INPAC WP6 Meeting

Investigation of organic dye fluorescence within a photonic crystal structure

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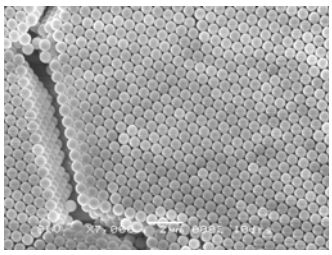
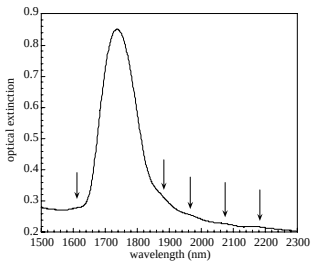
Outline

- Introduction
- Fluorophore as light-emitter
- Spectral narrowing
  - How to achieve
  - Experimental results
- Lifetime investigation
- Future work





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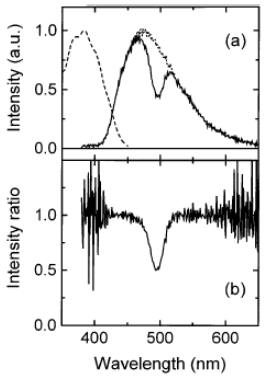
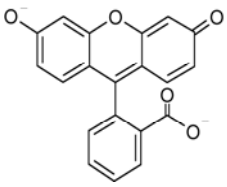
Photonic crystals: introduction

- Photonic crystal: refractive index changes periodically thus optical band structure. [1]
- Electronic crystal: electric potential changes periodically thus electronic band structure.
- Photonic crystals suppress spontaneous emission. [2]
- A convenient way of fabrication is convective self-assembly. [3]



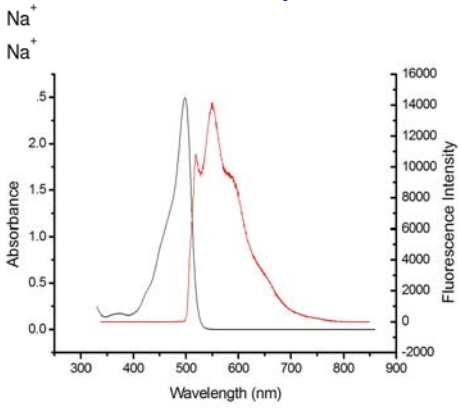
1. E. Yablonovitch, *Phys. Rev. Lett.* **58**, 2059 (1987), S. John, *Phys. Rev. Lett.* **58**, 3485 (1987).
2. E. P. Petrov, V.N. Bogomolov, I. I. Kalosha, S. V. Gaponenko, *Phys. Rev. Lett.* **81**, 77 (1998).
3. P. Jiang, J. F. Bertone, K. S. Hwang, and V. L. Colvin, *Chem. Mater.* **11**, 2132 (1999).

Organic dye as light-emitter



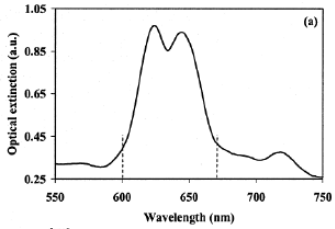
Excitation occured by 1 ps pulses at 488 nm wavelength in an inverted confocal microscope

Disodium fluorescein was used as dye

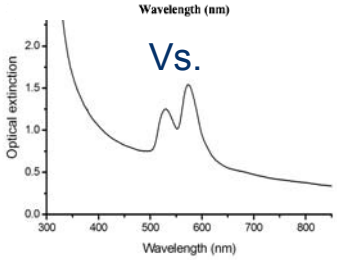


Photonic crystals for spectral narrowing

- We were able to insert a 2D defect into a photonic crystal. [4] This was not sufficient to induce spectral narrowing.
- New approach: heterostructure: broader stopband, deeper and wider passband



Vs.

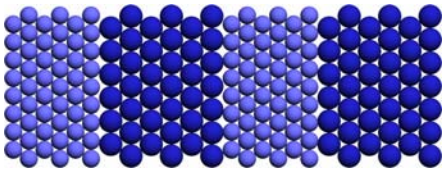


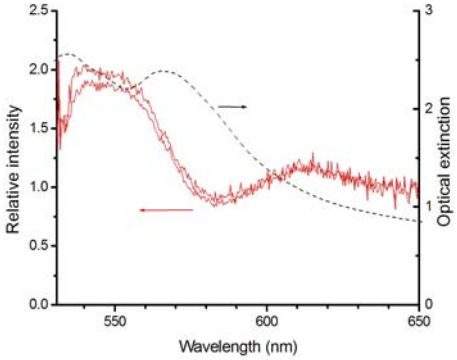
4. K. Wostyn, Y. Zhao, G. de Schaetzen, L. Hellemans, N. Matsuda, K. Clays, A. Persoons *Langmuir* **19**, 4465-4468 (2003)

Modification of emission by photonic crystal

ABAB heterostructure:

Both suppression and enhancement of emission gives spectral narrowing

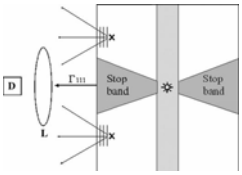


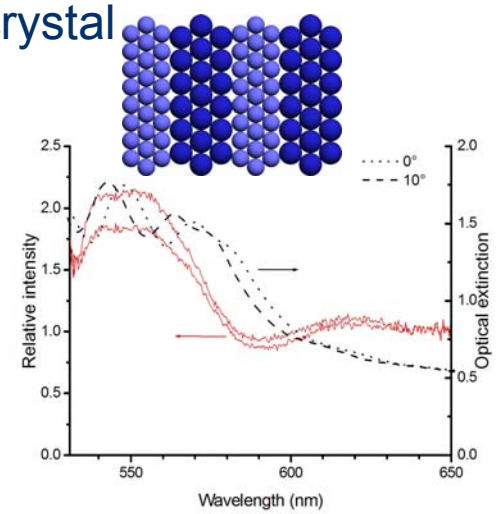


Modification of emission by photonic crystal

ABAB heterostructure:

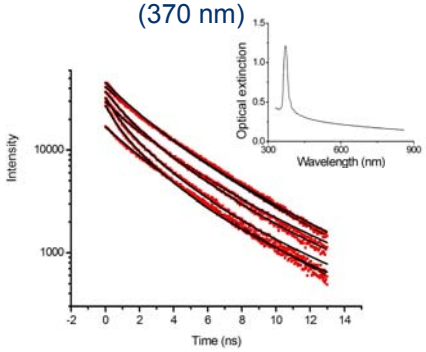
- Pronounced miniband features. Emission enhancement remains however, because of omnidirectionality of emission



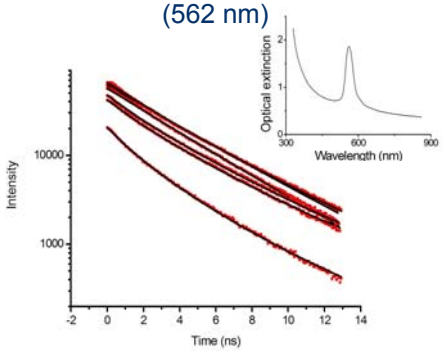


Effect of photonic bandgap on fluorescence lifetime of fluorescein

Reference photonic crystal (370 nm)



Sample photonic crystal (562 nm)



Future Work

- Using quantum dots as the fluorescent species
- Engineering of chromophore location
- Fabrication of inverse opals

Acknowledgments

- **Koen Clays**
- **Renaud Vallée**
- **Branko Kolaric**
- **…**

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