

Contents

Acknowledgments — V

Abbreviations list — XI

List of figures — XIII

List of tables — XV

General introduction — 1

Chapter 1

Perovskite-based solar cells — 2

- 1 Introduction — 2
- 2 Perovskites — 2
- 3 Crystal structure of the hybrid perovskite — 2
- 4 Characteristics of perovskites — 3
- 5 Structure of solar cells based on perovskites — 5
 - 5.1 Evolution of the structure of perovskite-based solar cells — 5
 - 5.2 Description of the structure of the perovskite solar cell — 5
 - 5.3 The components of the perovskite solar cell — 6
 - 5.3.1 Absorbers — 6
 - 5.3.2 Electron transporting layer — 9
 - 5.3.3 Hole transporting layer — 11
 - 5.3.4 Metal contacts — 13
 - 5.3.5 Substrates — 13
 - 5.4 Structures of the perovskite solar cells — 14
 - 5.4.1 Inorganic n-type/perovskite/organic p-type — 14
 - 5.4.2 Organic n-type/perovskite/inorganic p-type — 14
 - 5.4.3 Organic n-type/perovskite/organic p-type — 14
 - 5.4.4 Inorganic n-type/perovskite/inorganic p-type — 15
- 6 Operating principle of a perovskite solar cell — 15
- 7 The evolution of the perovskite solar cell efficiency — 15
- 8 Conclusion — 16

Chapter 2

Perovskite solar cell fabrication methods — 17

- 1 Introduction — 17
- 2 One-step spin-coating method — 17
- 3 The hot-casting technique — 18
- 4 The anti-solvent method — 18

5	The two-step spin-coating technique —	19
6	The dual-source vapor deposition technique —	19
7	The sequential dual-source vapor deposition technique —	20
8	The adduct method —	21
9	The vapor-assisted solution process (VASP) —	21
10	Ink-jet printing technique —	22
11	Techniques to improve the performance of perovskite —	23
11.1	Techniques to improve perovskite efficiency —	23
11.2	Techniques for improving the perovskite stability —	24
12	Conclusion —	28

Chapter 3

Perovskite-based tandem solar cells — 29

1	Introduction —	29
2	The definition and principle of tandem solar cells —	29
3	Tandem solar cell configurations —	29
3.1	Four-terminal tandem —	29
3.2	Monolithic tandem solar cell —	31
4	Tandem solar cells containing the perovskite sub-cells —	32
4.1	The perovskite/perovskite tandem solar cells —	32
4.1.1	Structure of the perovskite top cell —	32
4.1.2	Structure of the perovskite bottom cell —	33
4.1.3	Tandem solar cell configuration —	33
4.1.4	Characteristics of tandem solar cells and sub-cells —	34
4.1.5	Other perovskite/perovskite tandem solar cells —	35
4.2	Perovskite/CIGS tandem solar cells —	36
4.2.1	Introduction —	36
4.2.2	The perovskite sub-cell —	36
4.2.3	The CIGS sub-cell —	39
4.2.4	The tandem solar cell —	41
4.2.5	Other perovskite/CIGS tandem solar cells —	43
5	Conclusion —	43

Chapter 4

Perovskite/silicon heterojunction tandem solar cells — 44

1	Introduction —	44
2	The silicon heterojunction solar cell —	44
2.1	Description of the silicon heterojunction solar cell —	44
2.2	Evolution of the performances of silicon heterojunction solar cells —	45
2.3	The configuration of the record silicon heterojunction solar cell —	45

2.4	Fabrication method of the record silicon heterojunction solar cell — 46
3	Principle of the tandem perovskite/silicon heterojunction solar cell — 47
4	Perovskite/silicon heterojunction tandem solar cell — 47
4.1	The tandem solar cell of 18.1% efficiency — 47
4.1.1	The perovskite top cell — 48
4.1.2	The silicon heterojunction bottom cell — 49
4.1.3	Monolithic tandem solar cell — 50
4.2	The tandem solar cell of 21.2% efficiency — 52
4.2.1	The perovskite top cell — 52
4.2.2	Silicon heterojunction bottom cell — 55
4.2.3	The monolithic tandem solar cell — 56
4.3	The tandem solar cell of 23.6% efficiency — 58
4.3.1	The perovskite sub-cell — 58
4.3.2	Silicon heterojunction bottom cell — 61
4.3.3	The monolithic tandem solar cell — 62
4.4	Recent progress in perovskite/silicon tandem solar cells — 62
4.5	Perovskite/silicon monolithic tandem solar cells evolution — 64
5	Means to improve the performances of the tandem solar cells — 65
6	Conclusion — 68

General conclusion — 69

References — 71

Index — 77

