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Multi-wavelength channel selective switch by cascading TO-tunable quadruple series-coupled microrings

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Abstract

We demonstrated a multi-wavelength channel selective switch using individual Thermo-Optic tuning of quadruple series-coupled microring resonators. The extinction ratio and the switching crosstalk were extremely improved to 51.8dB and -23.9dB, respectively, from those of double series-coupled device (27.2dB and -8.4dB).

1 Introduction

Vertically coupled microring resonator filter [1] is suitable for the element of ROADM (Reconfigurable Optical Add/Drop Multiplexer), because it can be densely integrated via stacked configuration [1,2] and cross grid topology [1]. In addition, we fabricated a hitless wavelength selective switch (WSS) [3] without blocking other wavelength channels during the tuning. This switch is based on the individual tuning of resonant wavelength of double series-coupled microring resonator, and can serve as the building block of the wavelength selective switch matrix.

In this study, we proposed and demonstrated a multi-wavelength channel selective switch using the cascaded arrangement of hitless WSS based on the quadruple series-coupled microring resonator as shown Fig. 1, which can realize much more box-like spectrum response than the double series-coupled microring resonator.

2 Principle

In a series-coupled microring resonator, when resonant wavelengths of individual microrings are not matched to each other, all wavelength channels are transmitted to the through port and no spectrum peak appears in the drop port (OFF-state). After shifting all resonant wavelengths and adjusting these resonant wavelengths, a spectrum peak in the drop port response appears at another wavelength channel. Therefore, by controlling individual resonant wavelengths of a series coupled microring resonator using TO effect, a hitless wavelength selective switch can be realized.

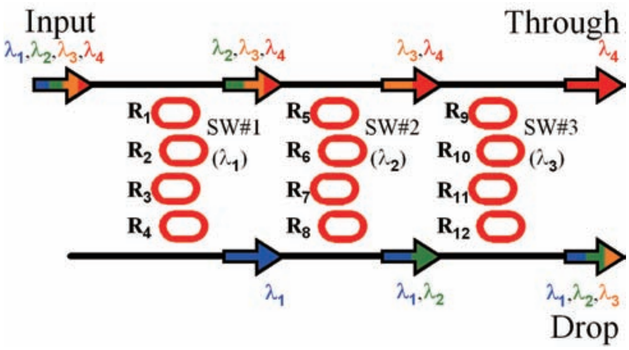

Fig.1. Multi-wavelength channel selective switch with cascaded arrangement.

3 Experiment

First, we fabricated a multi-wavelength channel selective switch by cascading three WSSs using quadruple series-coupled microring resonators. The basic structure including core and cladding materials and the fabrication process are the same as those described in our previous report [3,4].

By applying electric current to each Cr thin film heater above individual ring resonators separately, we measured multi-wavelength switching characteristics. When the electric current was changed, the measured drop port responses varied as shown in Figs. 2-4.

In the initial stage when no electric current was applied, the resonant wavelengths of individual microrings were slightly different due to the fabrication error.

The ON-states of λ_1, λ_2, and λ_3 were realized by supplying small amount of electric power to each ring as shown in Fig. 2. These three peaks correspond to these three switch elements. The crosstalk for the drop port was -51.5dB and the shape factor [5] was 0.654, which were much better than those of double series-coupled microrings (-35.3dB and 0.40). The FWHM bandwidth was 0.149nm at λ=1549.8nm (λ_2).

Figure 3 shows the measured two wavelength selective switching characteristics. The OFF-state of λ_3 was realized by supplying electric power to two of resonators in SW#3.

Figure 4 shows the measured zero wavelength selective switching characteristics. All OFF-states of λ_1 to λ_3 were realized by supplying electric power to two of resonators in each switch element.

