# CONTENTS

<table>
<thead>
<tr>
<th>Section</th>
<th>Page</th>
</tr>
</thead>
<tbody>
<tr>
<td>Preface</td>
<td>1-11</td>
</tr>
<tr>
<td>Chapter 1: Basic Physics of Amorphous Silicon</td>
<td>1-9</td>
</tr>
<tr>
<td>References</td>
<td>9</td>
</tr>
<tr>
<td>Chapter 2: Review of Hydrogenated Amorphous and Microcrystalline</td>
<td></td>
</tr>
<tr>
<td>Silicon Thin Films</td>
<td>10-50</td>
</tr>
<tr>
<td>2.1 Hydrogenated amorphous silicon (a-Si:H) films deposition at high growth rates</td>
<td>11</td>
</tr>
<tr>
<td>2.1.1 Introduction</td>
<td>11</td>
</tr>
<tr>
<td>2.1.2 Techniques to attain high deposition rates</td>
<td>11</td>
</tr>
<tr>
<td>2.1.3 Powder formation mechanism in rf glow discharge method</td>
<td>14</td>
</tr>
<tr>
<td>2.2 a-Si:H films deposition by hot wire chemical vapour deposition (HWCVD) technique</td>
<td>16</td>
</tr>
<tr>
<td>2.3 Doping in hydrogenated amorphous silicon (a-Si:H)</td>
<td>19</td>
</tr>
<tr>
<td>2.4 Light induced degradation of a-Si:H films</td>
<td>22</td>
</tr>
<tr>
<td>2.4.1 Conductivity changes</td>
<td>23</td>
</tr>
<tr>
<td>2.4.2 Theoretical models for the explanation of Staebler-Wronski (SW) effect</td>
<td>24</td>
</tr>
<tr>
<td>2.5 Gap states in a-Si:H films</td>
<td>28</td>
</tr>
<tr>
<td>2.6 Hydrogenated microcrystalline silicon (µc-Si:H) thin films</td>
<td>30</td>
</tr>
<tr>
<td>2.6.1 Deposition techniques and growth mechanisms of µc-Si:H</td>
<td>30</td>
</tr>
<tr>
<td>2.6.2 Optoelectronic and structural properties of µc-Si:H</td>
<td>33</td>
</tr>
<tr>
<td>2.6.3 Doping effect in µc-Si:H</td>
<td>36</td>
</tr>
<tr>
<td>References</td>
<td>42</td>
</tr>
</tbody>
</table>
Chapter 3: Film Deposition and Characterization Techniques 51-106

3.1 Thin Film Deposition Techniques 52-72

i) Sputtering 52

ii) Plasma enhanced chemical vapour deposition (PECVD) 57

iii) Chemical vapour deposition (CVD)
   a) Photochemical vapour deposition (Photo-CVD) 64
   b) Microwave chemical vapour deposition (MW-CVD) 65
   c) Electron cyclotron resonance chemical vapour deposition (ECR-CVD) 66
   d) Catalytic chemical vapour deposition (Catalytic-CVD) 66

3.2 Description of the deposition systems used 67-72

   a) Magnetron sputtering system 67
   b) Single chamber glow discharge deposition system 70
   c) Multichamber system 72

3.3 Characterization techniques and principles 73-101

   i) Film thickness measurement 73
   ii) Carrier transport—Conductivity, Thermoelectric Power and Hall measurements 73
   iii) Optical absorption measurements 79
   iv) Fourier-transform infrared (FTIR) vibrational spectroscopy 82
   v) Density of States (DOS) measurements 85
      a) Electron spin resonance (ESR) measurements 85
      b) Quasistatic capacitance-voltage (C-V) measurements 87
   vi) Internal quantum efficiency measurements 90
   vii) X-ray diffraction (XRD) analysis 93
   viii) Raman spectroscopy measurements 94
   ix) Transmission electron microscopy (TEM) measurements 97
   x) Scanning electron microscopy (SEM) measurements 99
  xi) Secondary ions mass spectroscopy (SIMS) measurements 99
  xii) Secondary neutral mass spectroscopy (SNMS) measurements 100

References 102-106
Chapter 4: Study of hydrogenated amorphous silicon films prepared at high growth rates: effects of interelectrode spacing and preheating of source gases

Summary
4.1 Introduction 109
4.2 Experimental 110
4.3 Results 112
4.4 Discussions 130
4.5 Conclusions 135
References 136

Chapter 5: Enhancement of doping efficiency in boron doped a-Si:H films by a novel combination of rf glow discharge technique and hot coil.

Summary
5.1 Introduction 139
5.2 Experimental 140
5.3 Results 142
5.3.1 Effect of pressure 142
5.3.2 Effect of gas phase dopant concentration 147
5.3.3 Effect of hydrogen dilution 147
5.3.4 Effect of coil current/substrate temperature 151
5.4 Discussions 157
5.5 Conclusions 165
References 166
Chapter 6: Influence of chamber pressure on the optoelectronic and structural properties of boron doped hydrogenated microcrystalline silicon films prepared by rf magnetron sputtering

Part A: Films prepared by a conventional rf magnetron sputtering system

Summary
6A.1 Introduction
6A.2 Experimental
6A.3 Results
6A.4 Discussions
6A.5 Conclusions
References

Part B: Films prepared by a simple modification of the rf magnetron sputtering system.

Summary
6B.1 Introduction
6B.2 Results
6B.3 Discussions
6B.4 Conclusion
References

Chapter 7: Study of the active layer in hydrogenated amorphous silicon solar cells using electrical and analytical techniques.

Summary
7.1 Introduction
7.2 Experimental
7.3 Results and Discussions
7.4 Conclusions
References

List of Publications