Towards stable red-emitting artificial fluorescent proteins for sustainable bio-hybrid WLEDs

S. Nejrotti[a], G. Renno[a], M. Bokan,[a] S. Ferrara[b], L. García González[c], H. Lechner[d], A. Fin[a], N. Barbero[a,f], G. Oberdofer[d], P. B. Coto[e], A. López Cortajarena[c], R. D. Costa[b], C. Barolo[a,f]

[a] *Department of Chemistry, NIS and INSTM Reference Centre, Università degli Studi di Torino, via G. Quarello 15/A, 10135 Torino, Italy*
[b] *Technical University of Munich, Chair of Biogenic Functional Materials, Schulgasse 22, 94315 Straubing, Germany*
[c] *Center for Cooperative Research in Biomaterials (CIC biomaGUNE), Basque Research and Technology Alliance, 20014 Donostia-San Sebastián, Spain*
[d] *Institute of Biochemistry, Graz University of Technology, Petersgasse10–12/II,8010 Graz, Austria*
[e] *Materials Physics Center (CFM)-Spanish National Research Council (CSIC) and Donostia International Physics Center (DIPC), Paseo Manuel de Lardizabal 5, 20018 Donostia-San Sebastián, Spain*
[f] *Istituto di Scienza, Tecnologia e Sostenibilità per lo Sviluppo dei Materiali Ceramici (ISSMC-CNR), via Granarolo 64, 48018 Faenza (RA), Italy*
stefano.nejrotti@unito.it

Due to their energetic efficiency, LEDs represent the present and the future of essentially all lighting applications. However, the sustainability of their production and disposal is still undermined by the need to employ rare earth-based colour down-converting filters. A valuable alternative is offered by bio-hybrid LEDs, based on fluorescent proteins (FPs) as sustainable and tuneable emitters, in which the fluorophore prosthetic group can be designed to obtain the desired photophysical features [1]. An ideal FP emitter should display high fluorescence quantum yield values and good photo- and thermal stability, to ensure long lifetime, compatible with the required applications. In particular, such features have still not been achieved for FPs with emission in the red region of the visible spectrum. We recently reported on the use of squaraine dyes (SQ), in combination with Lactococcal multidrug resistance Regulator (LmrR) as protein host, towards the preparation of deep-red bio-hybrid LEDs [2]. Here, we explore the versatility of fluorophores based on other molecular scaffolds, namely naphthalene diimide (NDI), 2,1,3-benzothiadiazole (BTD) and tetrahydroquinoxaline-difluoride boron complex (TQ). Through the introduction of suitable functional groups, it is possible to adapt the fluorophores to interact with the protein through the formation of a covalent bond or a host-guest complex.

Acknowledgment: The project leading to these results has received funding from the European Union's Horizon 2020 research and innovation programme under grant agreement No 863170.

References:

[1] Verónica Fernández-Luna, Pedro B. Coto, Rubén D. Costa, *Angew. Chem. Int. Ed.*, **2018**, *57*, 8826–8836.
[2] Sara Ferrara, Sara H. Mejias, Mantas Liutkus, Giacomo Renno, Francesca Stella, Irene Kociolek, Juan Pablo Fuenzalida-Werner, Claudia Barolo, Pedro B. Coto, Aitziber L. Cortajarena, Rubén D. Costa, *Adv. Funct. Mater.*, **2022**, *32*, 2111381.