WaveguidesThe Investigations of Material Characteriztions and Device Fabrication for Planar Optical

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ABSTRACT

This thesis studied the effect of deposition parameters on the properties of silica films that used as the layer materials for planar optical waveguides and the effect of fabrication process on the performance of planar optical waveguide devices. Plasma- enhanced chemical vapor deposition (PECVD) system and gas mixture of N2O and SiH4 were used to deposit the silica films. It was observed that N2O/SiH4 flow ratio, RF power and gas atmosphere had profound effects on the refractive index, a very important parameter for planar optical waveguides. The silica film obtained under the He atmosphere revealed good material properties, since a more stable deposition plasma prevented the occurrence of gaseous reaction and reduced the particles. The intrinsic stresses of silica films after annealing were found to be more stable than those without annealing. On the other hand, silica films cracked due to excessive stress (> 5x1010 dynes/cm2) for very thick films after annealing. Doping of boron (B) can be used to reduce the thermal stress (1.5x109 dynes/cm2) and to avoid the problems of film cracks. An unexpected phenomenum was that refractive index was higher for larger B2H6 flow rate. The addition of boron might resulted in the deficiency of oxygen atoms such that N-O radicals were bonded in silica films, and this brought about the increase of refractive index. It can be proved from the FTIR Spectrum Measurement. Besides, two additional bonds, Si-O-B (910cm-1) and N-O (1368cm-1) were observed in boron-doped silica films. Si-H, O-H, N-H, and N-O bonds were found to have the tendency of reduction or disappearance after annealing. The reduction of O-H and N-H bonds could reduce the optical waveguide loss and the reduction of N-O bonds prevented the lowerance of refractive index for boron-doped silica films. It seems that annealing was an inevitable process to satisfy the design specifications of planar optical waveguide.

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