

Contents

INTRODUCTION	1
1 PROCESSING OF WAVEGUIDE SENSORS.....	3
1.1 Silicon technology	3
1.2 Low pressure chemical vapor deposition (LPCVD).....	3
1.3 Silicon nitride (Si_3N_4)	5
1.4 Silicon oxynitride (SiON).....	6
1.5 Optical waveguides.....	7
1.5.1 Light coupling into waveguides.....	13
1.5.2 Optical losses	15
1.6 Chemical sensors	16
1.6.1 Background.....	16
1.6.2 Historical Perspective of chemical sensors.....	19
1.6.3 Applications of chemical sensors	25
1.7 Optical waveguide based chemical sensors	27
1.7.1 Refractive chemical sensors.....	28
1.8 Ammonia sensors.....	33
2 THEORETICAL CONSIDERATIONS.....	35
2.1 Introduction.....	35
2.2 Waveguide design.....	36
2.3 Design of Mach–Zehnder interferometer (MZI)	50
2.4 The heater design	55
3 DEPOSITION OF SILICON NITRIDE AND SILICON OXYNITRIDE BY LPCVD.....	59
3.1 Introduction.....	59
3.2 Description of LPCVD process	59
3.3 Measuring of layer thickness and refractive index by ellipsometer	63
3.4 Preparation of the silicon wafers	64
3.5 Deposition process	64
3.5.1 Silicon nitride (Si_3N_4) deposition	64

3.5.1.1 Deposition of Si ₃ N ₄ at 740 °C	65
3.5.1.2 Deposition of Si ₃ N ₄ at 760 °C	66
3.5.1.3 Deposition of Si ₃ N ₄ at 780 °C	67
3.5.1.4 Temperature optimization	68
3.5.2 Silicon oxynitride (SiON) deposition.....	76
4 SILICON OXYNITRIDE WAVEGUIDE BASED AMMONIA SENSOR	81
4.1 Introduction	81
4.2 Sensor fabrication.....	81
4.2.1 MZI waveguide fabrication.....	81
4.2.2 Heater fabrication.....	91
4.2.3 Sensitive layer fabrication.....	93
4.3 Experimental results.....	95
4.3.1 Waveguide characterization	95
4.3.2 Light modulation	97
4.3.3 Ammonia sensing.....	100
5 CONCLUSIONS	107
ABBREVIATIONS	111
REFERENCES.....	113
LIST OF FIGURES	117
LIST OF TABLES	121