Design, Fabrication and Characterization of 5 µm Ring Resonator

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Abstract: We present the design, simulation, fabrication and characterization of microring resonator on SOI platform. Proposed feature size device resonates at a wavelength of 1565.92 nm. The fabricated device has potential applications in communication and sensing.
Keywords: Microring resonator, E- beam lithography, Grating and tapered coupler.

1. Introduction

An integrated optical microring resonator (MRR) basically consists of a ring waveguide coupled to one or two bus waveguides. The large refractive index change between silicon and its oxide enables ring resonators radii less than 5 µm [1]. The ring resonator can find many applications in integrated optic devices, particularly wavelength division multiplexing (WDM)[2]. The position and the shape of the resonance dips are very sensitive to various effects such as, photo optics, electro-optics, acoustic-optics, magneto-optics, nonlinear-optic, electro-absorption, etc. in combination with micromechanical structures can be used for sensing applications [3]. The figure of merit of ring is, free spectral range (FSR), full width half maximum (FWHM) and quality factor (Q). For high sensitivity of the device, high FSR, low FWHM and high Q are the desirable parameters. Such miniaturized devices are suitable for automobile industries, aerospace and biomedical applications because of their small size and weight [4].

2. Design and simulation of Microring Resonator

The schematic of the device and design parameters are mentioned in the figure 1. Microring resonator is designed with a radius 5 µm, waveguide width 500 nm and thickness 220 nm. The designed device is simulated with 2-D Finite Difference Time Domain (FDTD) method at centre wavelength of 1550 nm for single mode TE polarization. The TE mode field, resonant conditions of microring resonator and transmission characteristicsare shown in the figure 2. In order to couple light into the device, the grating coupler with down taper is used at input port. The output is collected by the combination of grating coupler with up taper at the drop port.

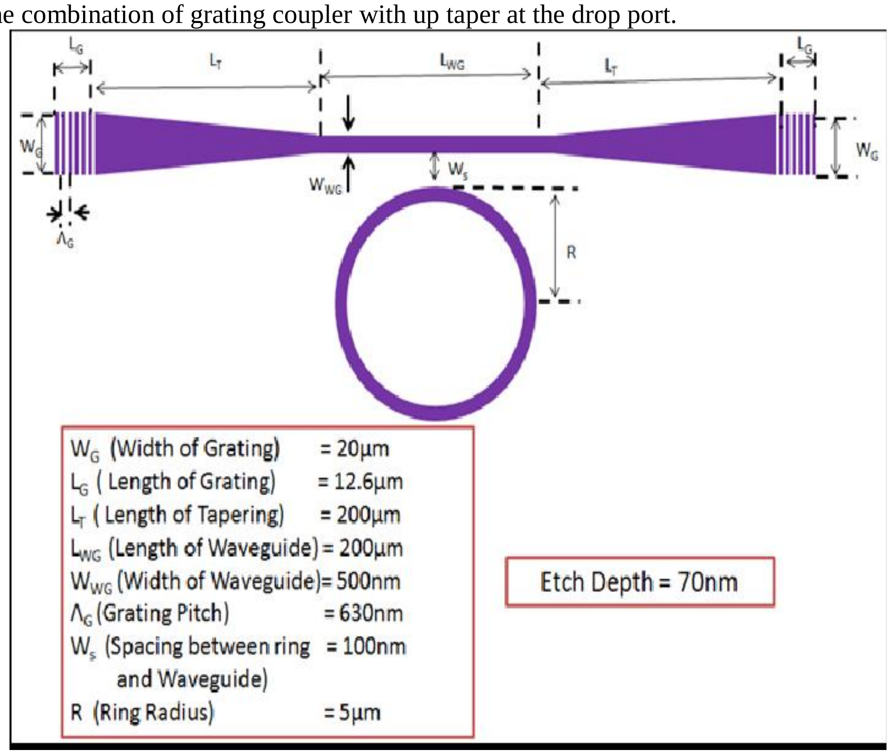

Figure 1: Schematic diagram of Microring resonator with single bus waveguide.

