Chapter 5

Conclusions

In this thesis, we propose a new structure that integrated EDWA and MMI waveguide. The EDWA plays an important role in the DWDM optical transport systems [54]. We described the basic theory of the optical amplifier and simulate the single channel erbium-doped rib waveguide with different lengths and keep several different pump power to find the relationship between length and net gain. From the simulation of the opti-system, we can find that a maximum net optical gain of 10.02 (dB) is expected for a waveguide length of 28cm with a higher pump power of 400 mW. In conclusion, according to the simulation result, erbium doped silicon waveguides operate at the third telecommunication window near 1.5μm. They are attractive due to their small size and potential integration as loss-compensating components with other optical devices, such as passive splitters or combiners.

It is reported an EDWA for applying the DWDM optical transport systems in chapter 3. The communication system includes a multi-port tunable laser array, Nx1 MUX, EDWA, 1xN DEMUX and Optical Spectrum Analyzer (OSA), N=8, 16, 32, 64. We use the Opti-system software and matlab software to simulate and calculate the DWDM system, respectively. We analyze the net gain and noise figure for these four kinds of Nx1 MUX EDWA/1xN DEMUX systems and compare the performance of these four Erbium-doped optical WDM elements based on Silicon on

Insulator (SOI) wafers. We show the relationship between gain and wavelength when the insertion loss of the waveguide is set at 3dB for 100mW, 200mW, 300mW, and 400mW pump power, respectively. In the case of 8x1 MUX/1x8 DEMUX and EDWA, The maximum net gain are 0.89 dB (1554.13nm), 2.32 dB (1548.51nm), 3.1dB (1548.51nm), 3.59dB (1548.51nm), respectively. In the case of 16x1 MUX/1x16 DEMUX and EDWA, the maximum net gain are 0.5565207 dB (1553.33nm), 1.8944544 dB (1548.91nm), 2.6956883 dB (1547.32nm), and 3.2220974 dB (1547.32nm), respectively. In the case of 32x1 MUX/1x32 DEMUX and EDWA, the maximum net gain are 0.24700275 dB (1558.98 nm), 1.3490968 dB (1554.94nm), 2.1059989 dB (1546.92 nm), and 2.6542471 dB (1546.92 nm), respectively. In the case of 64x1 MUX/1x64 DEMUX and EDWA, the maximum net gain are -0.15969588 dB (1560.61nm), 0.73560414 dB (1556.96nm), 1.3525746 dB (1554.54nm), and 1.8382285 dB (1546.92nm), respectively. In the case of N=8, 16, 32, and 64, if we consider the performance of maximum gain and minimum noise figure, pump power at 400mW is optimal. If we also consider the flatness of gain and NF, pump power at 300mW is optimal.

In chapter 4, we combine the EDWA and Multimode Interference (MMI) based on SOI (silicon on insulator) wafer by ion implantation. We use ion implantation to dope the Er^{3+} into our AWG and MMI. Our implanted energy is 100KeV. In these two samples, the dose is $3x10^{14}/cm^2$ and range from just under the silicon surface to a depth of 0.07 μm. Our experimental setups included tunable laser, 2 x 2 WDM fiber coupler, collimater, objective lens (and single mode fiber), and optical spectrum analyzer (OSA) for measuring the output beam from the output port of MMI. The saturation pump power is about 78mW and maximum signal enhancement is about 0.56dB/cm. In the future, our work is focused on trying to use lensed fibers to confine the light source of tunable laser and measure the performance of Er^{3+} AWG. Due to the dose and depth restricted by the implantator, we can only achieve such an effect. If we can use the implantator at high energy(MeV) and high dose in our research, we believe it will produce better performance in regards to amplification.