

## Contents

### Preface *xi*

<b>1</b>	<b>Introduction</b>	<b>1</b>
	References	1
<b>2</b>	<b>Magneto-switchable Electrodes and Electrochemical Systems</b>	<b>5</b>
2.1	Introduction	5
2.2	Lateral Translocation of Magnetic Micro/nanospecies on Electrodes and Electrode Arrays	5
2.3	Vertical Translocation of Magnetic Micro/Nanospecies to and from Electrode Surfaces	11
2.4	Assembling Conducting Nanowires from Magnetic Nanoparticles in the Presence of External Magnetic Field	24
2.5	Vertical Translocation of Magnetic Hydrophobic Nanoparticles to and from Electrode Surfaces	24
2.6	Repositioning and Reorientation of Magnetic Nanowires on Electrode Surfaces	45
2.7	Integration of Magnetic Nanoparticles into Polymer-Composite Materials	49
2.8	Conclusions and Perspectives	51
2.9	Appendix: Synthesis and Properties of Magnetic Particles and Nanowires	54
	References	62
	Symbols and Abbreviations	69
<b>3</b>	<b>Modified Electrodes and Electrochemical Systems Switchable by Temperature Changes</b>	<b>71</b>
3.1	Introduction	71
3.2	Thermo-sensitive Polymers with Coil-to-Globule Transition	72
3.3	Electrode Surfaces Modified with Thermo-sensitive Polymers for Temperature-controlled Electrochemical and Bioelectrochemical Processes	74
3.4	Electrode Surfaces Modified with Multicomponent Systems Combining Thermo-sensitive Polymers with pH-, Photo- and Potential-Switchable Elements	79
3.4.1	Temperature- and pH-sensitive Modified Electrodes	80

3.4.2	Temperature- and Photo-sensitive Modified Electrodes	83
3.4.3	Temperature-sensitive Modified Electrodes Controlled by Complex Combinations of External Signals	89
3.5	Electrodes Modified with Thermo-switchable Polymer Films Containing Entrapped Metal Nanoparticles – Inverted Temperature-dependent Switching	93
3.6	Conclusions and Perspectives	94
	References	96
	Symbols and Abbreviations	98
<b>4</b>	<b>Modified Electrodes and Electrochemical Systems Switchable by Light Signals</b>	<b>101</b>
4.1	Introduction	101
4.2	Diarylethene-based Photoelectrochemical Switches	103
4.3	Phenoxynaphthacenequinone-based Photoelectrochemical Switches	120
4.4	Azobenzene-based Photoelectrochemical Switches	125
4.5	Spiropyran–merocyanine-based Photoelectrochemical Switches	141
4.6	Conclusions and Perspectives	158
	References	159
	Symbols and Abbreviations	167
<b>5</b>	<b>Modified Electrodes Switchable by Applied Potentials Resulting in Electrochemical Transformations at Functional Interfaces</b>	<b>169</b>
	References	175
	Symbols and Abbreviations	176
<b>6</b>	<b>Electrochemical Systems Switchable by pH Changes</b>	<b>177</b>
6.1	Introduction	177
6.2	Monolayer Modified Electrodes with Electrochemical and Electrocatalytic Activity Controlled by pH Value	178
6.3	Polymer-Brush-Modified Electrodes with Bioelectrocatalytic Activity Controlled by pH Value	179
6.4	pH-Controlled Electrode Interfaces Coupled with <i>in situ</i> Produced pH Changes Generated by Enzyme Reactions	186
6.5	pH-Triggered Disassembly of Biomolecular Complexes on Surfaces Resulting in Electrode Activation	188
6.6	pH-Stimulated Biomolecule Release from Polymer-Brush Modified Electrodes	190
6.7	Conclusions and Perspectives	196
	References	197
	Symbols and Abbreviations	201
<b>7</b>	<b>Coupling of Switchable Electrodes and Electrochemical Processes with Biomolecular Computing Systems</b>	<b>203</b>
7.1	Introduction	203
7.1.1	General Introduction to the Area of Enzyme-based Biocomputing (Logic) Systems	203

7.1.2	General Definitions and Approaches Used in Realization of Enzyme-based Logic Systems	205
7.2	Electrochemical Analysis of Output Signals Generated by Enzyme Logic Systems	206
7.2.1	Chronoamperometric Transduction of Chemical Output Signals Produced by Enzyme-based Logic Systems	207
7.2.2	Potentiometric Transduction of Chemical Output Signals Produced by Enzyme-based Logic Systems	209
7.2.3	pH-Measurements as a Tool for Transduction of Chemical Output Signals Produced by Enzyme-based Logic Systems	209
7.2.4	Indirect Electrochemical Analysis of Output Signals Generated by Enzyme-based Logic Systems Using Electrodes Functionalized with pH-Switchable Polymers	212
7.2.5	Conductivity Measurements as a Tool for Transduction of Chemical Output Signals Produced by Enzyme-based Logic Systems	215
7.2.6	Transduction of Chemical Output Signals Produced by Enzyme-based Logic Systems Using Semiconductor Devices	218
7.3	Summary	220
	References	220
	Symbols and Abbreviations	226
<b>8</b>	<b>Biofuel Cells with Switchable/Tunable Power Output as an Example of Implantable Bioelectronic Devices</b>	<b>229</b>
8.1	General Introduction: Bioelectronics and Implantable Electronics	229
8.2	More Specific Introduction: Harvesting Power from Biological Sources – Implantable Biofuel Cells	231
8.3	Biofuel Cells with Switchable/Tunable Power Output	236
8.3.1	Switchable/Tunable Biofuel Cell Controlled by Electrical Signals	236
8.3.2	Switchable/Tunable Biofuel Cell Controlled by Magnetic Signals	239
8.3.3	Biofuel Cells Controlled by Logically Processed Biochemical Signals	242
8.4	Summary	256
	References	257
	Symbols and Abbreviations	260
<b>9</b>	<b>Signal-triggered Release of Biomolecules from Alginate-modified Electrodes</b>	<b>263</b>
9.1	Introduction – Signal-activated Biomolecular Release Processes	263
9.2	Alginate Polymer Cross-linked with $\text{Fe}^{3+}$ Cations – The Convenient Matrix for Molecular Release Stimulated by Electrochemical Signal	264
9.3	Self-operating Release Systems Based on the Alginate Electrodes Integrated with Biosensing Electrodes	268
9.4	Conclusions and Perspectives	278
	References	279
	Symbols and Abbreviations	282

<b>10</b>	<b>What is Next? Molecular Biology Brings New Ideas</b>	<b>285</b>
10.1	Switchable Enzymes and Their Use in Bioelectrochemical Systems – Motivation and Applications	286
10.2	Electrocatalytic Function of the $\text{Ca}^{2+}$ -Switchable PQQ-GDH-CaM Chimeric Enzyme	287
10.3	Integration of the $\text{Ca}^{2+}$ -Switchable PQQ-GDH-CaM Chimeric Enzyme with a Semiconductor Chip	289
10.4	A $\text{Ca}^{2+}$ -Switchable Biofuel Cell Based on the PQQ-GDH-CaM Chimeric Enzyme	291
10.5	Substance Release System Activated with $\text{Ca}^{2+}$ Cations and Based on the PQQ-GDH-CaM Chimeric Enzyme	292
10.6	Summary	294
	References	294
	Symbols and Abbreviations	296
<b>11</b>	<b>Summary and Outlook: Scaling up the Complexity of Signal-processing Systems and Foreseeing New Applications</b>	<b>297</b>
	References	301
	<b>Index</b>	<b>303</b>