

## Table of Contents

<b>ABSTRACT (ENGLISH)</b> .....	<b>3</b>
<b>RESUMÉ (FRANÇAIS)</b> .....	<b>5</b>
<b>RESUMEN (CASTELLANO)</b> .....	<b>7</b>
<b>RESUM (VALENCIÀ)</b> .....	<b>9</b>
List of Figures.....	13
List of Tables .....	15
<b>Chapter I</b> .....	<b>17</b>
<b>Introduction</b> .....	<b>17</b>
<b>1.1 General Introduction</b> .....	<b>19</b>
<b>1.2 Motivation and objectives</b> .....	<b>20</b>
<b>1.3 Structure of thesis</b> .....	<b>21</b>
<b>Chapter II</b> .....	<b>25</b>
<b>Theoretical Aspects</b> .....	<b>25</b>
<b>2.1 Introduction</b> .....	<b>27</b>
<b>2.2 General information on photovoltaics</b> .....	<b>27</b>
<b>2.2.1 Photovoltaic effect (History)</b> .....	<b>27</b>
<b>2.2.2 Preliminary concept of solar radiation</b> .....	<b>28</b>
<b>2.2.3 Basic principle of photovoltaic conversion</b> .....	<b>29</b>
<b>2.2.4 Characterization of photovoltaic cells</b> .....	<b>33</b>
<b>2.2.5 Electrical modeling of a photovoltaic cell</b> .....	<b>35</b>
<b>2.2.6 Generation / Materials for photovoltaic conversion</b> .....	<b>37</b>
<b>i. First generation</b> .....	<b>37</b>
<b>ii. Second generation</b> .....	<b>37</b>
<b>iii. Third generation</b> .....	<b>38</b>
<b>2.2.7 Importance and benefits of solar photovoltaic energy</b> .....	<b>39</b>
<b>2.2.8 Current research: While respecting the environment, the production of energy can be at low cost?</b> .....	<b>40</b>
<b>2.3 Kesterite Solar Cells</b> .....	<b>41</b>
<b>2.3.1 Crystal structure of CZTS</b> .....	<b>42</b>
<b>2.3.2 Electrical properties</b> .....	<b>44</b>
<b>2.3.3 Optical properties</b> .....	<b>44</b>
<b>2.3.4 Kesterite based cell</b> .....	<b>45</b>
<b>2.4 Techniques of elaboration</b> .....	<b>46</b>
<b>2.4.1 Sputtering</b> .....	<b>47</b>
<b>2.4.2 Pulsed laser deposition (PLD)</b> .....	<b>47</b>

2.4.3	Thermal evaporation .....	48
2.4.4	Spray pyrolysis .....	48
2.4.5	Sol-gel depot .....	49
2.4.6	Spin and Dip coating .....	49
2.4.7	Electrodeposition .....	49
<b>Chapter III .....</b>		<b>53</b>
<b>Elaboration and Characterization Techniques .....</b>		<b>53</b>
3. 1.	Phase development .....	55
3.1.1	Experimental setup used .....	55
3.1.2	Electrodes .....	56
3.1.3	Surface preparation of substrates .....	57
3. 2.	Heat treatments .....	57
3. 3.	Characterization techniques .....	58
3.3.1	X-ray diffraction .....	58
3.3.2	Raman spectroscopy .....	60
3.3.3	Field emission scanning electron microscopy (FESEM) .....	61
3.3.4	Energy dispersive spectroscopy (EDS) .....	63
3.3.5	Atomic force microscope (AFM) .....	63
3.3.6	UV-Visible spectroscopy .....	64
3. 4.	Numerical Analysis .....	65
3.4.1	Basic semiconductor equation .....	66
3.4.2	SCAPS-1D .....	68
i.	SCAPS-1D front end interface .....	69
ii.	SCAPS-1D problem setting .....	70
iii.	Adding layers to structure .....	71
<b>Chapter IV .....</b>		<b>74</b>
<b>Research Activity .....</b>		<b>74</b>
Article 1 .....		76
<b>Effect of complexing agent on the morphology and annealing temperature of CZTS kesterite thin films by electrochemical deposition .....</b>		<b>76</b>
Article 2 .....		92
<b>Back contact effect on electrodeposited CZTS kesterite thin films experimental and numerical investigation .....</b>		<b>92</b>
Article 3 .....		106
<b>Single step electrochemical deposition for the fabrication of CZTS kesterite thin films for solar cells .....</b>		<b>106</b>

<b>Chapter V .....</b>	<b>120</b>
<b>General Discussion .....</b>	<b>120</b>
<b>Chapter VI .....</b>	<b>126</b>
<b>Conclusion.....</b>	<b>126</b>
<b>Annexes .....</b>	<b>130</b>
<b>References .....</b>	<b>132</b>