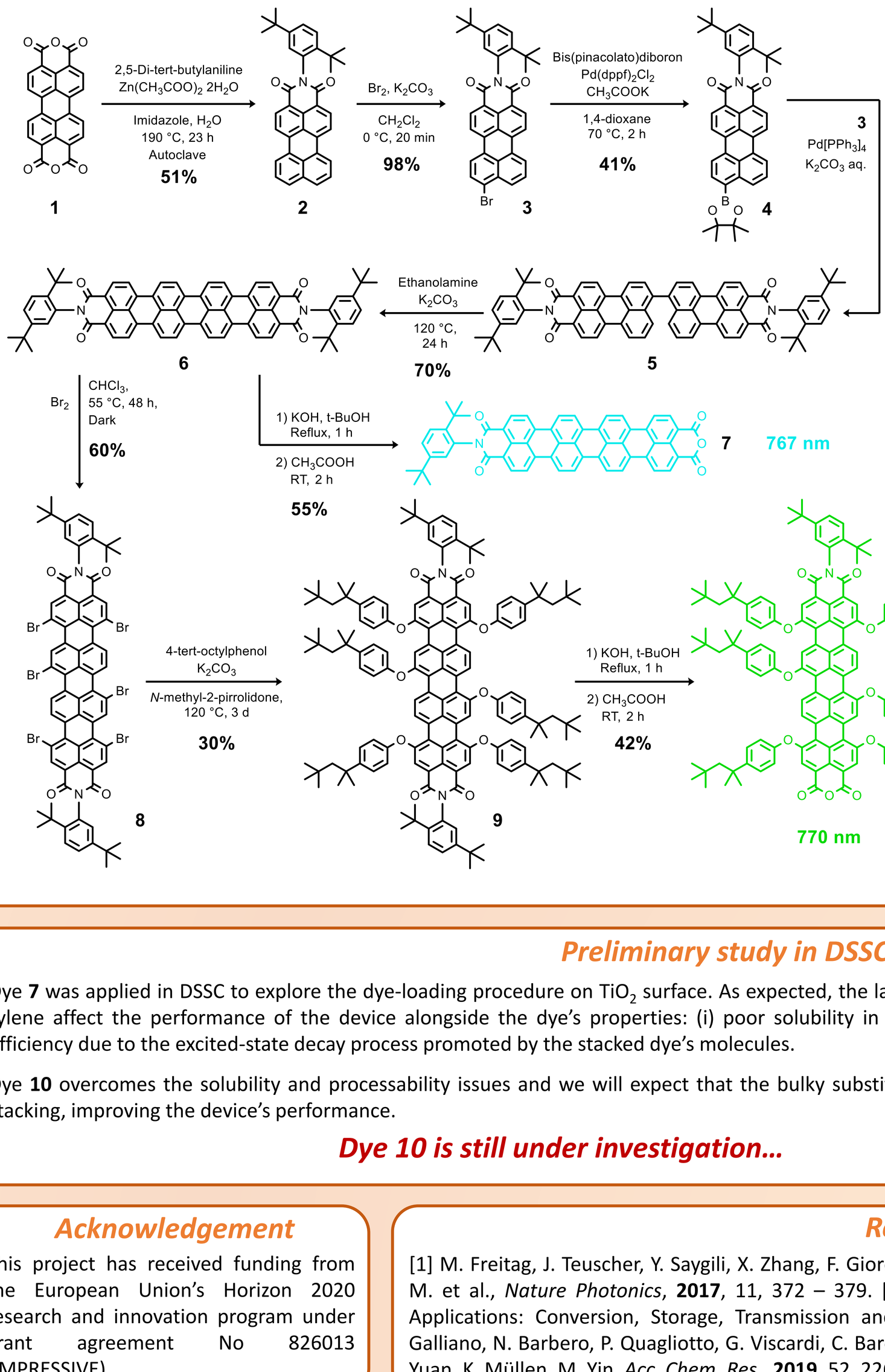
[b] *Dipartimento di Scienza e Tecnologia del Farmaco, Università di Torino, Torino, Italy*

