Control of light by photonic-crystal nanocavities

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Abstract :

I will discuss the recent progress in ultrahigh-Q optical nanocavities in photonic crystals and their impacts on several possible applications.

(1) Ultrahigh-Q optical nanocavities

Recently, there has been rapid progress in cavity *Q* of wavelength-sized cavities based on semiconductor photonic crystals owing to improvements in design and fabrication resolution. Our latest results on photonic-crystal nanocavities with *Q* of over million with nanosecond photon lifetime will be reviewed. [1]

(2) Slow-light media

Such ultrasmall and high-Q cavities are promising candidates for slow-light applications. We have demonstrated that the speed of light is slowed down to c/50,000 in these nanocavities. In addition, we have realized large-scale sequentially-coupled ultrahigh-Q cavity waveguides, which are ideal for slow-light applications. [1,2]

(3) All-optical switching and logic

Another merit of high-Q nanocavities is their potential in enhancing light-matter interaction. We applied them for optical nonlinear switching elements, and realized all-optical bistable switching operation with significantly low power. We are studying their applications in all-optical logic functionalities. [2]

(4) Adiabatic control of light

When the photon dwell time in a small optical system becomes longer enough, it is becoming possible to tune the system within the photon dwell time. It leads to novel way in controlling light. For example, we can change the wavelength of light adiabatically without using higher-order polarization. Furthermore, we can use this adiabatic wavelength conversion for converting optical energy to mechanical energy very efficiently. We will discuss some of examples of such adiabatic tuning phenomena. [2,3,4]

References.

[1] T. Tanabe et al., Nature Photonics 1, 49 (2007).

[2] M. Notomi et al. Opt. Express 15, 17458-17481 (2007). (review article)

[3] M. Notomi et al., Phys. Rev. A73, 051803(R) (2006).

[4] M. Notomi et al. Phys. Rev. Lett. 97, 023903 (2006).