Abstract of Presentation

Presentation Title:

Manipulation of Photons by Photonic Crystals

Abstract :

Photonic crystals, in which the refractive index changes periodically, provide an exciting new tool for the manipulation of photons and have received a keen interest from a variety of fields. In this presentation, I will describe the recent progresses of manipulation of photons by photonic crystals.

First of all, I will talk about ultrahigh *Q* nanocavities [1-4], which are very important for various scientific and engineering applications including stopping or slowing light, nano-lasers, photonic nano-chips, single-photon emitters, and electron-photon strong coupling devices. It will be shown that the cavity *Q* more than 3 million has been just realized successfully [5]. A concept to control *Q*-factors dynamically in picoseconds is also discussed [6].

Next, I will describe light emission control by the band-gap and defect engineering in photonic crystals. 2D crystals have a very unique feature on the control of spontaneous emission. It has been experimentally demonstrated that overall spontaneous emission rate can be suppressed by 2D bandgap effect, while emission efficiency for the vertical direction can be significantly enhanced [3, 7, 8]. The effect of artificially introduced point defects (nanocavities), in which the carriers accumulated by 2D bandgap effect can be effectively redistributed, will be also described [9]. The highlight here is the finding of new emission mechanism "Nanocavity-enhanced Anti-Zeno emission" [10].

Finally, I will describe novel 2D semiconductor lasers based on band-edge effect. At the band-edge of photonic crystals, the group velocity of light becomes zero, which leads to a formation of 2D broad and stable single-cavity mode [12, 13]. The output beam can be emitted in the direction normal to the 2D crystal plane, using the crystal itself as a diffraction grating. It will be shown that record high-power, single-lobed, surface-emitting operation has been successfully achieved, by optimizing photonic crystal structure. In addition, it will be described that various unique beams can be produced by further engineering of photonic crystals [14]. Very recently, lasing wavelength has been successfully brought into blue-violet wavelengths [15].

References:

[1] Y.Akahane, et al, *Nature*, 425 (2003) 944. [2] B.S.Song, et al. *Nature Materials*, 4 (2005) 207. [3] S.Noda, et al. *Nature Photonics*, 1 (2007) 449, [4] Y. Takahashi, et al. *Optics Express*, 15 (2007) 17206. [5] Y. Takahashi, submitted to CLEO 2009. [6] Tanaka, et al, *Nature Materials*, 6 (2007) 862. [7] M.Fujita, et al. *Science*, 308 (2005) 1296. [8] K.Kounoike, et al, *Electron.Lett.*, 41 (2005) 1402. [9] S.Noda, *Science*,314 (2006) 260. [10] M. Yamaguchi, et al, *Optics Express*,16 (2008) 18067. [11] M.Imada, et al, *Appl.Phys.Lett.*, 75 (1999) 316. [12] S.Noda, et al, *Science*, 293 (2001) 1123. [13] E.Miyai, et al. *Nature*, 441 (2006) 946. [14] H. Matsubara, et al, *Science*, 319 (2008) 445.