

CONTENTS

Abstract

Acknowledgement

CHAPTER 1. Introduction 1

CHAPTER 2. Review of Thin Film Silicon Nitride 4

2.1 Introduction	4
2.2 Preparation Techniques for Silicon Nitride	5
2.21 Chemical Vapour Deposition (CVD)	6
2.22 Glow Discharge Deposition	6
2.23 Reactive Ion-Beam Sputtering	8
2.24 Nitrogen Implantation	9
2.3 Reaction Mechanism In Glow Discharge Deposition	10
2.4 Glow Discharge System Design	17
2.5 Properties of Glow Discharge Silicon Nitride	26
2.51 Chemical Bondings	27
2.52 Film Composition	29
2.53 Optical Properties	33
References	35

CHAPTER 3. Material Preparation and Characterisation 42

3.1 Introduction	42
3.2 The Plasma Glow Discharge System	43
3.21 Vacuum Deposition Chamber	43
3.22 Vacuum Pumping System	47
3.23 Gas Feeding System	49
3.24 Detoxification System	49
3.25 Electrical Circuitry	51
3.3 Preparation Condition	51
3.4 The Substrate	53

3.5 Operation of the PGD System	54
3.51 Pre-deposition Procedure	54
3.52 Deposition Procedure	55
3.53 Post-deposition Procedure	56
3.54 Vacuum Chamber Cleaning	56
3.6 Material Characterization	57
3.61 Ultra-violet/Visible (UV/Vis) Spectroscopy	57
3.62 Fourier Transformed Infra-red (FTIR) Spectroscopy	57
References	58
CHAPTER 4. Experimental Results and Analysis	<u>59</u>
4.1 Introduction	59
4.2 Film Preparation Condition	60
4.3 UV-Visible Spectroscopy	63
4.4 Optical Constants Determination	67
4.5 Computed Values of Optical Constants	73
4.51 Effect of NH_3 to SiH_4 Flowrate Ratio	73
4.511 Static refractive index	73
4.512 Optical energy gap	76
4.513 Average deposition rate	76
4.52 Effect of Substrate Temperature	81
4.521 Static refractive index	81
4.522 Optical energy gap	81
4.523 Average deposition rate	81
4.6 FTIR Spectroscopy	87
4.61 Effect of NH_3 to SiH_4 Flowrate Ratio	87
4.62 Effect of Substrate Temperature	94
4.7 Analytical Techniques on FTIR Spectra	97
4.71 Decomposition of the Overlapping Bands	97
4.72 Determination of the Film Atomic Concentration	102
4.8 IR Vibrational Mode Quantitative Composition	105

4.81 Si-H and N-H stretching bands	105
4.811 Effect of NH ₃ to SiH ₄ Flowrate Ratio	105
4.812 Effect of Substrate Temperature	106
4.82 Components of the overlapping bands	115
4.821 Effect of NH ₃ to SiH ₄ Flowrate Ratio	116
4.822 Effect of Substrate Temperature	123
References	146
CHAPTER 5. Discussion	<u>150</u>
5.1 Dependence on NH ₃ to SiH ₄ Flowrate Ratio	153
5.11 Bonds in the As-deposited Films	153
5.12 Properties of the As-deposited Films	169
5.2 Dependence on Substrate Temperature	176
5.21 Bonds in the As-deposited Films.	179
5.22 Properties of the As-deposited Films.	189
References	197
CHAPTER 6. Conclusions	<u>201</u>
Appendix 1. Refractive Index Determination	206
Appendix 2. Error Analysis	212