Fluorescence concentration quenching in Zinc-containing as well as non-containing phthalocyanines

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Concentration quenching (CQ) [1,2] of fluorescence (FL) is a phenomenon of FL quantum yield decreasing with molecular concentration increasing. CQ is observed in various systems—from synthetic dyes to natural systems, e.g., chlorophylls. Since CQ results in loss of energy, it is important to understand how it can be controlled.

CQ can be observed both in thin films and in liquids. However, it is difficult to observe CQ of high concentrated solutions due to reabsorption effects [3], which affects both steady-state and time-resolved fluorescence. Using cuvettes as thin as possible could be a solution to avoid reabsorption.

In this work CQ is investigated in solutions (prepared in chloroform in thinnest commercially available borosilicate glasses) of Zinc 2,9,16,23-tetra-tert-butyl-29H,31H-phthalocyanine (ZnTTB; see Fig. 1a) and 2,9,16,23-tetra-tert-butyl-29H,31H-phthalocyanine (TTB; see Fig. 1b). The materials are of their own interest. They could be used as good model systems of close chlorophyll-containing systems, or as a model of artificial photosynthetic antenna; also, phthalocyanines themselves are used in organic solar cells and for photodynamic therapy.

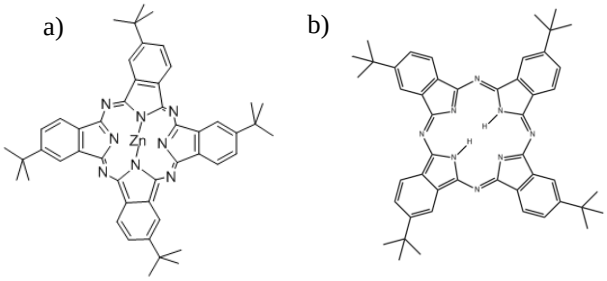

Fig. 1. Molecular structures of ZnTTB (a) and TTB (b).

We studied CQ by varying concentration of phthalocyanine by two orders of magnitude, from 0.1mM up to 10mM, and recoding FL decay kinetics (see Fig. 2a) together with FL spectrum (Fig. 2b). While FL spectra remain the same, FL kinetics clearly exhibit faster non-exponential decay at higher concentration. Each kinetics is analyzed with single- and double-exponential decay and stretched-exponential decay $\exp[-(t/\tau)^b]$, where parameter b indicates the deviation from single-exponential kinetics. CQ is explained in the terms of donor–trap model, where a single donor molecule is surrounded by an infinite number of acceptors. For this reason, all the kinetics are additionally fitted with $\exp\left[-t/\tau_D - (t/\tau_2)^{1/2}\right]$ function (called 'DAC'), where τ_D is the decay rate of excited donor molecule in the absence of acceptors and τ_2 represents quenching due to acceptors. A detailed analysis and supporting information will be provided during the conference.

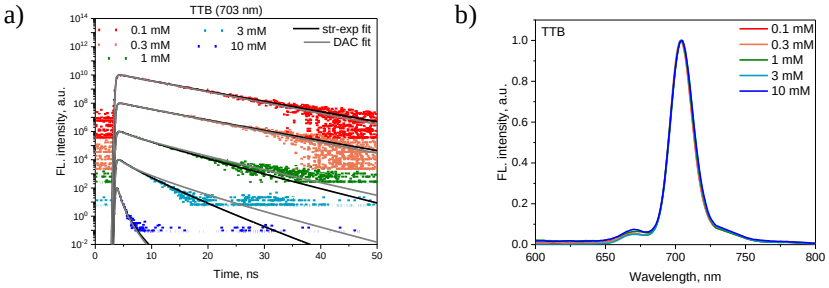

Fig. 2. FL kinetics (a) and spectrum (b) of TTB.

References

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