Towards investigation of light-matter interactions of single quantum emitters using a multimode nanofiber cavity

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Here we present the experimental realization of an optical nanofiber-based cavity consisting of a combination of 1-D photonic crystal and Bragg grating structures (Figure 1). The cavity is composed of a periodic, triplex air-nano-cube arrays at the nanofiber waist, with the nanofiber designed as single mode. The transmission spectrum for a very short periodic structure of the system shows a Q-factor of ~784 ± 87. [1] Meanwhile, a theoretical study of such a cavity with a narrow air-filled groove suggests a significantly high Purcell factor for single quantum emitters inside the groove (Figure 2). The coupling efficiency of single quantum emitters into the guided mode of the cavity is estimated to reach up to 80%. [2]

Such a system could be modified to use multimode ultrathin fiber in order to investigate interactions between single quantum emitters and higher order modes. This novel cavity design shows a lot of potential in the fields of nanophotonics and quantum information applications.

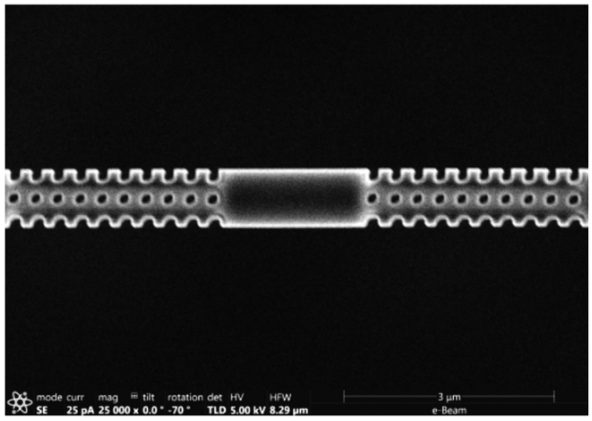

Figure 2. SEM image of an optical nanofiber-based cavity. The fiber waist diameter is ~830 nm, the milled-air-square length is ~ 100 nm, the pitch is ~310 nm and the cavity length is ~2.2 µm. [1]

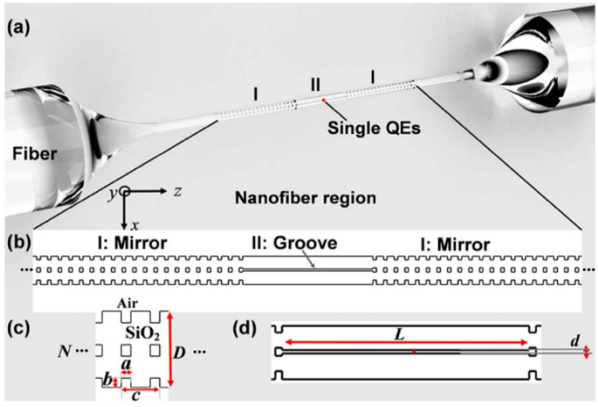

Figure 1. (a) Schematic of the proposed system with a single quantum emitter, cavity mirrors I, narrow groove II. The morphology of I and II are shown in (b). Detailed geometry I in (c) is a = 100nm, b = 100 nm, c = 310 nm, and fiber diameter D. Detailed geometry II in (d) is L = 2.2 µm and width d. [2]

1. Li, W., *et al.*, Applied Physics Letters, **110**, 253102 (2017).
2. Li, W., J. Du, and S. Nic Chormaic, Optics Letters, **43**, 1674 (2018).

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