Abstract

This work involves optimization and characterization of low pressure chemical vapour deposition (LPCVD) of silicon nitride and silicon oxynitride layers. The optimized parameters of this deposition were used in fabricating the guiding layer of an optical Mach-Zehnder interferometer which was used as a transducer for a waveguide based sensor used to detect chemical gases such as ammonia. In this sensor a titanium heater with aluminium contacts was integrated near to the reference arm in order to increase the sensitivity of the sensor by using the thermo-optical effect. A chemo-optical sensitive material to ammonia (its refractive index changes with changing the amount of ammonia that diffuses into it from the ambient air) was spin coated on a sensing window in the sensing arm.

The work in this thesis is split into three main areas of study. The first is designing a monomode silicon oxynitride waveguide using the imaginary distance beam propagation method (ID-BPM), also a design of waveguide parameters which increase the sensitivity, designing the Mach-Zehnder interferometer and the heater. The masks for the whole structure were designed using the Cadence program.

In the second area, LPCVD of silicon nitride and silicon oxynitride films were optimized by the adjustment of the deposition temperature and the gases flow rate. The homogeneity of the deposited layers, the deposition rate and the thickness variations along the wafers and the boats were discussed.

In the third area, the detailed fabrication procedures of the sensor are discussed including several important standard processes such as the thermal oxidation of the silicon substrate, the low pressure chemical vapour deposition (LPCVD), the photolithography for mask transfer, the reactive ion etching for a ridge waveguide formation, the metal evaporation and wet etching. Also the characterizations of the sensor were carried out. The waveguide was analyzed to make sure that the sensor is working as expected. The heater also was tested to see how much dissipated power the resistor can withstand during its heating, the heating effect on its resistance and the heating effect on the transmission intensity were checked too. Finally, the refractive index change in the sensitive layer during exposure to ammonia was measured. Also the sensor response, the response time and sensitivity of the sensor were discussed.