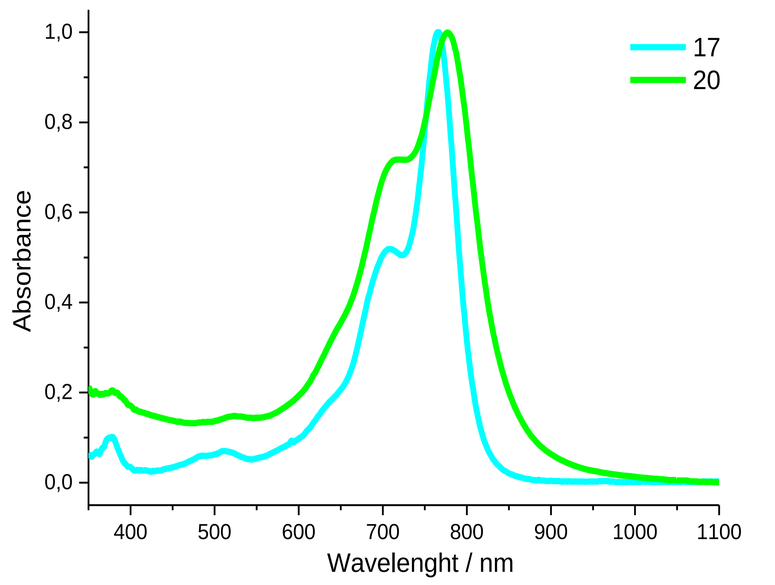
E-mail: marco.giordano@unito.it

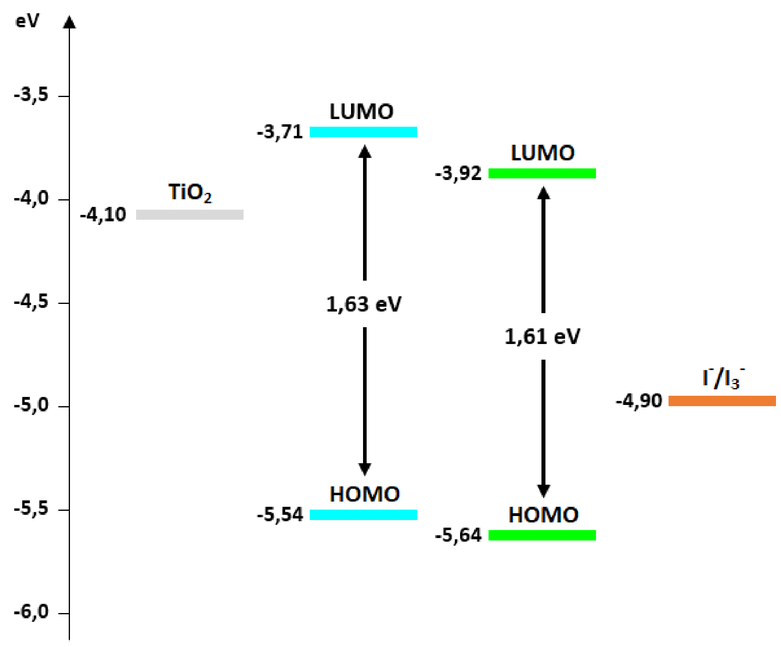
Photovoltaic cells (PV) based on semiconductor technology techniques are, nowadays, the most efficient systems for solar energy conversion. Dye-Sensitized Solar Cells (DSSCs) represent one of the best performing technologies developed though their performances are not comparable with the well-known silicon-based photovoltaics cells.[1,2] Building Integrated PhotoVoltaics (BIPV) based on DSSC are a promising application to make DSSC more attractive in the energy production field. An innovative approach resides on the implementation of colourless DSSCs based on NIR sensitizers such as polymethine and rylene dyes.[3,4]

Rylene dyes: synthesis and characterization

The quaterrylene dyes are synthetized following a three stage strategy: construction of the rylene scaffold, functionalization of the core and, finally, hydrolysis to release the anhydride group as anchoring moiety. Tert-octylphenol substituents are chosen to improve the processability alongside to hinder the π-π stacking during the dye-loading on the TiO_2 surface.







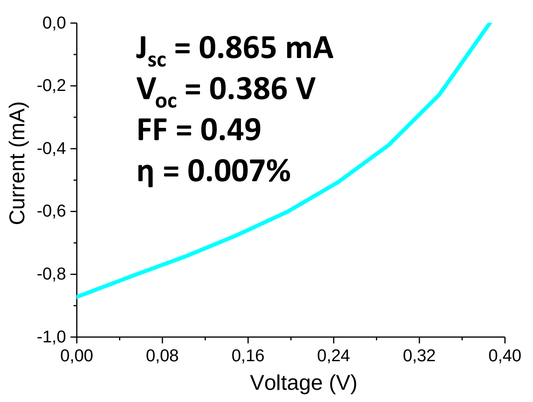
Both dyes have optimal HOMO and LUMO energy levels that guarantee a proper electron injection and dye-regeneration process.

Preliminary study in DSSC

Dye **7** was applied in DSSC to explore the dye-loading procedure on TiO_2 surface. As expected, the lack of substituents on the rylene affect the performance of the device alongside the dye's properties: (i) poor solubility in organic solvents, (ii) low efficiency due to the excited-state decay process promoted by the stacked dye's molecules.

Dye **10** overcomes the solubility and processability issues and we will expect that the bulky substituents will lower the π-π stacking, improving the device's performance.

Dye 10 is still under investigation…



Acknowledgement

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 826013 (IMPRESSIVE).

References

[1] M. Freitag, J. Teuscher, Y. Saygili, X. Zhang, F. Giordano, P. Liska, J. Hua, S. M. Zakeeruddin, J.-E. Moser, M. Grätzel, M. et al., *Nature Photonics*, **2017**, 11, 372 – 379. [2] N. Barbero, F. Sauvage, in Materials for Sustainable Energy Applications: Conversion, Storage, Transmission and Consumption, CRC Press, **2016**, 87-147. [3] D. Saccone, S. Galliano, N. Barbero, P. Quagliotto, G. Viscardi, C. Barolo, *Eur. J. Org. Chem.*, 2016, 2244 – 2259. [4] C. Ji, W. Cheng, Q. Yuan, K. Müllen, M. Yin, *Acc. Chem. Res.*, **2019**, 52, 2266 – 2277.