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Spatially Resolved Characterization in Thin-Film Photovoltaics

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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 miliwatt 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

Abbreviations

AM	Air mass
a-Si	Amorphous silicon
CCD	Charge-coupled device
CdTe	Cadmium telluride
CIGS	$Cu(In_x,Ga_{(1-x)})(Se,S)_2$
DSSC	Dye-sensitised solar cell
DUT	Device under test
EL	Electroluminescence
EQE	External quantum efficiency
ERE	External radiative efficiency
H	Irradiation
HOMO	Highest occupied molecular orbital
I-V	Current-voltage
LBIC	Light beam induced current
LUMO	Lowest unoccupied molecular orbital
LWIR	Long wavelength infrared
MC	Monolithic contact
mc-Si	Multicrystalline silicon
µc-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

SNR	Signal-to-noise ratio
STC	Standard test conditions
SWIR	Short wavelength infrared
T	Transmittance
TCO	Transparent conductive oxide
TF	Thin-film
TI	Transmittance imaging
TiO_2	Titanium dioxide