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Abstract

Nanomaterials with Thermally Activated Delayed Fluorescence for Sensing and Imaging: Challenges and Solutions †

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Thermally activated delayed fluorescence (TADF) recently emerged as the most effective strategy for converting non-emissive triplet states in emissive excitons in organic light emitting diodes [1]. Due to its intrinsic mechanism, the TADF process results in luminescence in the micro-to-millisecond timescale that is highly sensitive to external conditions, including polarity, temperature, or oxygen concentration. This provides an ideal platform to develop optical probes with long-lived luminescence for application in time-resolved optical imaging, or in sensing of local temperature or oxygen concentration in vivo [2]. However, TADF molecules perform poorly in polar media, and additional steps must be taken to enable their use in biological applications. Herein, we describe how nanoaggregation and nanoencapsulation of TADF emitters in silica and polymeric nanoparticles can be effective, straightforward methods for achieving TADF emission in water with high luminescence quantum yields and remarkable delayed-to-prompt fluorescence ratios and discuss the advantages and disadvantages of the different approaches. Through careful selection of optical probes and nanocarrier matrix, it is also possible to tune luminescence lifetime and oxygen permeability for optimal oxygen sensitivity in physiological conditions, as well as to achieve luminescent probes with excellent biocompatibility and cellular uptake and distribution for application in fluorescence microcopy imaging [3,4].

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References

1. Dias, F.B.; Penfold, T.J.; Monkman, A.P. Photophysics of thermally activated delayed fluorescence molecules. *Methods Appl. Fluoresc.* **2017**, *5*, 012001. [CrossRef] [PubMed]
2. Chen, W.; Song, F. Thermally activated delayed fluorescence molecules and their new applications aside from OLEDs. *Chinese Chem. Lett.* **2019**, *30*, 1717–1730. [CrossRef]
3. Crucho, C.I.C.; Avó, J.; Nobuyasu, R.; Pinto, S.N.; Fernandes, F.; Lima, J.C.; Berberan-Santos, M.N.; Dias, F.B. Silica nanoparticles with thermally activated delayed fluorescence for live cell imaging. *Mater. Sci. Eng. C* **2020**, *109*, 110528. [CrossRef] [PubMed]
4. Crucho, C.I.C.; Avó, J.; Diniz, A.M.; Pinto, S.N.; Barbosa, J.; Smith, P.O.; Berberan-Santos, M.N.; Pålsson, L.O.; Dias, F.B. TADF Dye-Loaded Nanoparticles for Fluorescence Live-Cell Imaging. *Front. Chem.* **2020**, *8*, 404. [PubMed]

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