1 × 2 Wavefront Control Type Wavelength-Selective Switch by Silicon Waveguides

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1. Introduction

A wavelength-selective switch (WSS) can route each of the input wavelength division multiplexed (WDM) signal to any one of the output ports. A WSS is the key device of an optical node in the optical network system. We previously proposed a 1 × 2 wavefront control type WSS [1], [2]. This WSS has no waveguide crossing; therefore the crosstalk between channels and the variation in loss among channels can be reduced. In this paper, we demonstrate successful switching operations with this WSS.

2. Design of the 1 × 2 wavefront control type WSS

The configuration of the 1 × 2 wavefront control type WSS is shown in Fig.1. The WSS consists of one arrayed waveguide grating (AWG) for the input, two AWGs for the output, one shared slab waveguide, and wavefront control waveguides. The incident WDM signal is demultiplexed by the input AWG. Each separated signal is expanded by propagation in the large slab waveguide and couple to eight wavefront control waveguides, each of which has a phase shifter with heater and a distributed Bragg reflector (DBR). The eight wavefront control waveguides of each channel are the same length. When the heaters on the wavefront control waveguides are OFF, the signal light is reflected by the DBRs and propagated in the slab waveguide toward output AWG #1, which is located symmetrically about the optical axis. On the other hand, when they are ON, the optical path length is changed due to the thermo-optical effect. The wavefront of the signal light is tilted and routed to output AWG #2.

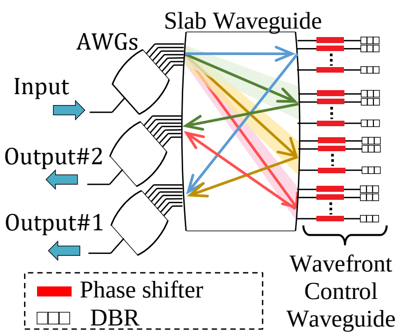

Fig. 1. Configuration of 1 × 2 wavefront control type WSS

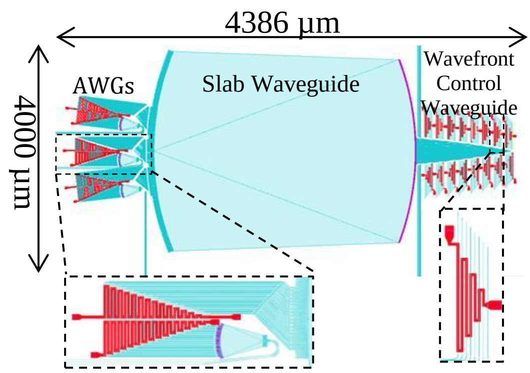

Fig. 2. Layout of 1 × 2 wavefront control type WSS

The layout of the 1 × 2 WSS is shown in Fig. 2. It has 16 channels and the channel spacing is 200 GHz. Each channel has eight wavefront control waveguides of the same length. As shown in the inset in Fig. 2, the heaters on the eight wavefront control waveguides are connected. A rib structure was adopted at the boundary part between the slab waveguide and array waveguides, in order to reduce the coupling loss. The designs of the input AWG and the output AWGs are the same. The WSS chip was fabricated on a 12" SOI wafer by using a CMOS pilot line at AIST.

3. Switching Characteristics

Fig. 3 shows a photograph of the 1 × 2 wavefront control type WSS chip. The each wavelength signal is switched by controlling the injection current to the heaters. The switching current required was about 6-11 mA. The switching characteristics are shown in Figs 4, 5, and 6. Figures 4 and 5 show transmittance to Output #1 and Output #2 respectively, when the heaters on wavefront control waveguides for all 16 channels were ON. Fig. 6 shows the transmittance to Output #2 when the heaters on the even channels were ON. The 9th channel could not be switched due to the bonding wire having broken. The transmittances shown in the figures do not include the coupling loss to optical fibers. The average insertion loss to Output #1 and Output #2 were 20.1 dB and 19.5 dB, respectively.

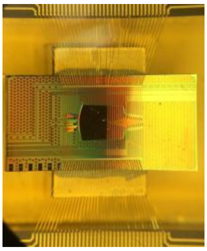

Fig. 3 Photo of the chip wire-bonded.

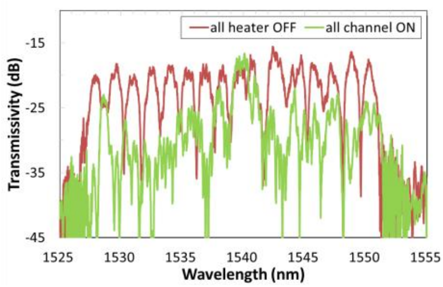

Fig. 4 Transmittance to Output #1.

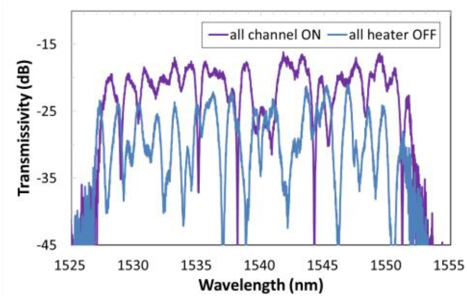

Fig. 5. Transmittance to Output #2.

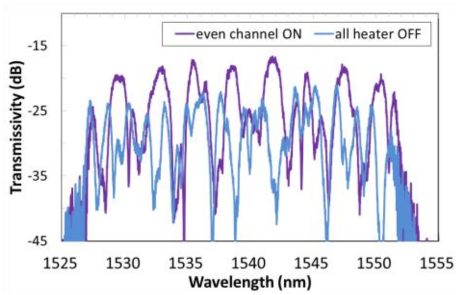

Fig. 6. Transmittance to Output #2 when even channel switched to Output #2.

4. Conclusion

We fabricated a 16-channel, 1 × 2 wavefront control type WSS using silicon waveguides and performed switching experiments. The switching current for each channel was about 6-11 mA. The variation in loss among the channels was reduced since this wavefront control type WSS has no waveguide crossing.

References

[1] Kyosuke Muramatsu et al., Photonics in Switching 2015, WeI2-4, Sep. 22-25, Florence, Italy. (2015).

[2] Fumi Nakamura, et al., Frontiers in Optics 2016, JW4A.144, Rochester, U.S.A. (2016).