A high-Q 4H-SiC photonic crystal nanocavity operating at 960 nm

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Photonic crystal (PC) nanocavities based on crystalline silicon carbide (SiC) have attracted interest in various applications such as efficient nonlinear wavelength conversions, high power and ultra-broadband nanophotonic devices, and vacancy center-based quantum information processing. For the above applications, nanocavities with high quality (Q) factors are important components. Recently, an ultrahigh-Q 2D-PC nanocavity with a Q factor > 6×10^5 has been realized in telecommunication range, and an efficient nonlinear wavelength conversion has been achieved.[1)] If a high-Q crystalline-SiC based nanocavity is realized in 900~1000 nm wavelength range, an efficient coupling with a Si vacancy color center of SiC can be expected, which leads to various quantum applications. Although there have been many studies on crystalline SiC-based photonic nanocavities operating at wavelengths < 1000 nm , the previous Q factors have remained lower than 2×10^4 (reported for a 1D-nanobeam cavity).[2)]

In this work, we report a high-Q crystalline-SiC based 2D-PC nanocavity operating at 960 nm . Fig. 1 shows a SEM image of the fabricated heterostructure PC nanocavity. We modulated the lattice constants as a_1 = 350 nm, a_2 = 351.5 nm, and a_3 = 353 nm to obtain a cavity resonance near the emission wavelengths of Si vacancy (0.9 ~ 1 μm) in 4H-SiC. The radius of the air holes and thickness of the slab were 90 nm and ~150 nm, respectively. An input waveguide was formed nearby the nanocavity for the excitation. To measure the resonant spectrum of the fabricated cavity, we used a tunable CW laser with a tunable range λ = 950 ~ 990 nm. Fig. 2 shows the measured resonant spectrum. The resonant wavelength and the linewidth were ~ 960 nm and 24 pm, respectively, and the corresponding Q factor was 4×10^4, which is higher than previous results. In addition, we observed a single spot radiation from the resonant mode (inset). We expect that our nanocavity can provide advantages for strong coupling with vacancy centers of SiC and its quantum applications. Details will be presented at the conference.

Ref: 1) B. S. Song, T. Asano, H. Kim, S. Noda et. al, Optica. **6**, 991 (2019). 2) D. M. Lukin, J. Vuckovic et. al, Nat. Photonics (2019). **Acknowledgement:** This work was supported by JSPS KAKENHI (19H02629), and the National Research Foundation of Korea (2017R1A2B4003374) grant funded by the Ministry of Science and ICT.

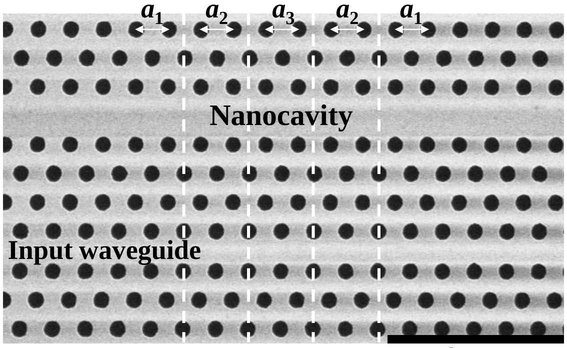

Fig. 1: Surface SEM image of a fabricated SiC photonic crystal nanocavity

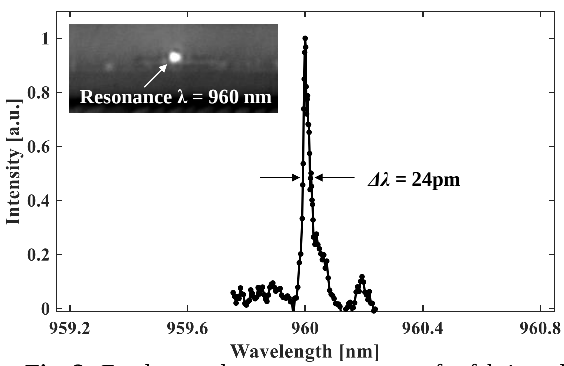

Fig. 2: Fundamental resonant spectrum of a fabricated nanocavity. The inset shows a radiation pattern.