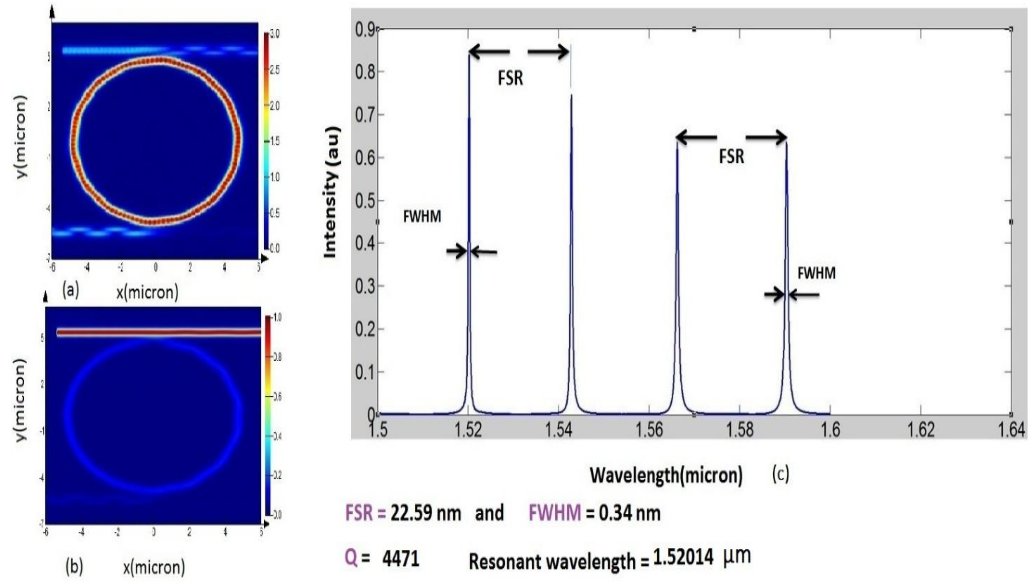

Figure 2: Results of MRR at (a) resonant (b) non resonant conditions and (c) transmission characteristics.

3. Fabrication of MRR

Proposed device is realized on a SOI wafer with device layer of 220 nm thickness and 2 µm BOX layer. The process steps involved in fabrication are as shown in figure 3. Electron beam lithography technique is used to patternover a negative photoresist followed by dry etch process. The SEM image of thus obtained device is shown infigure 4. The fabricated device consists of two linear grating couplers, with pitch 630 nm, 50 percentage dutycycle and 70 nm etch depth, to couple from the input fiber to the device and from the device to the collectionfiber. A tapering waveguide (20 µm to 500 nm) of length 200 µm is added to the gratings as a mode converter
to the strip waveguide of width 500 nm.

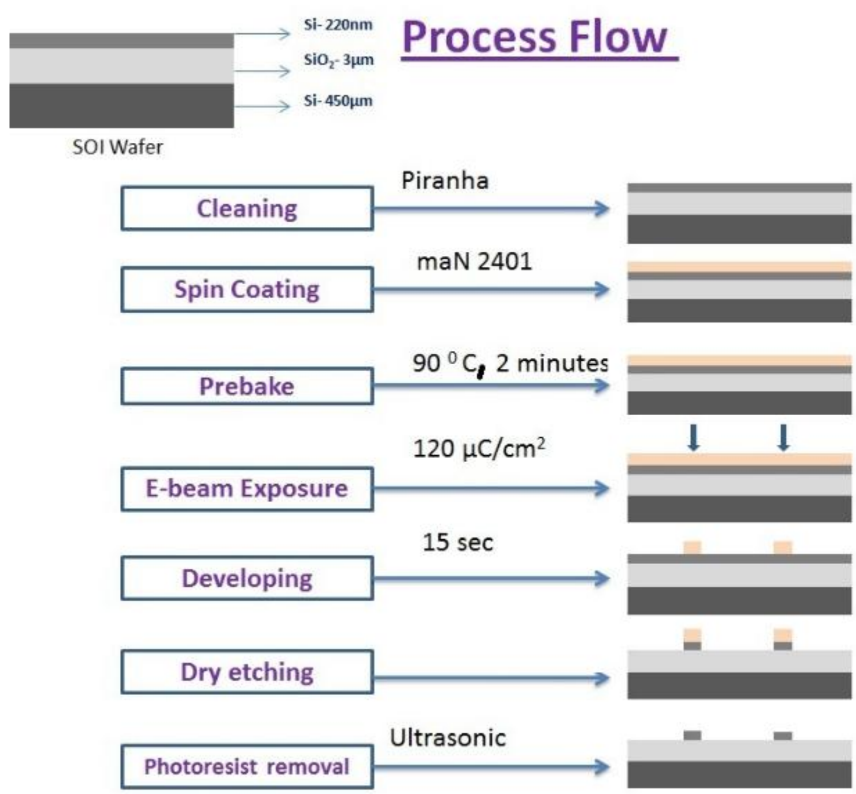

Figure 3: Fabrication process steps

4. Characterization of MRR

A broad band source emitting at C and L band is used to characterize the device. Light is coupled to and from the device using a single mode fiber with vertically cleaved ends. Optical Spectrum Analyzer from Yokogawa, AQ6370 is used to analyze the output from the device. A schematic diagram of the experimental set up is as shown in figure 5. As fitting with the design, the output showing a dip at 1565 nm at through put port. The output spectrum is as shown in figure 6.

