Table of Contents

Acknowledgment ............................................................... i

Abstract of the Thesis .......................................................... ii - iii

   English Version ............................................................ ii - iii

   Malay Version .............................................................. iv - v

Chapter 1  Introduction ....................................................... 1

   1.1  Introduction .......................................................... 1

Chapter 2  Background Theory and Literature Review ..................... 5

   2.1  Introduction .......................................................... 5

   2.2  Metal-Oxide-Semiconductor (MOS) Device ......................... 5

      2.2.1  MOS Structure ................................................. 5

      2.2.2  Energy Band Profile of MOS Junction ..................... 6

      2.2.3  MOS Characteristics ....................................... 12

         2.2.3-1  Threshold Voltage .................................... 12

         2.2.3-2  Capacitance-Voltage (C-V) ........................... 14

         2.2.3-3  Non-Ideal MOS Structure ............................ 17

   2.3  Field-Effect Transistor (FET) .................................. 24

      2.3.1  Metal-Oxide-Semiconductor Field-Effect Transistor (MOSFET) 26

         2.3.1-1  MOSFET Structure .................................... 26

         2.3.1-2  Energy Band Profile and Principle of Operation .... 27

         2.3.1-3  Current-Voltage Characteristic ..................... 29
2.3.1-4 Types of MOSFET 32

2.3.2 Junction Field-Effect Transistor (JFET) 34

2.3.2-1 JFET Structure 34

2.3.2-2 Band Energy Profile and Principle of Operation 37

2.3.2-3 Current-Voltage Characteristics 40

2.4 Power Semiconductor Devices 43

2.4.1 Thyristor 44

2.4.2 Power Bipolar Junction Transistor (BJT) 46

2.4.3 Power MOSFET 48

2.4.3-1 Structure 48

2.4.3-2 Principle of Operation 52

2.4.3-3 Current-Voltage Characteristics 55

2.4.4 Importance and Applications of Power Semiconductor Devices 56

2.4.4-1 Comparison of "Controllable Switches Group" 56

2.4.4-2 Power Semiconductor Device Capability 57

2.4.4-3 Applications of Device 58

Chapter 3 High Frequency Characterization of the n-Channel Enhancement Mode Power MOSFET Device 61

3.1 Introduction 61

3.2 Power MOSFET Device Structure 62

3.3 Experimental Set-up for Device Characterization 65

3.4 Test Fixture Design 67
3.5 Capacitance-Voltage and Conductance-Voltage Measurement Techniques

3.6 Capacitance-Voltage and Conductance-Voltage Measurement at Elevated Temperatures

3.7 Annealing Process

3.7.1 Calibration of Furnace

3.7.2 Annealing Process

Chapter 4

High Frequency Capacitance-Voltage Measurements On The n-Channel Enhancement Mode Power Device: Results and Analysis

4.1 Introduction

4.2 High Frequency Capacitance-Voltage Characteristics of Device

4.2.1 Measurements across Gate-Source Structure

4.2.2 Measurements across Gate-Drain Structure

4.2.3 Measurement across Source-Drain Structure

4.3 High Frequency Capacitance-Voltage Measurement Results at Different Measurement Temperatures across Gate-Source Structure

4.4 High Frequency Capacitance-Voltage Characteristics of Device: Effects of Annealing on Device

4.5 High Frequency Capacitance-Voltage Measurement Results of Device Annealed at 400°C at Different Measurement Temperatures

Chapter 5

High Frequency Conductance-Voltage Measurements On The n-Channel Enhancement Mode Power Device: Results and Analysis

5.1 Introduction

5.2 High Frequency Conductance-Voltage Characteristics of Device

5.2.1 Measurement across Gate-Source Structure
5.2.2 Measurement across Gate-Drain Structure 110
5.2.3 Measurement across Source-Drain Structure 112
5.3 High Frequency Conductance-Voltage Measurement Results at Different Measurement Temperatures across Gate-Source Structure 115
5.4 High Frequency Conductance-Voltage Characteristics of Device: Effects of Annealing on Device 121
5.5 High Frequency Conductance-Voltage Measurement Results of Device Annealed at 400°C at Different Measurement Temperatures 123

Chapter 6 Conclusion and Suggestion for Further Works 129
6.1 Conclusion 129
6.2 Suggestion for Further Works 132

Appendix A References 134
Appendix B Error Analysis 138