

Contents

Preface *ix*

Author Biographies *xi*

List of Acronyms and Abbreviations *xiii*

1	Introduction	1
1.1	Different Interfaces in OFETs	1
1.2	Brief Historic Overview of Interface Engineering in OFETs	3
1.3	Scope of the Book	3
2	Interfacial Modification Methods	7
2.1	Noncovalent Modification Methods	7
2.1.1	Charge Insertion Layer at the Electrode Surface	7
2.1.2	Dielectric Surface Passivation Methods	9
2.2	Covalent Modification Methods	12
2.2.1	SAM Modification of Electrodes	12
2.2.2	SAM Modification of Dielectrics	12
2.2.2.1	SAM/SiO ₂ Dielectrics	14
2.2.2.2	SAM/High- <i>k</i> Dielectrics	14
2.2.2.3	Self-Assembled Monolayer Field-Effect Transistors (SAMFETs)	28
2.3	Efforts in Developing New Methods	31
3	Semiconductor/Semiconductor Interface	33
3.1	Influence of Additives on a Material's Nucleation and Morphology	37
3.1.1	Solvent Additives	37
3.1.2	Nucleating Agents	41
3.1.3	Template-Mediated Crystallization	43
3.1.4	Blending with Insulating Polymers	45
3.1.5	Blending with Polymer Elastomer: Nanoconfinement Effect	50
3.2	Enhancing the Performance Through Semiconductor Heterojunctions	55
3.2.1	Planar Bilayer Heterostructures	57
3.2.2	Molecular-Level Heterojunction	61
3.2.3	Supramolecular Arrangement of the Heterojunctions	64

3.3	Integrating Molecular Functionalities into Electrical Circuits	69
3.3.1	Charge-Trapping-Induced Memory Effect	69
3.3.2	Photochromism-Induced Switching Effect	72
4	Semiconductor/Electrode Interface	77
4.1	Work Function Tuning for Better Contact	79
4.1.1	SAM Modification	80
4.1.2	Charge Insertion Layer Modification	84
4.1.3	Polymer-Based Electrodes	89
4.1.4	Carbon Nanomaterial-Based Electrodes	92
4.1.5	Covalent Bond Formation at the Molecular Level	97
4.2	Installing Switching Effects at Semiconductor/Electrode Interface	100
5	Semiconductor/Dielectric Interface	103
5.1	Dielectric Modification to Tune Semiconductor Morphology	105
5.1.1	Dielectric Surface Energy Control	106
5.1.1.1	Modify with SAM	106
5.1.1.2	Surface Modification with Polymers	112
5.1.2	Dielectric Microstructure Design	113
5.1.2.1	Roughness Effect	114
5.1.2.2	Nano-fabrication Created Microstructure	116
5.1.2.3	Self-assembled Morphology of Dielectric	118
5.2	Eliminating Interfacial Traps	120
5.2.1	Dielectric Surface Passivation (Treatment) Methods	121
5.2.1.1	Polymer Encapsulation of Dielectrics	122
5.2.1.2	Gap Dielectrics	124
5.2.2	SAM/SiO ₂ Dielectrics	126
5.2.2.1	Provide Efficient Insulating Barrier Height	127
5.2.2.2	Control Surface Polarity and Carrier Density	128
5.2.3	SAM/High- <i>k</i> Dielectrics	131
5.2.3.1	Fundamentals of SAM-Modified High- <i>k</i> Dielectrics	132
5.2.3.2	SAM/High- <i>k</i> Hybrid Dielectrics for Flexible Substrate	134
5.2.4	Self-assembled Monolayer Field-Effect Transistors (SAMFETs)	137
5.2.4.1	Molecule Design for SAMFETs	137
5.2.4.2	Morphology Control of SAMFET	139
5.3	Integrating New Functionalities	141
5.3.1	Photoresponsive Dielectrics	142
5.3.2	Other External Stimuli-Responsive Dielectrics	144
5.3.2.1	Pressure Sensor	145
5.3.2.2	Thermal Sensor	147
5.3.2.3	Magnetic Sensor	147
5.3.2.4	Multifunctional Sensor	148
5.3.3	Integrating Memory Effect at the Dielectrics	148

6	Semiconductor/Environment Interface	155
6.1	Device Optimization to Improve Sensing Performance	156
6.1.1	Monolayer Functionalization	156
6.1.2	Bilayer Heterojunction Approach	158
6.1.3	Remote Floating Gate	159
6.2	OECT-Based and EGOFET-Based Sensors	160
7	Interfacing Organic Electronics with Biology	165
7.1	Integration of OFETs/OECTs with Nonelectrogenic Cells	166
7.2	Integration of Flexible Bioelectronics with Electrogenic Cells	170
7.3	Light/Cell/Device Interfaces	174
8	Concluding Remarks and Outlook	179
8.1	New Challenges in Molecular Design	179
8.2	High-Quality OSC Films: Self-Assembly Control	180
8.3	High-Performance Scalable Flexible Optoelectronics	180
8.4	Exploration of Novel Structures: Organic/2D Heterostructures and Vertical Structures	181
8.5	Instability: Stability in Aqueous Media and Thermal Stability in Hygienic Applications	181
8.6	Multifunctional Sensor Systems	183
	References	185
	Index	251