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SiC ナノビームフォトニック結晶共振器の作製

Fabrication of SiC nanobeam photonic-crystal cavities

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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]. However, the experimental Q factors (~10^4) of the fabricated nanocavities have proved to be much lower than the design Q factors (~10^7), and in the previous report we have confirmed that absorption loss is the major origin of the Q factor degradation [3]. This absorption loss is considered due to the damage induced by the ion implantation process during the fabrication of SiC-on-insulator substrates. For this reason, we have proposed a nano-beam photonic crystal structure that can be fabricated directly on a SiC bulk wafer using an oblique etching [4]. Here, we report an experimental results on the fabrication of the nano-beam photonic crystal structure.

Firstly, we fabricated a SiC nano-beam structure without photonic crystal pattern. A 200 nm-thick Ni mask of the nano-beam pattern was prepared on a 4H-SiC bulk wafer by using a metal lift-off technique (Fig. 1 (a)). The sample was then vertically etched by about 1.5 μm using an inductively coupled plasma etching technique to obtain a high-mesa structure (Fig. 1(b)). Next, the lower part of the mesa was removed by the oblique etching using an electric field control plate [5] in order to obtain air-bridged structure. As can be seen in Fig. 1 (c), a nano-beam structure with a triangular cross-section that is separated from the SiC bulk region has been successfully obtained. The length and width of the nano-beam are 20 μm and 1 μm respectively (Fig. 1(d)), and separation between the beam and bulk region is 1.5 μm, which is enough large to reduce the coupling loss to the bulk region [4].

Next, SiC nano-beam PC cavity has been fabricated. In this process, PC air-holes were first fabricated and then the nano-beam was fabricated by aligning the Ni marks (Fig. 1(a)) to the air-holes. As can be seen Fig.1(e), a nano-beam photonic crystal is successfully fabricated directly on the SiC bulk wafer. Further details on the other results will be presented at the conference.

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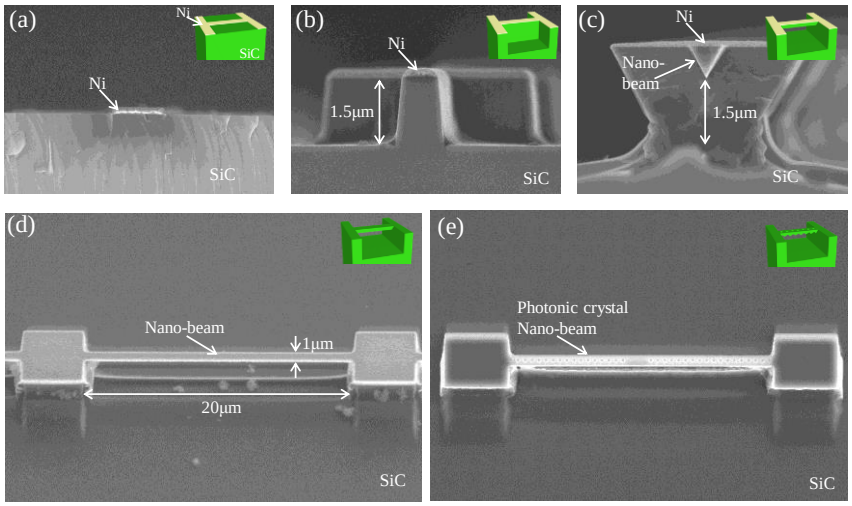

Fig. 1: Cross section SEM image after (a) the Ni lift-off (b) the vertical etching (c) the oblique etching, (d) SEM image of nano-beam structure (e) SEM image of Photonic crystal nano-beam structure