

Contents

Contributors	xi
Preface	xiii
1 Transparent Organic–Inorganic Nanocomposite Coatings	1
<i>Shuxue Zhou and Limin Wu</i>	
1.1 Introduction	1
1.2 Fabrication Strategies	2
1.2.1 Blending Method	2
1.2.2 Sol–Gel Process	10
1.2.3 Intercalation Method	11
1.3 Mechanically Enhanced Nanocomposite Clearcoats	13
1.3.1 Solventborne Polyurethane Nanocomposite Coatings	15
1.3.2 Waterborne Nanocomposite Clearcoats	17
1.3.3 UV-Curable Nanocomposite Coatings	19
1.3.4 Other Mechanically Strong Nanocomposite Coatings	26
1.4 Optical Nanocomposite Coatings	28
1.4.1 Transparent UV-Shielding Nanocomposite Coatings	28
1.4.2 High Refractive Index Nanocomposite Coatings	34
1.4.3 Transparent NIR-Shielding Nanocomposite Coatings	41
1.5 Transparent Barrier Nanocomposite Coatings	45
1.6 Transparent Conducting Nanocomposite Coatings	49
1.7 Other Functional Nanocomposite Coatings	54
1.8 Conclusions and Outlook	57
References	58
2 Superhydrophobic and Superoleophobic Polymeric Surfaces	71
<i>Jie Zhao and W. (Marshall) Ming</i>	
2.1 Introduction	71
2.2 Surface Wettability	72
2.3 Various Approaches to Obtain Super-Repellent Surfaces	74
2.3.1 Template-Replicating Methods	74
2.3.2 Hierarchically Structured Particles	75

2.3.3	LbL Deposition	78
2.3.4	Plasma Treatment	79
2.3.5	Chemical Vapor Deposition	81
2.3.6	Electrospinning	83
2.3.7	Electrochemical Polymerization	85
2.3.8	Other Methods	86
2.4	Applications of Super-Repellent Polymeric Surfaces	86
2.4.1	Self-Cleaning	86
2.4.2	Anti-bioadhesion	87
2.4.3	Anti-Icing	89
2.4.4	Oil–Water Separation	89
2.5	Summary and Outlook	90
	Acknowledgments	90
	References	90
3	Superhydrophilic and Superamphiphilic Coatings	96
	<i>Sandro Oliveira, Ana Stojanovic, and Stefan Seeger</i>	
3.1	Introduction	96
3.2	Basic Concepts of Superhydrophilicity	97
3.3	Naturally Occurring Superhydrophilic and Superamphiphilic Surfaces	100
3.4	Artificial Superhydrophilic Coatings	101
3.4.1	TiO ₂ Coatings	101
3.4.2	SiO ₂ Coatings	103
3.5	Methods for Fabricating Superhydrophilic and Superamphiphilic Surfaces	104
3.5.1	Sol–Gel Method	104
3.5.2	Layer-By-Layer Assembly	105
3.5.3	Electrochemical Methods	106
3.5.4	Electrospinning	106
3.5.5	Etching	107
3.5.6	Plasma Treatment	107
3.5.7	Hydrothermal Method	108
3.5.8	Dip Coating	109
3.5.9	Phase Separation	109
3.5.10	Templating Method	109
3.6	Applications	110
3.6.1	Self-Cleaning	110
3.6.2	Antifogging and Antireflective Coatings	111
3.6.3	Antifouling Properties	114

3.6.4	Enhanced Boiling Heat Transfer	115
3.6.5	Efficient Water Evaporation	118
3.6.6	Switchable and Patterned Wettability Coatings	118
3.6.7	Other Applications	119
3.7	Commercial Coatings	120
3.8	Conclusions and Outlook	122
	References	123
4	Self-Healing Polymeric Coatings	133
	<i>A.C.C. Esteves and S.J. García</i>	
4.1	Introduction	133
4.1.1	Self-Healing Materials	134
4.1.2	Self-Healing Polymeric Coatings	137
4.2	Self-Healing Approaches for Functional Polymeric Coatings	138
4.2.1	Intrinsic Healing	138
4.2.2	Extrinsic Healing	147
4.3	Functionalities Recovery and Possible Applications	149
4.3.1	Surface Properties: Wettability and Anti-(bio)adhesion	149
4.3.2	Barrier and Corrosion Protection	151
4.3.3	Interfacial Bonding between Dissimilar Materials	153
4.4	Concluding Remarks and Challenges	154
	Acknowledgments	155
	References	155
5	Stimuli-Responsive Polymers as Active Layers for Sensors	163
	<i>Sergio Granados-Focil</i>	
5.1	Introduction	163
5.2	Stimuli-Responsive Soft Materials	164
5.2.1	Thermally Responsive Polymers	165
5.2.2	Field-Responsive Polymers	166
5.2.3	Biologically Responsive Polymer Systems	168
5.2.4	Multistimuli-Responsive Materials	172
5.2.5	Stimuli-Responsive Hydrogels	175
5.3	Sensors from Stimuli-Responsive Hydrogel Layers	176
5.3.1	pH Sensors	178
5.3.2	Metal Ion Sensors	179
5.3.3	Humidity Sensors	180
5.3.4	DNA Sensors	181
5.3.5	Glucose Sensors	181

