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"Ultrabright" molecular-based fluorescent nanoparticles for bioimaging purposes : a bottom-up engineering approach

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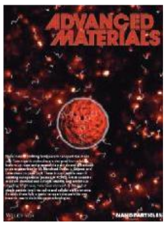
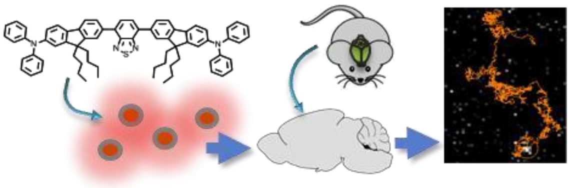
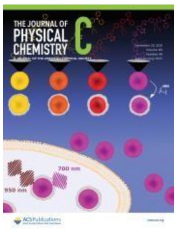
Presentation :

In the last decades inorganic nanoparticles have attracted growing attention in the field of nanophotonics, especially for bioimaging purposes. Among them luminescent metal-, semiconductor- or oxide-based "hard" nanoparticles have been the most widely used. Yet, they raise concern with respect to toxicity and degradability issues. In that respect, ***molecularbased fluorescent organic nanoparticles*** (FONs) hold foremost promises and our goal has been to develop bottom-up approaches towards FONs specifically engineered as nanotools for bioimaging

Our strategy is based on the design/synthesis of dedicated *multipolar* dyes as *interacting* building blocks of FONs which are readily prepared using expeditious and green protocols involving nanoprecipitation of the dyes in water [1-5]. Their luminescent and NLO properties can be engineered to yield tunable, hyper-bright and photostable NPs. Intriguingly, the implemented strategy also enables modulating and improving the FONs colloidal and structural stability [1-2]. As a result, FONs that combine unprecedented brightness (up to 10^8 $M^{-1}cm^{-1}$ and 10^6 GM), remarkable colloidal stability and absence of toxicity, have been elaborated, providing superior substitutes to QDs. Green-emitting FONs can be used as ultra-sensitive contrast agents for ***in vivo two-photon angiography in small animals*** [1a], while Hyper-bright NIR-emitting FONs which show unprecedented photostability and excellent biocompatibility [2-3] can be successfully imaged and tracked at the single particle level in water [2]. Furthermore, realtime ***multicolor single particles tracking within living cells*** can be achieved [3]. Alternatively ***naturally stealth FONs*** [4] that diffuse deep into the brain extracellular space have been designed [4a]







The FONs luminescence and NLO properties are strongly dependent on the self-orientation of the dyes [1, 4c], which also controls their interface with water. Their surface potentials promote surface interactions that can be exploited for surface coating or for the creation of core-shell nanoparticles from complementary dedicated dyes.[1c,5] These fully molecular-based core-shell nanoparticles promote efficient ***shell-to-core fluorescence resonant energy transfer*** and induce extraordinary fluorescence quantum yield and two-photon absorption enhancement.

Biography :

After training in Chemistry at Ecole Normale Superieure in Paris, M. BlanchardDesce defended her PhD in the field of *Molecular Electronics* at the College de France (1989) under the supervision of Nobel Laureate Pr. Jean-Marie Lehn on the design and synthesis of electronic molecular wires. After a postdoctoral stay in the field of *photosynthesis* (1991), MBD developed her own research activities as a CNRS researcher in molecular NonLinear Optics (NLO). After spending five years in the Department of Chemistry of Ecole Normale Supérieure, MBD moved to the University of Rennes in 2000 (ATIP CNRS) where she created a new research group on *Molecular Photonics and Multiphotonics,* MBD then moved to Bordeaux University in 2011 in the framework of the highly selective Aquitaine region Excellence Chair. MBD is recognized for her expertise in the design and synthesis of molecular compounds and nanoparticles for optics meant for applications in different fields, especially life sciences (bioimaging, biomedical sciences). A special emphasis is placed on interdisciplinary approaches and her current research focusses on molecular multiphotonics, biophotonics and nanophotonics. MBD has a good track record in her research field as evidenced by over 300 publications in international journals, 6 book chapters, 8 patents, over 100 invited lectures at conferences and awards. These include the Bronze Medal of the CNRS (1990), the Physical Chemistry prize of the French Chemical Society (1996), the French Academy of Sciences Prix Mergier-Bourdeix (1999), the Silver Medal of the CNRS (2008) and "légion d'honneur" (2012). H-index: 66.

References
1. a) V. Parthasarathy et al, *Small*, 2011, *7*, 3219. b) K. Amro et al, *Tetrahedron* 2014, *70*, 1903. c) C. Mastrodonato et al, *Molecules* 2016, *21*, 1227. d) J. Daniel et al, *ACS Photonics* 2015, *2*, 1209.
2. E. Genin et al, *Adv. Mater*. **2014**, *26*, 2258.
3. J. Daniel et al, *J. Phys. D: Appl. Phys.*, 2016, *49*, 084002.
4. a) M. Rosendale et al, *Adv. Mater.* 2021, *33*, 2006644 . b) M. Rosendale et al *Proc. SPIE*, 2020, *11360*, 1136005. c) P. Pagano et al, *J. Phys. Chem. C*, 2021, *125*, 25695.
5. a) E. Campioli et al, *Small* 2013, *9*, 1982 ; b) E. Campioli et al., *J. Mater. Chem. C* 2015, *3*, 7483