Chapter 5

Conclusions

From the basic theory of Maxwell's equations, we used several of them to describe the electromagnetic waves guide equations and the propagation of light in the optical waveguide. We explained the Common Design Methods and analyzed the optical waveguide through the Finite-Element Method (FEM). By calculating the correlating matrices from smaller elements, we can show the image of how the light-wave propagation works in the optical waveguide. According to the analysis of various optical waveguides with computer-aided Full-WAVE software mentioned in Chapter 2, the conclusions are given in the following texts.

It has also been discussed that the situations that cause the propagation loss from fabricated defects of the waveguide. From the results of the simulation, we can see that the roughness attenuation of the trapezoid waveguides are more serious than ellipse waveguides. This result fits in with a large sized fabricated defect on the waveguide, which may be caused by dust during lithography process. At last, we have designed a regular sidewall's roughness which can be approached to a nearby waveguide width. We have showed the result of the simulation to fit our ideal waveguide.

In Chapter 3, we have demonstrated the possibility of writing optical waveguides by means of a Pico-second Nd:YVO_4 laser. An analysis of the characteristics of the waveguides written with different pulse energies, depths, and translation speeds is presented, and an optimum set of writing parameters is evidenced. Lower power or higher speed will cause waveguide roughness to be obvious.

In Chapter 4, we presented the fabrication of rib waveguide based on SOI through the Laser Direct-Writing Technique. Comparing the short-pulses laser direct-writing technique with the waveguide device to the long-pulse laser, the short-pulses laser doesn't need too much power. The sidewall of the waveguide, short-pulses laser machining, has a well defined boundary and the ditch width can be shortened to less than ten micrometers. Not like the long-pulse laser that caused a serious consequence of debris, the short-pulses laser machining have clear waveguide surface. By comparing the sidewall's roughness of laser machining with straight waveguide and the waveguide has a 60 degree angle to the left. We find that the sidewall's roughness is quite different in those two parts of the waveguide. From the straight waveguide before turning, the sidewall's roughness is about 4μm. After a turn of 75 degree angle to the left, we will find that the sidewall's roughness will reduce to hundredths of a nanometer. The different lattice structure is the important factor to cause this result.

In this thesis, we are the first group to try to fabricat the optical waveguide based on SOI by laser direct-writing technique. Although the few deviations presented in our designed optical SOI waveguide devices, the characteristics of such SOI waveguide devices still show promising results for applying photonic integrated devices in the future optical systems applications.