Tunable optical filter enabled by phase change material embedded in SOI microring resonator

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1. Introduction

Phase change material $Ge_2Sb_2Te_5$ (GST) has been utilized as optically active material to design and experimentally realize active silicon photonic devices, mainly owing to its self-holding bi-stability and large difference in optical properties between its amorphous and crystalline phases [1].

Here, we propose a tunable optical filter which can be realized using state of the art SOI technology. The proposed device is based on the thermal tuning of microring resonator embedded with active phase change material GST.

2. Designs and Simulations

Figure 1 shows the structure of GST-based microring resonator tunable optical filter. The bus waveguide has a cross section of 400 nm (width) × 300 nm (height), and ring waveguide has a cross section of 480 (width) × 300 (height), with a slab layer of 80 nm height. Both waveguides support single mode operation at 1550 nm. The inner radius of microring is 5 µm. The cross section of active part of the microring is shown in Fig. 1. The indium-tin-oxide (ITO) forms the electrodes for application of voltage. At 1550 nm, the amorphous GST phase refractive index is set to 4.6 ＋ 0.12i [2], and that for Si and SiO_2 as 3.45 and 1.45, respectively. For thermo-optic simulations, temperature dependent refractive indices are taken [3]. All the simulations are performed using the Multiphysics module of CST Microwave studio.

The ring embedded with low-loss amorphous phase is designed to be critically coupled, the attenuation within the cavity is small resulting in a large extinction ratio (ER) of ~50dB at resonance wavelength of 1566.07 nm.

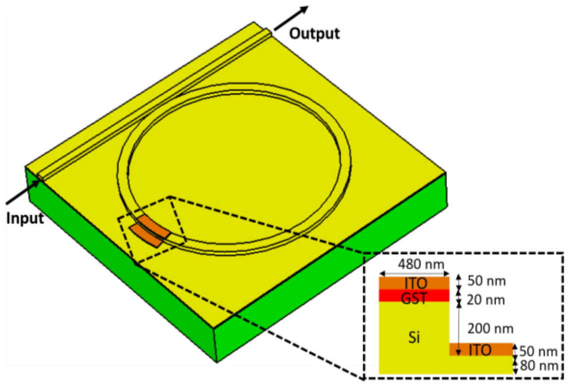

Figure 1: Schematic view of proposed microring tunable optical filter.

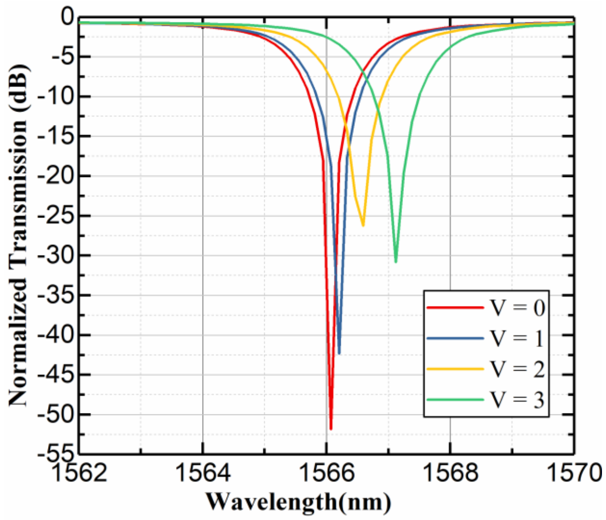

Figure 2: The normalized transmission of proposed tunable optical filter as a function of applied voltage.

Now, as we increase the temperature of GST, by applying voltage, the resonance dips exhibit non-uniform change in red shift and ER as shown in Fig. 2. This non-uniform change in red shift and ER is due to the non-uniform change in the real and imaginary effective refractive index, respectively. Therefore, the output wavelength can be tuned through the applied voltages.

3. Conclusions

We have proposed, designed and simulated tunable optical filter using GST-SOI microring resonator. With different applied voltages, it is shown that the GST-SOI microring can be tuned to different wavelengths. This filter can be used as fundamental building blocks in more sophisticated photonic integrated circuits.

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References

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