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Spatially Resolved Characterization in Thin-Film Photovoltaics

 Springer

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Preface

Photovoltaics (PV) is a young scientific discipline and a fast growing energy sector, which is already proving and, even more, promising that it will significantly contribute to a sustainable supply of electricity. No single photovoltaic technology can satisfy all different applications and consumer needs in different environments and installations, ranging from a few milliwatt stand-alone power supplies to multi-megawatt utility-scale power plants. Common to all PV generators, regardless of size or technology, is that they exhibit an active area where imperfections including spatial inhomogeneities can occur and lead to reduced performance.

This book is devoted to the spatial characterization of thin-film solar cells and PV modules. It was designed both as a monograph and as a succinct guide for state-of-the-art spatial characterization techniques and approaches. Amongst the approaches discussed are visual imaging, luminescence imaging and light beam-induced mapping techniques. We have incorporated accompanying simulation tools and highlighted practical examples for using spatial characterization in real thin-film PV devices. The contents are aimed at a readership of undergraduate and postgraduate students and senior researchers in R&D as well as engineers in industry who are newcomers to the spatial characterization of either thin-film solar cells or PV modules. The technical level assumes that the reader has a sound knowledge of semiconductor physics and solar cells. The concepts and approaches presented herein are in line with the opportunities and challenges in spatial characterization of thin-film PV, although not limited solely to them.

In the race for higher conversion efficiency and higher yields at the same or lower cost, spatial characterization proves to be a constituent part for any PV technology, either in laboratories or in production lines of solar cells and modules.

The authors truly hope that this book will provide useful information and hints on spatial characterization, encourage students, engineers and scientists to apply spatial characterization and, last but not least, highlight the importance of spatial characterization in research, development, production and during the operation of large-area electronic devices.

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Contents

1	Introduction	1
1.1	Thin-Film Photovoltaics	1
1.2	Motivation for Spatially Resolved Characterisation	3
	References	4
2	Theoretical Background	5
2.1	Photovoltaic Device Operation and Performance Parameters	5
2.2	Luminescence	10
2.3	Reciprocity Relation	11
	2.3.1 Thermal Equilibrium	11
	2.3.2 Non-equilibrium	13
	2.3.3 Usage and Validity	15
2.4	Summary	15
	References	16
3	Spatially Resolved Characterisation Techniques	19
3.1	Introduction	19
3.2	Optical Imaging	21
3.3	Beam Induced Techniques	22
3.4	Luminescence Imaging	24
	3.4.1 Introduction	24
	3.4.2 Setup	24
	3.4.3 Image Acquisition	29
	3.4.4 Image Interpretation	29
	3.4.5 Image Processing	32
	3.4.6 Towards Absolute Luminescence Evaluation	33
3.5	Thermal Imaging	34
3.6	Summary	35
	References	36

4	SPICE Model and Simulations	41
4.1	Introduction	41
4.2	Model	42
4.2.1	Introduction	42
4.2.2	Microcell	43
4.2.3	Cell	44
4.2.4	Module	44
4.3	Simulations	46
4.3.1	Introduction	46
4.3.2	Technique Specific Simulation Approaches	46
4.4	Modelling and Iterative Simulations	48
4.5	Summary	50
	References	50
5	CdTe Solar Cells	53
5.1	Introduction	53
5.1.1	Device Structure and Fabrication	54
5.1.2	Operation and Measurements	55
5.1.3	CdTe Solar Cell's SPICE Model	55
5.2	Electroluminescence Properties	56
5.2.1	Back Contact Position Dependence	57
5.2.2	Forward Bias Current Dependence	59
5.2.3	Temperature Dependence	60
5.2.4	Extraction of Resistive Parameter Values	62
5.3	Summary	64
	References	64
6	Dye-Sensitised Solar Cells	67
6.1	Introduction	67
6.1.1	Device Structure and Fabrication	68
6.1.2	Operation and Measurements	69
6.2	Conversion Efficiency Inhomogeneities	72
6.2.1	Manufacturing Inhomogeneities	73
6.2.2	Other Inhomogeneities	74
6.2.3	Unknown Inhomogeneities	76
6.2.4	Summary	76
6.3	Ageing	77
6.4	Summary	78
	References	78
7	Module Level Electroluminescence Imaging	81
7.1	Introduction	81
7.1.1	Thin-Film Module Production	82

- 7.2 Examples 83
 - 7.2.1 Crystalline Silicon PV Module 83
 - 7.2.2 CIGS PV Module 85
 - 7.2.3 CdTe PV Module 87
 - 7.2.4 Amorphous Silicon PV Module 89
 - 7.2.5 Micromorph Silicon PV Module 91
 - 7.2.6 Flexible Triple Junction TF Si PV Module 93
- 7.3 Summary 94
- References 95

- 8 Concluding Remarks and Outlook Trends 97**
- References 99

Abbreviations

AM	Air mass
a-Si	Amorphous silicon
CCD	Charge-coupled device
CdTe	Cadmium telluride
CIGS	$\text{Cu}(\text{In}_x\text{Ga}_{1-x})(\text{Se},\text{S})_2$
DSSC	Dye-sensitised solar cell
DUT	Device under test
EL	Electroluminescence
<i>EQE</i>	External quantum efficiency
<i>ERE</i>	External radiative efficiency
<i>H</i>	Irradiation
HOMO	Highest occupied molecular orbital
<i>I-V</i>	Current-voltage
LBIC	Light beam induced current
LUMO	Lowest unoccupied molecular orbital
LWIR	Long wavelength infrared
MC	Monolithic contact
mc-Si	Multicrystalline silicon
$\mu\text{c-Si}$	Microcrystalline silicon
μcell	Micro-cell
MPP	Maximum power point
MWIR	Medium wavelength infrared
NIR	Near-infrared
OC	Open-circuit
OSC	Organic solar cells
PL	Photoluminescence
PV	Photovoltaics, photovoltaic
R&D	Research and development
ROI	Region of interest
SC	Short-circuit
SCR	Space charge region

<i>SNR</i>	Signal-to-noise ratio
STC	Standard test conditions
SWIR	Short wavelength infrared
<i>T</i>	Transmittance
TCO	Transparent conductive oxide
TF	Thin-film
TI	Transmittance imaging
TiO ₂	Titanium dioxide