Fabrication of nanofiber Bragg cavities with lower acceleration voltage to avoid process damage

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In order to realize photonic quantum information technologies, it is important to develop photonic quantum devices, such as single photon sources, quantum memories, and quantum phase gates. For these devices, we have developed nanofiber Bragg cavities (NFBCs), which are the optical nanofibers embedded an optical cavity in it using a gallium focused ion beam (FIB), and realized the enhancement of photon emission from single light emitter coupled with it [1]. According to our theoretical simulations, they can realize coupling efficiency over 80% from the single light emitter to a single mod fiber [2] and efficient excitation of the single light emitters via the optical fiber [3]. In addition, we have recently developed the NFBCs with high quality factor (*Q* factor) using a helium FIB [4]. However, when using the He FIB, the NFBCs were fragile and sometimes broken during transportation. There is a possibility that this is caused by the damage to the nanofiber by the He ions during the fabrication.

In order to consider this issue, we calculate the implantation depth of the He ions using Stopping and Range of Ions in Matter (SRIM). The calculated implantation depths of the He ions when the acceleration voltage is 20 keV and 30 keV are 205 ± 64 nm and 295 ± 81 nm, respectively. This implantation depth at 30 keV is comparable to the diameter of the NFBCs (about 300 nm) [4]. In order to avoid the damage by the He ions, we try to fabricate the NFBCs at lower acceleration voltage. As the result, we succeeded in a good NFBC with a *Q* factor of 800 whose transmission spectrum is shown in Fig. 1.

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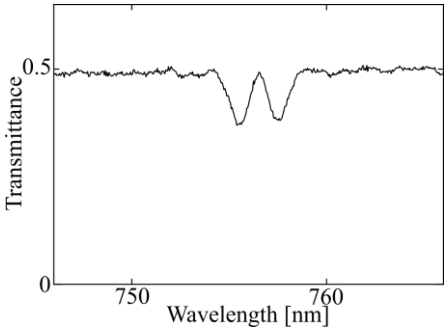

Fig. 1 Transmission of the NFBC fabricated at the acceleration voltage of 20 keV

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[2] Takashima, Fujiwara, Schell, and Takeuchi, Opt. Express, **24**, 15050 (2016)

[3] Tashima, Takashima, and Takeuchi, Opt. Express, **27**, 27009 (2019)

[4] Takashima, Fukuda, Maruya, Tashima, Schell, and Takeuchi, Opt. Express, **27**, 6792 (2019).