Enhancement of Transmission and Wavelength Selectivity of Spiral Bull's Eye Structure by Spiral-shaped Bragg Reflector

T. Oiwa, S. Warisawa and R. Kometani
Graduate School of Frontier Science, The University of Tokyo,
5-1-5 Kashiwanoha, Kashiwa, Chiba 277-0882, Japan
taoiwa@s.h.k.u-tokyo.ac.jp

To realize on-chip spectrometer, optical microelectromechanical systems (MEMS) spectrometer which utilizes MEMS resonator and spiral bull's eye structure has been researched[1]. This optical MEMS spectrometer uses spiral bull's eye structure as a wavelength filter. Spiral bull's eye absorbs incident light with different wavelength according to position or polarity of incident light. This is because SBE has different groove pitches along the circumferential direction. SBE couples the absorbed light to surface plasmon polariton (SPP). Excited SPPs are collected at the center of the structure and detected by MEMS resonator located at the center. To improve wavelength resolution of this MEMS spectrometer, wavelength filter with higher wavelength selectivity is needed.

We propose spiral Bragg reflectors (SBR) as shown in Fig 1(a). SBR enhances transmission and wavelength selectivity. SBR to improve SBE characteristics has not been reported. As shown in Fig. 1(b) and Fig. 1(c), this structure is designed to reflect outward propagating SPPs back to the aperture at the center.

We fabricated spiral-shaped plasmonic devices which consists of a combination of SBE and spiral Bragg reflectors, as shown in Fig. 2. The devices were fabricated on Si substrate. The device was patterned with electron beam lithography. Au film was deposited on patterned resist, and excess Au film was removed through liftoff process. The SBE consists of 10 grooves, whose pitch ranges from 1400 nm to 1700 nm and depth is 200 nm. The reflectors consist of 20 grooves each, and groove pitch ranges from 700 nm to 850 nm and groove depth is 200 nm.

Transmission spectrum of the fabricated devices was measured with linearly polarized light for 64 times and averaged. Background component of spectrum was then subtracted. The measured spectra are shown in Fig. 3. Reflectors improved peak transmission from 0.013 to 0.038, and full width at half maximum from 247.5 nm to 54.4 nm. This result indicates that despite spiral shape, SBR surrounding SBE reflects SPPs back to the aperture. The result also implies enhancement and suppression of transmission occurred in certain wavelengths. In summary, we found that spiral Bragg reflectors enhance both peak transmission and wavelength selectivity of SBE. Functionality and characteristics of SBR will be reported in detail.

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[1] K. Penekwong et al., *in Proc. Of MNC2018, 2018*, 15P-7-85.

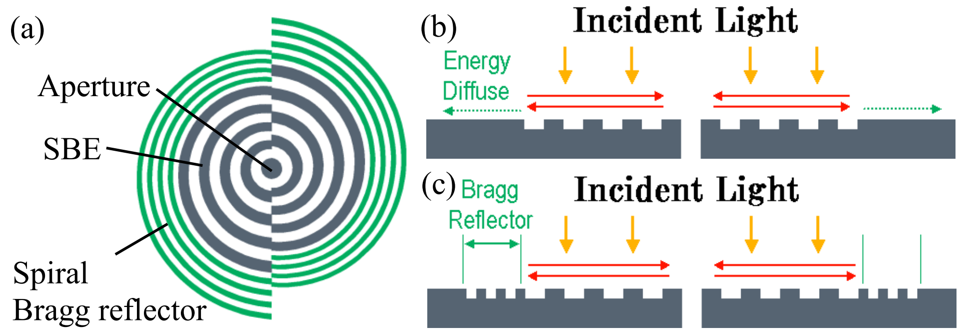

Figure 1: (a) Top View and (b, c) diagram of the mechanism of the proposed device: (a) Green grooves show spiral Bragg reflector. Number of illustrated grooves is fewer than that of actual device. (b) Outward propagating SPPs are shown in green.

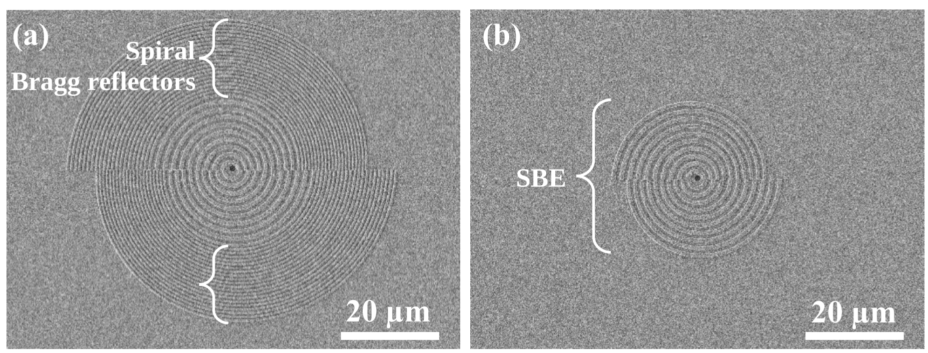

Figure 2: Fabricated Spiral Bull's Eye Structure (a) with and (b) without Spiral Bragg Reflector:

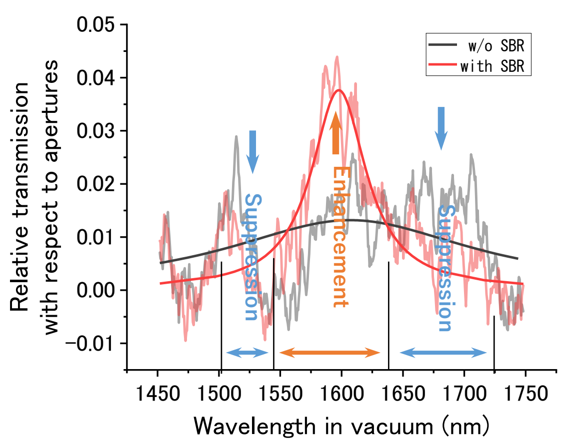

Figure 3: Comparison of Transmission Spectrum of Spiral Bull's Eye Structure with and without Spiral Bragg Reflector: Both peak transmission and wavelength selectivity are enhanced. Reflectors enhance peak transmission and suppress transmission of adjacent wavelength range. Blue and orange arrows show wavelength range with suppressed and enhanced transmission, respectively.