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Experimental Confirmation of Strong Fluorescence Enhancement Using One-dimensional GaP/SiO\textsubscript{2} Photonic Band Gap Structure

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Motivation

Fluorescent microscopy is undoubtedly useful in bio-sensing and imaging due to:

- Optical Sensitivity
- Bio-chemical Flexibility

For single molecule imaging on conventional microscope, there are two challenges:

1. Low signal to noise ratio
2. Low collection efficiency

Due to:

- Weak signal strength
- Signal loss in the environment

Proposed Device

Excitation light comes from the back coupled by a prism.

Structure of 1DPBG

Alternating thin films with high and low refractive indices.

GaP was chosen as the high index material with $n_1=3.45$, $h_1=55$ nm.

SiO\textsubscript{2} was chosen as the low index material with $n_2=1.45$, $h_2=122$ nm.

Performance

Photonic crystal resonance

- Field enhancement of 9.2 folds for TE excitation beam at 532 nm, 44.07 degree incidence, 6-layer design.

- Field enhancement of 8.9 folds for TM excitation beam at 532 nm, 45.07 degree incidence, 7-layer design.

Omni-directional reflection

Fluorescence signal $\lambda=0.625\mu\text{m}$ can be reflected back to the objective lens regardless of angle and polarization. The collection efficiency is increased to 80%.

Enhancement Test

Two 1DPBG samples with 6 and 7-layer designs were fabricated.

Quantum dots were used as the fluorescent materials.

Enhancement for both TE and TM excitation was verified.

Omni-directional reflection was also verified.