

Contents

Preface IX

1	Towards a Solar Energy Revolution	1
1.1	Flexible Solar Cells	1
1.2	Why We are Entering the Solar Age	5
1.3	Capturing Solar Light and Transferring Energy Efficiently	9
1.4	Three Waves of Innovation	12
1.5	Solar Design	15
1.6	New Solar Companies	22
	References	29
2	Photovoltaics	31
2.1	How a Solar Cell Works	31
2.2	The Solar Cell: A Current Generator	38
2.3	Efficiency Limits of the Photovoltaic Conversion	41
2.4	Multiple Junction Cells	44
2.5	Solar Cell Applications	46
2.6	Brief History of Modern Photovoltaics	52
	References	53
3	Inorganic Thin Films	55
3.1	Thin Film PV: Technology for the Future	55
3.2	Amorphous Si Thin Films	62
3.3	CIGS Thin Films on Metal Foil	67
3.4	CdTe Thin Films	74
3.5	CIS Thin Films	77
3.6	Environmental and Economic Concerns	80
	References	82

4	Organic Thin Film Solar Cells	85
4.1	Organic Solar Cells	85
4.2	Bulk Heterojunction Solar Cells	88
4.3	Optimization of Organic Solar Cells	90
4.4	Printed Plastic Solar Cells	92
4.5	Brushing Plastic Solar Cells	98
4.6	Power Plastic	101
	References	106
5	Organic-Inorganic Thin Films	107
5.1	Dye Cells: A Versatile Hybrid Technology	107
5.2	DSC Working Principles	111
5.3	A Roadmap for Dye Solar Cells	118
5.4	Building-Integrated PV with Colored Solar Cells	124
5.5	Personalizing Solar Power	126
	References	129
6	Emerging Technologies	133
6.1	The Solar Paradox	133
6.2	Quantum Well Solar Cells	136
6.3	Nanostructured Solar Cells	140
6.4	Graphene Solar Cells	145
6.5	Nanorectennas	147
	References	154
7	Helionomics	157
7.1	Oil Peak Meets Climate Change	157
7.2	Solar Energy, Rewarding People, Rewarding Capital Markets	160
7.3	Zero Emissions, Lean Production	162
7.4	The Solar Energy Market	165
7.5	PV Technology Trend	170
7.6	Grand Solar Plans	173
7.7	A New Manhattan Project?	177
	References	181
	List of Companies	183
	Index	185