5.4	Ionophore-Based Sensors	182
5.4.1	Ion-Selective Electrodes	182
5.4.2	Chromoionophores	184
5.4.3	Optodes	185
5.4.4	Dynamic Optodes	185
5.5	Challenges and Opportunities	186
	References	187
6	Self-Stratifying Polymers and Coatings	197
	<i>Jamil Baghdachi, H. Perez, and Punthip Talapatcharoenkit</i>	
6.1	Introduction	197
6.2	Basic Concepts of Self-Stratification	200
6.2.1	Evaporation Effect	200
6.2.2	The Surface Tension Gradient	201
6.2.3	The Substrate-Wetting Force	203
6.2.4	Kinetically Controlled Reactions	205
6.3	Conclusions	214
	References	215
7	Surface-Grafted Polymer Coatings: Preparation, Characterization, and Antifouling Behavior	218
	<i>Marc A. Rufin and Melissa A. Grunlan</i>	
7.1	Introduction	218
7.2	Surface-Grafting Methods	219
7.2.1	"Grafting-From" Method	219
7.2.2	"Grafting-To" Method	220
7.3	Behavior of Surface-Grafted Polymers	222
7.3.1	Conformation of Grafted Chains	222
7.3.2	Chain Migration	223
7.4	Characterization Techniques	224
7.4.1	Ellipsometry	224
7.4.2	Contact Angle	224
7.4.3	X-ray Photoelectron Spectroscopy	225
7.4.4	Scanning Probe Microscopies	226
7.5	Antifouling Coatings	227
7.5.1	Surface-Grafted PEG	228
7.5.2	Surface-Grafted Zwitterionic Polymers	229
7.6	Summary	230
	References	230

8	Partially Fluorinated Coatings by Surface-Initiated Ring-Opening Metathesis Polymerization	239
	<i>G. Kane Jennings and Carlos A. Escobar</i>	
8.1	Basic Concepts	239
8.2	Surface Chemistry	241
8.3	Kinetics of Film Growth	242
8.4	Surface Energy of pNBF _n Films	243
8.5	Micromolding SIP	245
8.6	Conclusions and Outlook	247
	Acknowledgments	248
	References	248
9	Fabrication and Application of Structural Color Coatings	250
	<i>Zhehong Shen, Hao Chen, and Limin Wu</i>	
9.1	Introduction	250
9.2	General Methods of Colloidal Assembly	252
9.2.1	Flow-Induced Deposition	252
9.2.2	Field-Induced Deposition	257
9.3	Colloidal Assembly of Soft Polymer Spheres	260
9.4	Uses of Structural Colors	265
9.4.1	Photonic Paper	265
9.4.2	Coloring and Protection of Substrates	267
9.4.3	Color Responses	268
9.4.4	Structural Color Coatings with Lotus Effects and Superhydrophilicity	272
9.4.5	Structural Color as Effect Pigments	273
9.5	Conclusions and Outlook	274
	References	274
10	Antibacterial Polymers and Coatings	280
	<i>Jamil Baghdachi and Qinhua Xu</i>	
10.1	Introduction	280
10.2	Basic Concepts	281
10.2.1	Coatings that Resist Adhesion	282
10.2.2	Coatings that Release Toxins	282
10.3	Polymers and Antimicrobial Coating Binders	283
10.3.1	Polymeric Coatings with QA Groups	283
10.3.2	Polymers with Quaternary Phosphonium Groups	284

10.3.3	Norfloxacin-Containing Polymers	286
10.3.4	Polymeric <i>N</i> -Halamines	288
10.4	Addition of Inorganic Particles	289
10.4.1	Titanium Dioxide	289
10.4.2	Zinc Oxide	290
10.4.3	Silver Compounds	290
10.5	Conclusions and Outlook	292
	References	292
11	Novel Marine Antifouling Coatings: Antifouling Principles and Fabrication Methods	296
	<i>Yunjiao Gu and Shuxue Zhou</i>	
11.1	Introduction	296
11.2	Marine Biofouling	297
11.3	Enzyme-Based Coatings	300
11.4	Fouling Release Coatings	302
11.4.1	Principles of FR Coatings	302
11.4.2	Hybrid Silicone-Based FR Coatings	304
11.4.3	Fluoropolymer-Based FR Coatings	305
11.5	Nonfouling Coatings	305
11.5.1	Principles of NF Coatings	306
11.5.2	PEG-Based NF Coatings	307
11.5.3	Poly(Zwitterionic) NF Coatings	311
11.5.4	Other Hydrophilic NF Materials	313
11.6	Bioinspired Micro-Topographical Surfaces	316
11.6.1	AF Principles of Bioinspired Microtopographical Surfaces	316
11.6.2	Approaches to the Production of AF Coatings with Surface Topographies	320
11.7	Amphiphilic Nanostructured Coatings	322
11.7.1	Principles of Amphiphilic Nanostructured Coatings	323
11.7.2	PEG-Fluoropolymers Amphiphilic Coatings	325
11.7.3	Other Amphiphilic AF Polymers	329
11.7.4	Characterization Techniques	329
11.8	Summary	331
	References	333
	Index	338