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半導体ナノワイヤにより Si フォトニック結晶中に形成されたナノ共振器
(2) 共振器の移動とパーセル増強

Semiconductor nanowire induced nanocavity in Si photonic crystals
(2) Cavity movement and Purcell enhancement

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Most of the conventional cavities are prefixed to the surrounding arrangement and immovable [1]. Here we demonstrate a movable high-*Q* cavity by manipulating the position of a semiconductor nanowire (NW) inside the groove in the waveguide of photonic crystal (PhC). This is the first demonstration for the movable subwavelength-size nanocavities [2]. By this flexibility, we may use the NW position inside the groove to control the spontaneous emission of embedded emitters inside the NW.

A 95-nm-diameter and 940-nm-length InP NW embedded with 10 InAsP QDs (10-nm-thick each)[3] was manipulated in the 150-nm-width groove of Si PhC with a lattice constant of 350 nm using an AFM manipulation. We overlay three AFM images after the first, second, and third manipulations in Fig. 1a. The displacement by the second and third manipulations was 3 and 6 μm, respectively. We measured PL spectrum at each NW position and we obtained a narrow peak due to the cavity as shown in Fig. 1b. All peaks in three positions are at the wavelength λ_{peak} of ~1,277 nm with slightly different *Q* (5,200 - 2,900 - 3,200). The deterioration of *Q* with the spatial movement is caused by the vertical alignment of NW as we pushed the NW back to the slot, *Q* improves to 4,200. We recorded the time-resolved emission from three different *Q*s, see Fig 1c. The shortest lifetime ($1/\Gamma_{cav}$) is 91 ps, which is much shorter than the NW lifetime ($1/\Gamma_{NW}$) of 730 ps on bare SOI. When we collect the emission enhancement rates, we find the linear dependence of Γ_{cav}/Γ_{NW} with *Q*/*V*, see Fig 1d.

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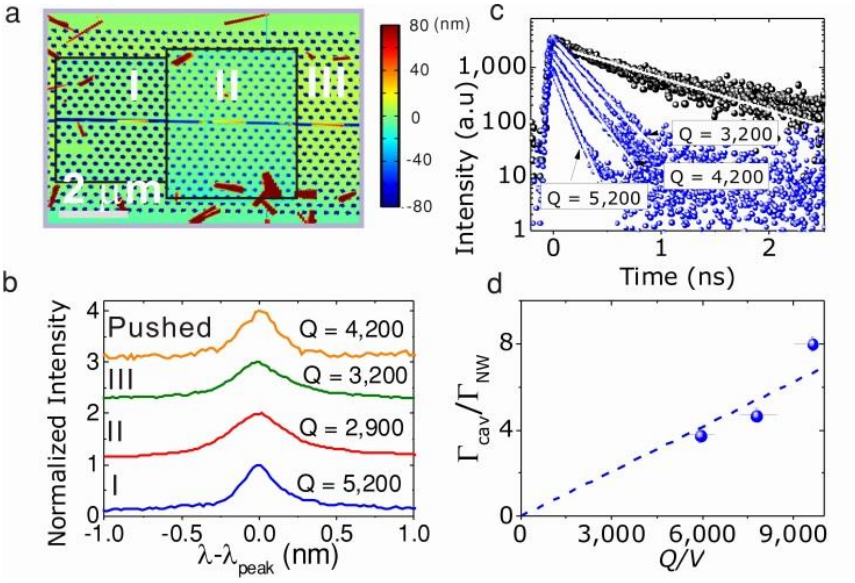

Fig. 1. (a) AFM images of the single NW at different positions inside the groove in the PhC waveguide. (b) PL spectra of the cavity at the NW position in (a) stacked for the clarity. (c) Time-resolved emission of the single NW on the bare SOI (black spheres) and inside the groove (blue spheres). (d) Summary of emission rate enhancement for different *Q*/*V*. (a), and (b) were performed at RT while (c) and (d) at 4 K.