

Table of Contents

1. Introduction and Motivation	1
2. Theoretical Background.....	7
2.1. Basic concepts of solar cells.....	7
2.1.1. Semiconductor-metal/semiconductor junctions	7
2.1.2. Physical processes in the solar cell junction.....	10
2.1.3. The equivalent circuit for the solar cell.....	12
2.1.4. Basic parameters of a solar cell	14
2.1.5. Parasitic resistances	16
2.2. Cu ₂ O as an earth abundant material for photovoltaics	17
2.2.1. Crystal structure and lattice parameters of Cu ₂ O	17
2.2.2. Phonons and band structure of Cu ₂ O.....	18
2.2.3. Other properties of Cu ₂ O.....	20
2.2.4. Fabrication approaches for Cu ₂ O nanostructures and thin films.....	22
2.2.5. Applications of Cu ₂ O	26
2.2.6. Previous work on electrodeposited Cu ₂ O thin films for PV.....	27
2.3. Aluminum-doped zinc oxide (AZO) as a window layer material	31
3. Experimental Techniques	33
3.1. Electrochemical Deposition (ED).....	33
3.1.1. Basics of Electrodeposition	33
3.1.2. Modes of Electrodeposition.....	38
3.2. Direct Current (DC) Magnetron Sputtering.....	39
3.3. Characterization Techniques	40
3.3.1. Scanning Electron Microscopy (SEM).....	40
3.3.2. Raman Spectroscopy	41
3.3.3. Electron Beam Induced Current (EBIC)	43
3.3.4. Current–Voltage (I–V) Measurement	44
3.3.5. Capacitance –Voltage(C–V) Measurement.....	44
3.3.6. External Quantum Efficiency (EQE) Measurements	46
4. Fabrication and characterization of p-Cu₂O/AZO heterojunctions	47
4.1. Substrates.....	47
4.2. Electrodeposition of Cu ₂ O thin films	47
4.2.1. Potentiostatic and galvanostatic modes of electrodeposition	49
4.2.2. The junction between Au and Cu ₂ O.....	51

4.3. Sputtering of Al doped ZnO (AZO) layer	52
4.4. Optical lithography and wet chemical etching	52
4.5. Effect of electrodeposition modes on the solar cells properties	54
4.5.1. Raman and SEM results	54
4.5.2. I-V results	56
4.5.3. EQE and C-f results	59
4.6. Effect of the deposition time on the film thickness and the solar cells properties	62
4.6.1. SEM and Raman results	63
4.6.2. I-V results	65
4.6.3. Reflectivity results	69
4.6.4. EQE and C-V results	70
5. Illumination time and temperature dependences of the devices	73
5.1. Illumination time dependence of the devices	73
5.2. Temperature dependence of the devices	75
5.2.1. I-V results	75
5.2.2. C-V results	81
6. Flexible p-Cu₂O/ZnO/AZO heterojunction device	83
6.1. Flexible solar cells	83
6.2. Device fabrication	84
6.3. ALD process to insert ZnO thin film as buffer layer	84
6.4. Device characterization	87
7. Summary	95
8. List of References	101
9. Publications and conference contribution	117
Acknowledgement	118
Biography	120