

Double Enhancement of Spontaneous Emission of Light at Photonic Band Edges

In photonic crystals with periodic variation of refractive indices, we may realize such frequency ranges that do not allow radiational eigenmodes, which are called photonic band gaps (PBGs). In the vicinity of the PBG frequencies, on the other hand, the photon density of states increases and the group velocity decreases accordingly. By using these phenomena, it is expected to achieve double enhancement of photoluminescence due to enhanced probability of spontaneous emission of photons and efficient photo excitation, although this double enhancement has not been actually achieved so far because specimens with both sufficiently high regularity and a sufficiently large number of unit structures were not available.

We recently found that one-dimensional photonic crystals composed of multilayers of SiO_2 and Ta_2O_5 with oxygen vacancies as photo emitters can be used for this purpose. We verified the double enhancement for the first time by careful observation of their angle-resolved luminescence spectra to confirm the presence of emission peaks in the vicinity of the PBG frequency (top panel of Fig. 1) and increased emission intensity by band edge excitation (Fig. 2).

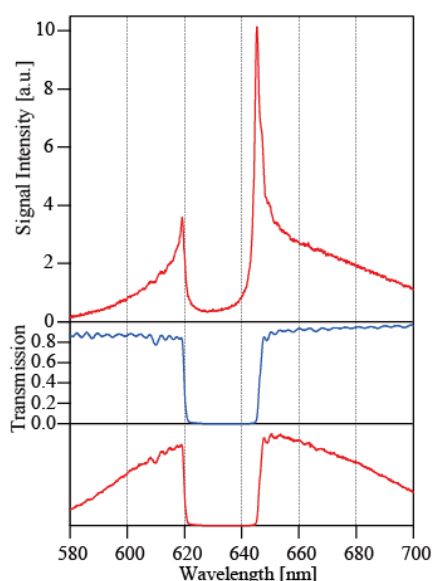


Fig. 1 Top: emission spectrum, middle: transmission spectrum, and bottom: emission spectrum on the assumption of the mere filter effect of the one-dimensional photonic crystal.

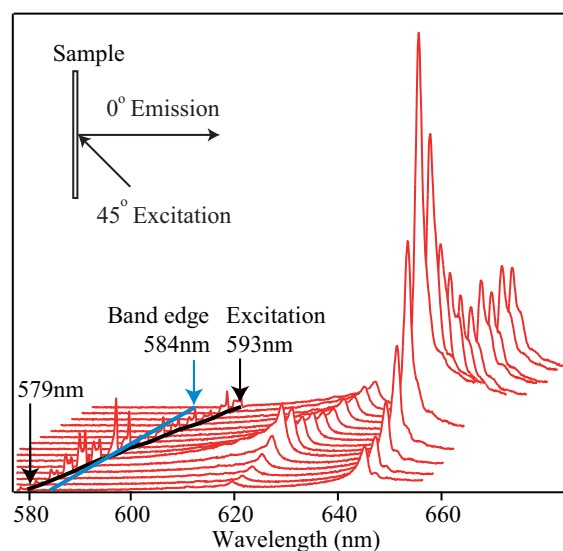


Fig. 2 Excitation-wavelength dependence of the emission intensity. K. Kuroda et al., *Opt. Express* 17, 13168 (2009)