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SiC フォトニック結晶ナノ共振器の高 *Q* 値化に向けた基礎検討(2)

Basic study on SiC-based high *Q* photonic crystal nanocavity (2)

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We have demonstrated that photonic-crystal (PC) nanocavities based on Silicon Carbide (SiC) have many advantageous properties over Si nanocavities such as suppression of two-photon absorption [1] and ultra-broad band operation [2]. In addition, we have reported various nonlinear phenomena [3] in the SiC nanocavities. However, the experimental *Q* factors (~10^4) of the fabricated nanocavities have proved to be much lower than the design *Q* factors, and in the previous report we have confirmed that material absorption is the major origin of the *Q* factor degradation [4]. Here, we report the reduction of the material absorption by high temperature annealing, and demonstrate the improvement of the *Q* factor of SiC PC nanocavities.

It is considered that the material absorption is originated from the defect states generated within the SiC slab during the fabrication process of the SiC-on-insulator (SiCOI) substrates. In order to reduce the defect states and to improve the *Q* factors, we tried high-temperature annealing over 1300 °C because it is known in the field of SiC-based electronic devices that some kinds of defects in SiC can be eliminated by such process [5]. We cut out two SiCOI pieces (5mm × 8mm) from the same SiCOI wafer (360 nm-thick SiC/ 1500nm-thick SiO2/ 380μm-thick Si), and annealed one of the pieces at 1400 °C for 30min. We fabricated PC nanocavities using the annealed and non-annealed SiCOI pieces for comparison, where five types of different nanocavity designs with the vertical *Q* factors of ~10^6 were adopted (Fig. 1(a)). The *Q* factor of each sample was measured and Fig. 1 (b) shows the result. It is seen in the figure that nanocavities fabricated using SiCOI substrates annealed at 1400°C have *Q* factors of ~12000 while those without the annealing have *Q* factors of ~7000 in average (1.7 times improvement). Although the experimental *Q* factors are still lower than the designed *Q* factors, the result indicates the possibility of further improvement of *Q* factors based on annealing process. Further details on the other results will be presented at the conference.

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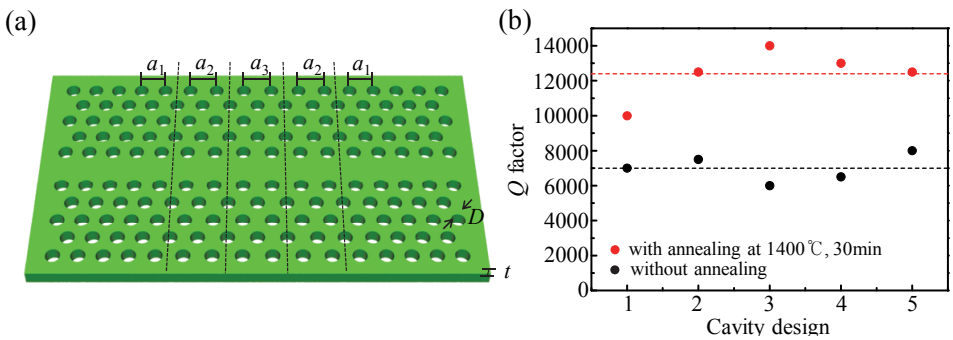

Fig. 1: (a) Schematic of SiC based PC nanocavity structure with $D = 0.58a_1$, $t = 0.6a_1$. Here, the lattice constants are set as the follows: $a_3 > a_2 > a_1$. (b) *Q* factor withg or without annealing (dotted lines: average)

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