

國立交通大學

材料科學與工程研究所

碩士論文

在矽基板上製造鍺 p-i-n 以及砷化鎵金屬-半導體-金屬光偵測器



The Fabrication of Ge p-i-n and GaAs M-S-M Photodetectors
on Si Substrate

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中華民國九十四年八月

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A Thesis

Submitted to Department of Materials Science and Engineering

College of Engineering

National Chiao Tung University

In Partial Fulfillment of the Requirements

For the Degree of

Master in Engineering

2005

Hsinchu, Taiwan, Republic of China

中華民國九十四年八月

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摘要

近幾年來，由於光纖通訊市場之需求，操作在 1300nm 到 1550nm 波段 (近紅外光)之光偵測器有很廣泛的應用價值，同時，將光與電元件整合在同一基板上是非常熱門的研究。

在本論文中，矽鍺緩衝層被拿來當作差排介面阻擋層以成長高品質的鍺以及砷化鎵薄膜在矽基板上並在薄膜成長之後對薄膜做材料分析，最後我們成功地在矽基板上製作了鍺 p-i-n 以及砷化鎵金屬-半導體-金屬光偵測器同時並量測其光電性質。

對鍺p-i-n光偵測器而言，在-1 伏以及-3 伏特時其暗電流分別為 2.6×10^{-6} A [0.1625 A/cm²] 以及 4.85×10^{-6} (安培) [0.303 A/cm²]，同時其響應度為 0.107 A/W 以及 0.565 A/W 在 1310nm 波段。

而對砷化鎵金屬-半導體-金屬光偵測器而言，在-1 伏以及-3 伏特時其暗電流分別為 6.92×10^{-9} A [1.081×10^{-4} A/cm²] 以及 2.01×10^{-8} A [3.14×10^{-3} A/cm²]，同時其響應度為 0.0217 A/W 以及 0.0401 A/W 在 850nm 波段。經過與純砷化鎵金屬-半導體-金屬光偵測器比較，可發現兩者有幾乎相同之響應度但砷化鎵金屬-半導體-金屬光偵測器有比純砷化鎵金屬-半導體-金屬光偵測器有較大一點之暗電流，這暗示在矽基板上砷化鎵薄膜之品質和純砷化鎵差不多。

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ABSTRACT

In recent years, the demand for photodetector operating at wavelength, of 1300 nm and 1550 nm (near infrared light) is growing rapidly, due to the need for optical fiber communication systems. Also, the integration of the optical and electrical devices on a chip is very of great interest.

In this thesis, the SiGe buffer layer was used to serve as the interface blocking layer and the high quality Ge and GaAs layers were grown on Si substrate. After epitaxial growth, Ge and GaAs films were analyzed. Finally the Ge p-i-n and the GaAs metal-semiconductor-metal (M-S-M) photodetectors was successful fabricated on Si substrate and the performance was measured.

For the fabricated Ge p-i-n photodetector, the dark currents were 2.6×10^{-6} A [0.1625 A/cm²] and 4.85×10^{-6} A [0.303 A/cm²] and the responsivities were 0.107 A/W and 0.565 A/W respectively when biased under -1V and -3V at 1310 nm wavelength.

For GaAs M-S-M photodetector on Si substrate, the dark currents were 6.92×10^{-9} A [1.081×10^{-4} A/cm²] and 2.01×10^{-8} A [3.14×10^{-3} A/cm²] and the responsivities were 0.0217 A/W and 0.0401 A/W respectively when biased at -1V and -3V at 850 nm wavelength. After comparing the

results with the pure GaAs photodetector, it was found that the responsivities of the two structures were almost the same but the dark current of the GaAs/Ge/SiGe/Si structure MSM photodetector was only a little larger than the pure GaAs structure MSM photodetector. It implies that the quality of the GaAs film on Si substrate is almost the same as the pure GaAs film.