Comparing the peak transmittance of Fig. 2 (three wavelengths selected) with that of Fig. 3 (two wavelength selected), the extinction ratio and the switching crosstalk at λ=1550.64nm (λ_3) were 51.8dB and -23.9dB, respectively. However, unexpected wavelength shift occurred for λ_1 ($\Delta\lambda_1$=0.58nm) and λ_2 ($\Delta\lambda_2$=0.30nm), resulting from thermal interference. Comparing Fig. 2 with Fig. 4 (zero wavelength selected), the extinction ratio and the switching crosstalk at λ=1549.29nm (λ_1) were 51.0dB and -26.4dB, respectively. These characteristics were also much better than those of double series-coupled microring resonators (27.2dB and -8.4dB).

4 Conclusion

Since this hitless WSS has a feature of scalable integration, multi-wavelength and multi-port channel selective switch matrix with more than three wavelengths will be possible.

References

1. S. T. Chu, *et al*, *Photon. Technol. Lett.*, **11**, p.691, 1999.
2. D. V. Tishinin, *et al*, *Photon. Technol. Lett.*, **11**, p.1003, 1999.
3. Y. Goebuchi, *et al*, *Photon. Technol. Lett.*, **18**, p.538, 2006.
4. Y. Goebuchi, *et al*, *MOC'06*, Seoul, **C3**, Sept. 2006.
5. Y. Yanagase, *et al*, *J. Lightwave. Technol.*, **20**, p.1525, 2002.

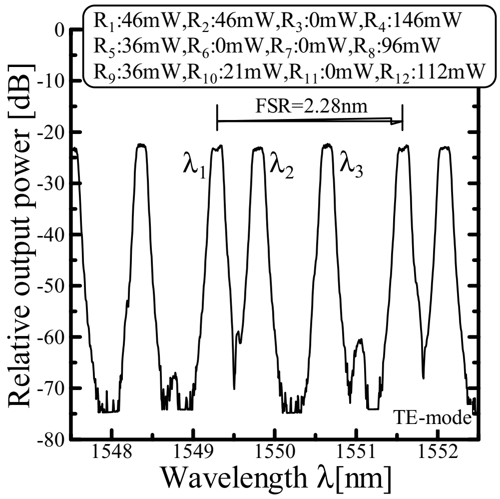

Fig.2. Drop port spectrum response when three wavelength channels were selected.

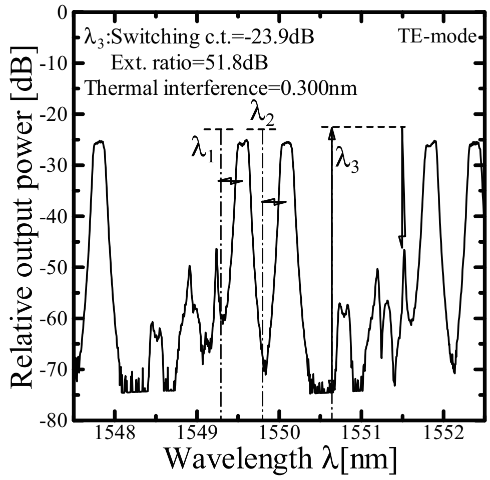

Fig.3. Drop port spectrum response when two wavelength channels were selected.

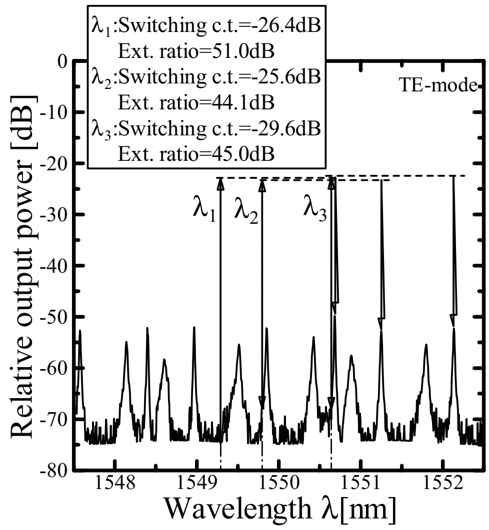

Fig.4. Drop port spectrum response when no wavelength channel was selected.