Table of Contents

Chapter 1 Introduction 1
  1.1 Introduction 1
  1.2 References 5

Chapter 2 Review on Hydrogenated Amorphous Silicon 8
  2.1 Introduction 8
  2.2 Deposition Conditions 9
    2.2.1 Thermal Evaporation 9
    2.2.2 Sputtering 10
    2.2.3 Chemical Vapour Deposition 10
    2.2.4 Plasma Glow Discharge Technique 13
  2.3 Structural Properties of a-Si:H 16
    2.3.1 Theoretical Structural Modelling 17
    2.3.2 Experimental Probes 17
    2.3.3 Infra-red Spectroscopy 18
    2.3.4 Defects in Pure a-Si:H 24
    2.3.5 Vacancies 28
  2.4 Transport Properties of a-Si:H 29
    2.4.1 The Cohen-Fritzsche-Ovshinsky Model 30
    2.4.2 The Davis-Mott Model 32
    2.4.3 Direct-Current Electrical Conductivity 33
  2.6 Optical Properties of a-Si:H 37
    2.6.1 Dispersion Energy and Valence Electrons 41
  2.7 The Role of Hydrogen in a-Si:H 43
  2.8 Conclusion 45
  2.9 References 46

Chapter 3 Film Preparation 52
  3.1 Introduction 52
  3.2 The direct-current (dc) Glow Discharge System 53
    3.2.1 The Reaction Chamber 53
3.2.2 The Pumping System 59
3.2.3 The Gas Distribution System 59
3.2.4 The Detoxification System 63
3.2.5 The Electrical System 63
3.3 Deposition of a-Si:H by dc Glow Discharge 65
  3.3.1 Leak Testing Operation 65
  3.3.2 Deposition Procedure 67
  3.3.3 Post Deposition Operation 68
3.4 Deposition Parameters 68
3.5 Annealing 68
3.6 References 69

Chapter 4 Measurement and Calculation Techniques 70
  4.1 Introduction 70
  4.2 Chemical Bonding Analysis 71
  4.3 Electrical Characterization 73
    4.3.1 Direct-Current Conductivity Measurements 73
  4.4 Optical Characterization 79
    4.4.1 The Tolansky Technique 80
    4.4.2 Brewster Reflection Technique 80
    4.4.3 Ellipsometry 82
    4.4.4 Optical Transmission Spectroscopy 88
  4.5 Conclusion 93
  4.6 References 94

Chapter 5 Experimental Results 95
  5.1 Introduction 95
  5.2 Preparation Conditions of a-Si:H thin Film Samples 96
  5.3 Fourier Transform Infra-red Spectroscopy 99
    5.3.1 As-prepared a-Si:H thin Film Samples 99
    5.3.2 Annealed a-Si:H samples 108
  5.4 Visible Optical Spectroscopy 127
    5.4.1 As-prepared a-Si:H 128
    5.4.2 Annealed a-Si:H thin Film 131
5.5 Electrical Characterization for Direct-Current
   5.5.1 Current-Voltage for As-prepared a-Si:H 139
   5.5.2 Current versus Inverse Temperature of As-Prepared 141
       a-Si:H 144
   5.5.3 Current-Voltage Characteristic for Annealed a-Si:H 147
   5.5.4 Current versus Inverse Temperature of Annealed 150
       a-Si:H
5.6 Conclusion 153
5.7 References 153

Chapter 6 Analytical Technique and Hydrogen Content 156
6.1 Introduction 156
6.2 Effects of Deposition Parameters 158
   6.2.1 Chemical Bonding Structures 158
   6.2.2 Optical Energy Gap 162
   6.2.3 Conductivity, Activation Energies and Density of 164
       States at the Fermi Level
6.3 Analytical Technique of Hydrogen Content in a-Si:H 167
   6.3.1 Chemical Bonding Infra-red Model 169
   6.3.2 Optical Valence Electron Model 170
   6.3.3 Analysis of Hydrogen Content Results 176
6.4 Effects of Annealing 177
   6.4.1 Chemical Bonding Structure 177
   6.4.2 The Optical Energy Gap 180
   6.4.3 Direct-Current Conductivity, Activation Energies and 183
       Density of States at the Fermi Level
   6.4.4 Hydrogen Content 186
6.5 References 191

Chapter 7 Discussion 195
7.1 Introduction 195
7.2 Review of Growth Mechanism of a-Si:H Film 196
7.3 Hydrogen Diffusion and Evolution Mechanism in Annealed 199
    a-Si:H
7.4 Growth Mechanism Model of a-Si:H Films 203
7.5 Hydrogen Content: Comparison between the Chemical Bonding Infra-red Model and Valence Electron Model  

7.6 References  

Chapter 8  Conclusion and Proposal for Future Work  

Appendix A