# CONCENTRATION QUENCHING OF ZINC-PHTHALOCYANINE IN THIN FILMS

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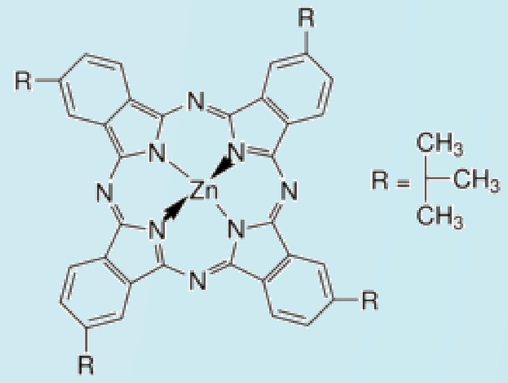
## ABSTRACT

Sharply decreased emission intensity with increasing fluorophore concentration is known as concentration quenching, or aggregation-induced quenching [1], which tends to reduce fluorescence quantum yield [2]. This effect occurs in many systems from biology to optoelectronics [1, 3], and it may adversely affect the operation of the latter systems or devices.

In this study, **Zinc 2,9,16,23-tetra-tert-butyl-29H,31H-phthalocyanine** (TB-ZnPC) concentration quenching of thin films in toluene with polystyrene is investigated. These molecules are being used in diverse fields for their peculiar properties [4, 5], and, having a comparable structure to chlorophylls, they are applied as model systems.




Scheme 1. Structure of Zinc 2,9,16,23-tetra-tert-butyl-29H,31H-phthalocyanine (TB-ZnPC)

## RESULTS

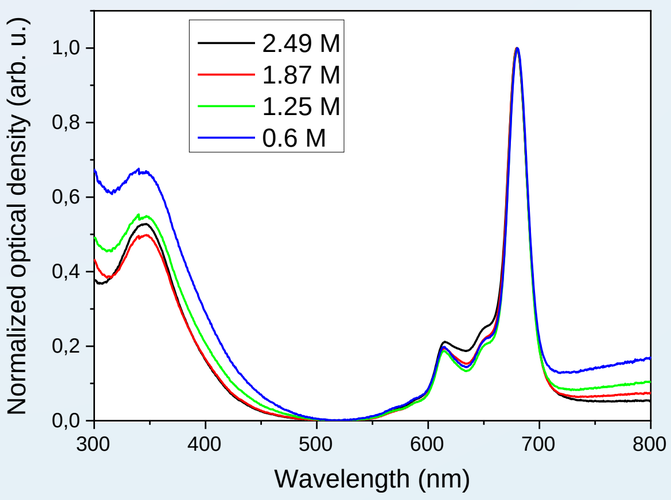



Fig. 1 Normalized absorption spectra of a few different TB-ZnPC thin films concentrations.

Spectral differences are quite small, hence aggregation can not be huge.

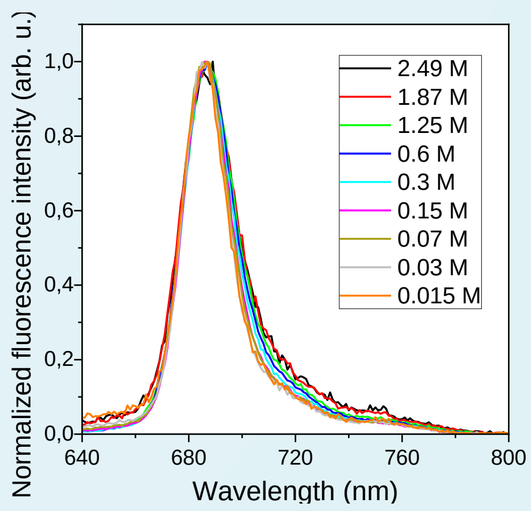



Fig. 3 Normalized fluorescence spectra.

$\lambda_{em}$ = 375 nm

Wing in the red region is getting smaller upon decreasing thin film concentration.

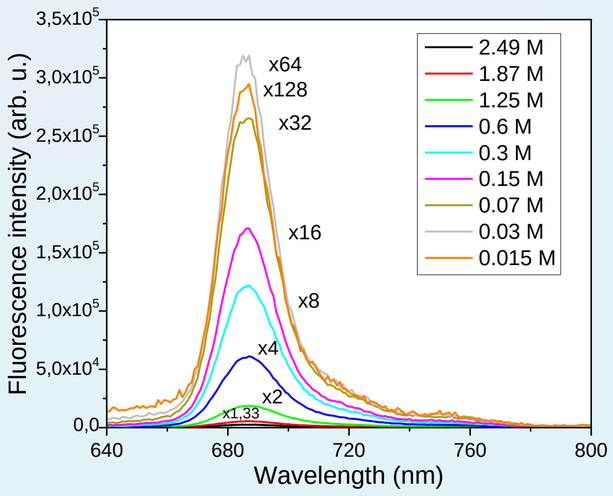



Fig. 2 Fluorescence spectra normalized to concentration: each spectrum was multiplied to match 2.5 M concentration.

Concentration quenching is visible - with increasing concentration of thin films the quenching is more intense.

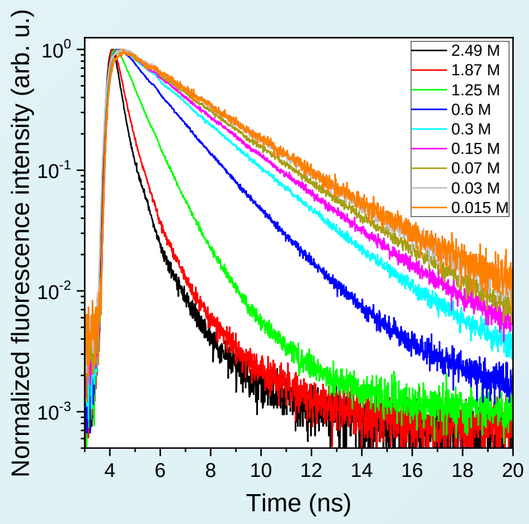



Fig. 4 Fluorescence decay kinetics.

$\lambda_{ex}$ = 690 nm

Fluorescence decay kinetics are getting faster with increasing thin film concentration.

## SUMMARY

- Fluorescence intensity, if normalized to concentration, decreases with increasing concentration, indicating quenching of concentration;
- Fluorescence decay kinetics are getting longer for smaller TB-ZnPC concentrations. Samples were checked and no signs of anihilation were observed;
- Fitting of fluorescence decay kinetics with stretched exponential function show coefficient b changes, and even in the low concentration range, where b is close to 1, the decay timescale varies.

Usually fluorescence decay kinetics are being fitted with exponential function:

$$f(t) = Be^{-\frac{t}{\tau}} \quad (1)$$

But in our case, for > 0.6 M concentration films this method require over 2 or 3 exponents to fit the decay. Therefore, the stretched exponential function (2) was used and results are shown in 1 table.

$$f_b(t) = Ae^{-\left(\frac{t}{\tau}\right)^b} \quad (2)$$

1 table. Fluorescence decay kinetics fits using stretched exponential function.

| Concentration, M | τ, ns | b |
|---|---|---|
| 2.49 | 0.01 | 0.36 |
| 1.87 | 0.03 | 0.41 |
| 1.25 | 0.53 | 0.75 |
| 0.6 | 1.55 | 0.92 |
| 0.3 | 2.26 | 0.96 |
| 0.15 | 2.48 | 0.95 |
| 0.07 | 2.8 | 0.97 |
| 0.03 | 3.26 | 1.06 |
| 0.015 | 3.37 | 1.06 |

## REFERENCES

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