Narrowband Photonic Absorber with Nano-Fins in Near-Infrared Region for Wavelength Detection with Mechanical Resonator

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In fiber optical information systems, near infra-red (NIR) light waves are applied for wavelength division multiplexer (WDM). WDM allow us to multiplex optical signals onto a single optical fiber. In WDM system, wavelength locker is used to stabilize the wavelength in optical fiber. The wavelength locker consists of interferometers which are expensive and complex system. For the purpose of cost reduction and simplify the wavelength locker, wavelength detector with optomechanical resonator was proposed [1]. The schematic diagram of the wavelength detector with optical absorber and mechanical resonator is shown in Figure 1. The difference in the absorption spectrum of optical absorber leads the thermal stress difference in the mechanical resonator. The thermal stress difference results in the frequency shift of mechanical resonator.

In this report, new narrowband photonic absorber for wavelength detection in NIR region is presented. Our narrowband photonic absorber can detect wavelengths in wideband NIR region (from 1 to 2 μm). The schematic of the proposed photonic absorber is described in Figure 2. The structure consists of separated nano-fins which show narrowband absorption in NIR region[2]. The parameter study of the narrowband photonic absorber is shown in Figure 3. In case of the nano-fin elements, the height of the structure is important as well as the period of the elements. The peak of the absorption spectrum shifts toward longer wavelength as increase in the period and height. The length and width have less importance in our optical absorber than period and height. For the fabrication process, thickness control is easier than the accurate drawing of elements on surface. Simulated results allow us to easy fabrication of the optical absorber on the mechanical resonator.

The absorption, transmission, and reflection spectrum of estimated structure (period = 1.38 μm, length = 1.18 μm, width = 50 nm, and height = 200 nm) are shown in Figure 4. The structure can absorb almost 100% light wave in NIR region. Figure 5 shows scanning electron microscopic image of fabricated sample.

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[1] R. Kometani *et al*., "Optomechanical resonator fabrication with the surface plasmon antenna for the wavelength detection," *EIPBN2013*.

[2] E. Maeda *et al*., "Sensitivity to refractive index of high-aspect-ratio nanofins with optical vortex," *Nanotechnology*, 23 505502, 2012.

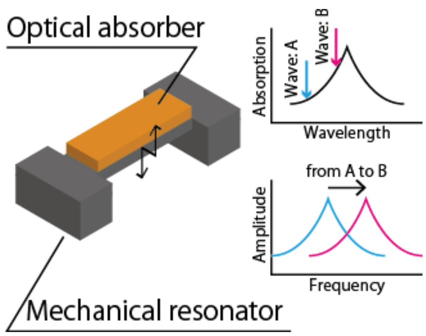


Figure 1: The wavelength detector with optical absorber and mechanical resonator.

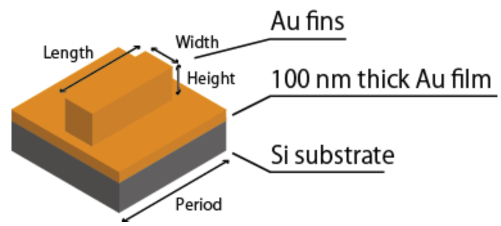


Figure 2: Schematic of the optical absorber for NIR region.

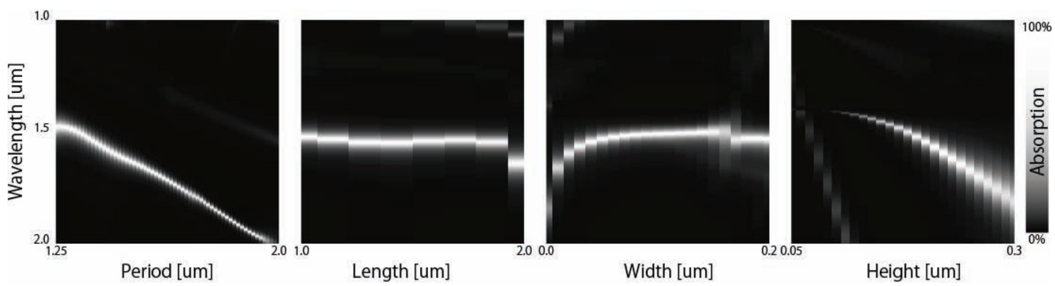
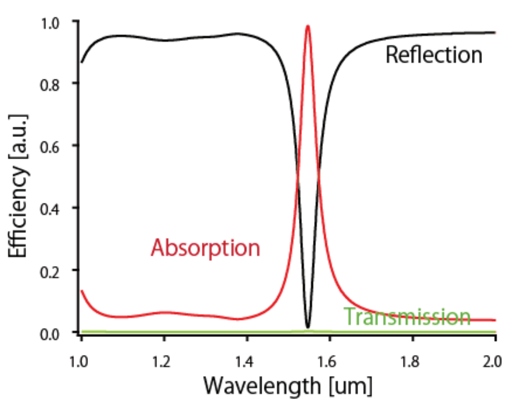


Figure 3: Parameter study of optical absorber for period, length, width, and height. The initial parameters were period = 1.38 µm, length = 1.18 µm, width = 50 nm, and height = 200 nm. Rigorous coupled-wave analysis was carried out for optical simulation.



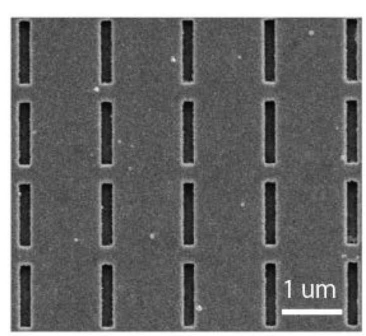


Figure 4: The simulated spectra of the optical absorber in NIR region.

Figure 5: The fabricated sample of the optical absorber.