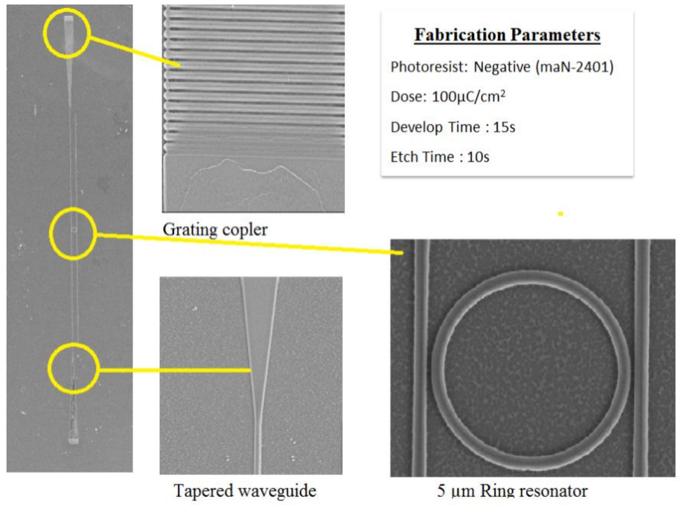

Figure 4: SEM images of MRR with grating coupler

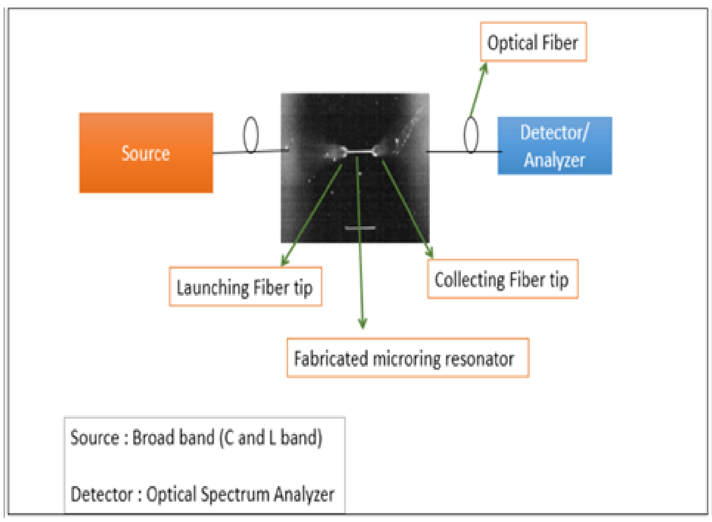

Figure.5.Experimental setup for characterization of MRR

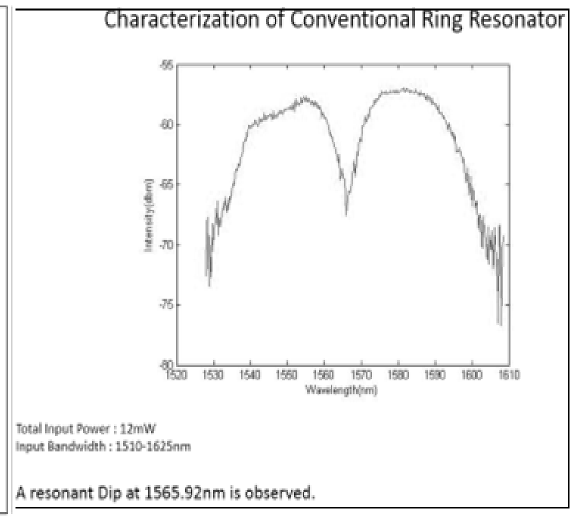

Figure.6.Characterization of MRR

5. Conclusion

We have designed, simulated and fabricated microring resonator of radius 5 µm. The simulation results of MRR match well with the fabrication and experimental characterization. We have obtained FSR of 22.59 nm, FWHM of 0.34 nm and quality factor of 4447. This miniaturized device may find applications in micro force measurement applications.

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