

CONTENTS

| | Page |
|---|------------|
| Chinese Abstract | I |
| English Abstract | III |
| Acknowledgements | V |
| Contents | VI |
| List of Figures | IX |
| Chapter 1 | |
| Introduction | |
| 1.1 Silicon based optoelectric device | 1 |
| 1.2 Background of nanocrystallite Si | 3 |
| 1.3 Motivation of Si nanocrystal based light-emitting-diode (LED) | 6 |
| 1.4 Organization of dissertation | 7 |
| References | 9 |
| Chapter 2 | |
| Optical and electrical characteristics of a metal-oxide-semiconductor diode on SiO₂/Si by multi-recipe Si-ion-implantation | |
| 2.1 Introduction | 12 |
| 2.2 Material fabrication of Si-ion-implanted SiO₂ | 14 |
| 2.3 Experimental setup | 14 |
| 2.4 Optical properties of the furnace-annealed Si-ion-implanted SiO₂ | 16 |
| 2.5 Electrical properties of the furnace-annealed Si-ion-implanted SiO₂ | 22 |
| 2.6 Conclusion | 26 |
| References | 28 |
| Figures | 31 |
| Chapter 3 | |
| Optical and electrical characteristics of a plasma enhanced chemical vapor deposition (PECVD) grown metal-oxide-semiconductor diode with buried Si nanocrystal | |
| 3.1 Introduction | 39 |
| 3.2 PECVD-grown Si-rich SiO₂ film deposited at a high-plasma power, different fluence ratios and | 40 |

| | |
|---|----|
| substrate temperatures | |
| 3.2.1 Sample preparation and experimental setup | 40 |
| Current-voltage measurement | |
| 3.2.2 Effect of N ₂ O/SiH ₄ ratio on density of nc-Si in PECVD-grown Si-rich SiO _x film | 41 |
| 3.2.3 Effect of substrate temperature on density of excess Si atoms and nc-S | 43 |
| 3.2.4 Effect of annealing time on size and PL lifetime of nc-Si | 44 |
| 3.2.5 Conclusion | 46 |
| 3.3 Deposition temperature dependent electrical characteristics of low-plasma-power PECVD deposited electroluminescent silicon-rich silicon oxide film | 47 |
| 3.3.1 Sample preparation and experimental setup | 47 |
| 3.3.2 Effect of N ₂ O/SiH ₄ ratio on density of nc-Si in PECVD-grown SiO _x film | 48 |
| 3.3.3 Effect of substrate temperature on density of nc-Si | 51 |
| 3.3.4 Conclusion | 57 |
| 3.4 Carrier transport mechanism of MOS diode | 58 |
| 3.4.1 Direct tunneling | 58 |
| 3.4.2 Fowler Nordheim tunneling | 59 |
| 3.4.3 Thermionic emission tunneling | 60 |
| 3.4.4 Poole-Frenkel tunneling | 60 |
| 3.5 Localized CO ₂ laser annealing induced dehydrogenation/ablation and optical refinement of silicon-rich silicon dioxide film with embedded Si nanocrystals | 61 |
| 3.5.1 Introduction | 61 |
| 3.5.2 Sample preparation and experimental setup | 62 |
| 3.5.3 Optical properties and structural diagnosis of CO ₂ laser-annealed PECVD grown Si-rich SiO ₂ | 64 |
| 3.5.4 Photoluminescence and transmission spectra diagnosis of CO ₂ laser-annealed PECVD grown Si-rich SiO ₂ | 67 |
| 3.5.5 Electrical properties of CO ₂ laser-annealed PECVD grown Si-rich SiO ₂ | 72 |
| 3.6 Conclusion | 76 |
| References | 78 |

| | |
|---|------------|
| Figures | 84 |
| Chapter 4 | |
| Electrical and optical improvement of Si nanocrystal based LED | |
| 4.1 Si nanocrystal based LED with Si nano-pyramid | 104 |
| 4.1.1 Introduction | 104 |
| 4.1.2 Sample preparation and experimental setup | 105 |
| 4.1.3 Fowler-Nordheim Tunneling Enhanced Light Emission | 105 |
| 4.1.4 Performances of the Interfacial Si Pyramid based Si Nanocrystal MOSLED | 107 |
| 4.1.5 Conclusion | 111 |
| 4.2 Si nanocrystal based LED with Si nano-pillar | 112 |
| 4.2.1 Introduction | 112 |
| 4.2.2 Sample preparation and experimental setup | 113 |
| 4.2.3 Precipitation of Ni nano-dots | 114 |
| 4.2.4 μ-PL of Si nano-pillar | 115 |
| 4.2.5 Optical property of the Si nanocrystal based LED with Si nano-pillar | 117 |
| 4.2.6 Fowler-Nordheim tunneling enhanced light emission Si nanocrystal based LED with Si nano-pillar | 119 |
| 4.2.7 Surface roughen enhanced external quantum efficiency | 120 |
| 4.3 Conclusion | 121 |
| References | 124 |
| Figures | 128 |
| Chapter 5 | |
| Conclusion | |
| 5.1 Summary | 138 |
| | |
| Curriculum Vitae | |
| Publication list | |