Acknowledgment

致 謝

本篇論文得以順利完成，學生非常感謝指導教授張翼博士。老師兩年來不只在學業上，還有做人處事和一些觀念上給予指導，使我獲益良多。

其次要感謝羅廣禮博士以及楊宗火喜學長在實驗研究上的大力幫忙和指導，以及在日常生活上的關心，實驗才能在兩年之中有個完整的結果，也讓我學到了許多東西，真的非常感謝兩位。

還有，感謝CSD lab., C. Y. Chang group 的伙伴們，張信源、戴忠霖、柯志廷、陳柏舟、許立翰、林勃遠、張家達、黃珍燁、胡吟竹、林良郡、李忠哲、陳俊淇、莊蕙菁、馮立偉以及給過我建議的學長們，林岳欽學長、連亦中學長、謝炎璋學長、黃瑞乾學長、徐金鈺學長、吳偉誠學長、呂宗育學長、涂俊豪學長、陳怡誠學長、陳漢譽學長這些人的幫助使我過了兩年充實又快樂的時光。

特別感謝NDL謝嘉民博士以及張同學協助我量測光電性質，也感謝清大材料所侯承浩同學幫我鍍金屬。

最後，要感謝我的家人，父母親、宜蓓、珮菁不管何時都能夠鼓勵我，讓我能夠無後顧之憂度過這六年的求學生涯，謝謝你們。

Table of Contents

| | |
|---|-----|
| Abstract in Chinese | III |
| Abstract in English..... | IV |
| Acknowledgement..... | VI |
| Table of Contents..... | VII |
| Table Captions..... | X |
| Figure Captions..... | XI |
| | |
| Chapter 1 Introduction | 01 |
| 1-1 Ge/Si Epitaxy on Si Substrate..... | 01 |
| 1-2 GaAs/Ge/Si Epitaxy on Si Substrate..... | 03 |
| 1-3 Photodetector..... | 04 |
| | |
| Chapter 2 Device Physics..... | 09 |
| 2-1 p-n junction | 09 |
| 2-1-1 Build-in Electric Field..... | 09 |
| 2-1-2 Applied Bias..... | 09 |
| 2-2 Mechanism of the Current Transport for p-n Junction | 09 |
| 2-3 The Parameters of Photodetector..... | 11 |
| 2-3-1 Dark Current | 11 |
| 2-3-1-1 Diffusion Current..... | 12 |
| 2-3-1-2 Surface Leakage Current..... | 12 |
| 2-3-1-3 Generation-recombination Current..... | 13 |

| | |
|--|----|
| 2-3-1-4 Tunneling Current..... | 14 |
| 2-3-2 Quantum Efficiency and Responsivity Quantum Efficiency..... | 14 |
| 2-4 Photodetector..... | 18 |
| 2-5 MSM Photodetector..... | 19 |
| | |
| Chapter 3 Experimental Method..... | 25 |
| 3-1 Ge/Si P-I-N Photodetector..... | 25 |
| 3-1-1 Crystal Growth of the SiGe and Ge Epitaxial Layers..... | 25 |
| 3-1-2 Device Fabrication..... | 26 |
| 3-1-2-1 Wafer Cleaning..... | 26 |
| 3-1-2-2 Active Region..... | 26 |
| 3-1-2-3 P Type Implant..... | 27 |
| 3-1-2-4 N Type Implant..... | 27 |
| 3-1-2-5 Metal Deposition..... | 27 |
| 3-2 GaAs/Ge/Si M-S-M Photodetector..... | 28 |
| 3-2-1 Crystal Growth of the GaAs Epitaxial Layers on Si Substrate...28 | |
| 3-2-2 Device Fabrication..... | 29 |
| 3-2-2-1 Wafer cleaning..... | 29 |
| 3-2-2-2 Active region..... | 29 |
| 3-2-2-3 Metal deposition..... | 30 |
| | |
| Chapter 4 Results and Discussion..... | 34 |
| 4-1 Material Analysis..... | 34 |
| 4-1-1 TEM Analysis..... | 34 |
| 4-1-2 XRD Analysis..... | 35 |
| 4-1-3 AFM Analysis..... | 36 |

| | |
|--|--------|
| 4-2 Photodetector Characteristics..... | 37 |
| 4-2-1 Ge/SiGe/Si p-i-n Structure Photodetector..... | 37 |
| 4-2-1-1 Dark Current..... | 37 |
| 4-2-1-2 Photo Current and Dark Current..... | 38 |
| 4-2-1-3 Responsivity..... | 39 |
| 4-2-2 GaAs/Ge/SiGe/Si M-S-M Structure Photodetector..... | 39 |
| 4-2-2-1 Dark Current..... | 39 |
| 4-2-2-2 Photo Current and Dark Current..... | 40 |
| 4-2-2-3 Responsivity..... | 40 |
| Chapter 5 Conclusion..... | 59 |
| References..... | 61 |



