
Contents

Introduction	ix
Chapter 1. Organic Light-Emitting Diodes	1
1.1. Introduction.	1
1.2. Reminders on optics.	2
1.2.1. Photometry and radiometry	2
1.2.2. Colors.	3
1.3. OLED operating principle	6
1.3.1. P–N junction LED	6
1.3.2. OLEDs	15
1.4. OLED applications	35
1.4.1. OLEDs for lighting	36
1.4.2. OLEDs for display	37
1.4.3. OLEDs for automotive equipment	39
1.5. Conclusion	40
Chapter 2. Organic Solar Cells	41
2.1. Introduction.	41
2.2. Solar spectrum	42
2.3. Operating principle	44
2.3.1. Absorption of photons	45
2.3.2. Diffusion of excitons	46
2.3.3. Dissociation of excitons	47
2.3.4. Diffusion of carriers to electrodes	50
2.3.5. Collection of charges.	50
2.3.6. Process optimization for an organic solar cell	50

2.4. Characteristic parameters of solar cells	52
2.4.1. Current–voltage characteristics	52
2.4.2. Photovoltaic parameters of a solar cell	54
2.4.3. Efficiency	57
2.5. Organic materials	59
2.5.1. Electron donor materials.	59
2.5.2. Electron acceptor materials	61
2.6. P3HT:PCBM	63
2.7. Perovskite.	65
2.7.1. Structure of perovskite.	66
2.7.2. Solar cells based on perovskite	67
2.7.3. Conversion efficiency	69
2.7.4. Problems with the use of perovskite solar cells	69
2.8. Solar cells based on organic, hybrid and silicon materials	73
2.9. Strategies to improve the performance of organic and hybrid solar cells.	75
2.9.1. Low bandgap semiconductors	76
2.9.2. Tandem cells.	78
2.10. Conclusion	82
Chapter 3. Organic Transistors.	85
3.1. Introduction.	85
3.2. Operating principle	86
3.2.1. Transistor effect.	87
3.2.2. Field effect.	88
3.3. Principal OFET parameters	95
3.3.1. Charge carrier mobility	96
3.3.2. Contact resistance.	97
3.3.3. Hysteresis	101
3.3.4. Gate-bias stress effects, V_{GS}	102
3.3.5. I_{on}/I_{off} current ratio	102
3.4. Materials	103
3.4.1. Metals used for electrodes.	103
3.4.2. Dielectric materials	104
3.4.3. Active organic materials.	109
3.5. Ambipolar transistors and semiconductors	115
3.5.1. Ambipolar semiconductors	115
3.5.2. Ambipolar transistors	116
3.6. Light-emitting transistors.	118
3.6.1. Ambipolar OLETs with BHJ structure	118
3.6.2. Single-semiconductor ambipolar OLETs.	118
3.6.3. Vertical OLETs	120

3.7. OFET applications	121
3.7.1. RFID tags	121
3.7.2. Sensors	122
3.7.3. Active-matrix displays	123
3.8. Conclusion	124
Chapter 4. The Brabec Triangle	127
4.1. Introduction	127
4.2. Device efficiency	128
4.2.1. OLED efficiency	128
4.2.2. Solar cell efficiency	130
4.2.3. OFET performance	133
4.3. Stability of materials and devices	134
4.3.1. Process of degradation of organic materials and devices	135
4.3.2. Classification of device degradation mechanisms	137
4.3.3. Degradation of OFETs	143
4.3.4. Measuring the lifetime of devices	146
4.4. Organic device production cost and marketing	151
4.4.1. Production of OLEDs	152
4.4.2. Production of OSCs	153
4.4.3. Production of OFETs	155
4.5. Synthesis on Brabec's criteria	156
4.6. Environmental dimension	157
4.6.1. Life-cycle assessment	158
4.6.2. Levelized cost of energy	160
4.6.3. Energy payback time	160
4.6.4. Life cycle of organic solar cells	161
4.6.5. Fate of released pollutants	162
4.6.6. Mass production and environment	165
4.7. Prospects and developments	167
List of Acronyms	173
References	181
Index	197