Table Captions

Table 2-1 Bandgap energies (in eV) at 300°K for representative photodiode materials.....21



Figure Captions

| | |
|---|----|
| Figure 1-1 The block diagram of a representative optical digital receiver | 08 |
| Figure 1-2 The loss vs. wavelength curve for the optical fiber..... | 08 |
| Figure 2-1 The diagram of a p-n junction under bias..... | 20 |
| Figure 2-2 Photons incident on a reverse biased p-n junction region with indicated photons absorbed by various mechanisms in this diagram..... | 21 |
| Figure 2-3 The optical intensity as a function of distance from the surface of a photodiode..... | 22 |
| Fig. 2-4 The absorption coefficient vs. wavelength for a few semiconductor materials..... | 22 |
| Figure 2-5 The general quantum efficiency vs. wavelength curve for semiconductor materials..... | 23 |
| Figure 2-6 The p-i-n photodetector structure..... | 23 |
| Figure 2-7 The schematic illustration of an MSM diode..... | 24 |
| Figure 2-8 The band diagram of the MSM photodiode with an applied bias V | 24 |
| Figure 3-1 The schematic cross-section of the Ge / SiGe buffer layer/ Si epitaxy hetero-structures..... | 31 |
| Figure 3-2 The fabrication procedures of (a) the Ge p-i-n photo-detector on Si substrate (b) the GaAs M-S-M photo-detector on Si substrate..... | 32 |
| Figure 4-1 Cross-sectional TEM image of the Ge/SiGe/Si epitaxial | |

| | |
|---|----|
| structure..... | 41 |
| Figure 4-2 The plan-view TEM image of the top Ge image of the Ge/SiGe/Si epitaxy structure..... | 42 |
| Figure 4-3 Cross-sectional TEM image of the GaAs layer grown on the Ge/ SiGe buffer structure..... | 43 |
| Figure 4-4 The DCXD analysis of the Ge/SiGe/Si epitaxy structure... | 44 |
| Figure 4-5 The DCXD analysis of the GaAs/Ge/SiGe/Si epitaxy structure..... | 45 |
| Figure 4-6 The AFM images of the surfaces of the Ge/SiGe/Si sample..... | 46 |
| Figure 4-7 The AFM images of the surfaces of the GaAs/Ge/SiGe/Si sample..... | 47 |
| Figure 4-8 The optical microscope (OM) image of the pin1 sample... | 48 |
| Figure 4-9 The optical microscope (OM) image of the pin2 sample... | 49 |
| Figure 4-10 The AFM images of the surfaces of the pin2 sample..... | 50 |
| Figure 4-11 The dark current vs. reverse bias characteristics of the pin1 and pin2 samples..... | 51 |
| Figure 4-12 The photo current and dark current vs. reverse bias characteristics of the Ge/SiGe/Si pin1 sample at 1064 nm and 1310 nm..... | 52 |
| Figure 4-13 The responsivity vs. reverse bias characteristics of the Ge/SiGe/Si pin1 sample at 1064 nm and 1310 nm..... | 53 |
| Figure 4-14 The optical microscope (OM) image of the GaAs/Ge/SiGe/Si structure MSM photodetector..... | 54 |
| Figure 4-15 The optical microscope (OM) image of the pure GaAs structure MSM photodetector..... | 55 |

Figure 4-16 The dark current vs. reverse bias characteristics of the GaAs/Ge/SiGe/Si structure and pure GaAs structure MSM photodetectors.....56

Figure 4-17 The photo current and dark current vs. reverse bias characteristics of the GaAs/Ge/SiGe/Si structure and pure GaAs structure MSM photodetectors at 850 nm.....57

Figure 4-18 The responsivity vs. reverse bias characteristics of the GaAs/Ge/SiGe/Si structure and pure GaAs structure MSM photodetectors at 850 nm.....58

