

Contents

1	Electrochemical Etching Methods for Producing Porous Silicon.	1
	Abel Santos and Tushar Kumeria	
1.1	Introduction	1
1.2	Basic Concepts	3
1.3	Electrochemical Etching of Silicon	6
1.3.1	Macroporous Silicon	7
1.3.2	Mesoporous and Microporous Silicon	14
1.4	Metal-Assisted Etching of Silicon	17
1.4.1	Pore Formation Mechanism in Metal-Assisted Etching of Porous Silicon	18
1.4.2	Influence of Fabrication Parameters in Metal-Assisted Etching of Porous Silicon.	20
1.4.3	Metal-Assisted Etching of Porous Silicon Combined with Lithographic Methods.	25
1.5	Conclusions	28
	References.	29
2	Methods, Properties and Applications of Porous Silicon	37
	Elisabet Xifré-Pérez, Josep Ferré-Borrull, Josep Pallarés and Lluís F. Marsal	
2.1	Introduction	37
2.2	Fabrication Process and Morphological Structure of Porous Silicon	38
2.2.1	Porous Silicon Formation by Electrochemical Etching	38
2.2.2	Porous Silicon Formation Mechanisms.	39
2.2.3	Current-Voltage Curves	40
2.2.4	Pore Size and Morphology	42
2.2.5	Anodization Parameters	43

2.2.6	Experimental Aspects of Silicon Electrochemical Etching	47
2.2.7	Porous Silicon Structures	49
2.3	Optical Properties of Porous Silicon	53
2.3.1	Photoluminescence	53
2.3.2	Refractive Index	54
2.4	Applications of Porous Silicon	54
2.4.1	Optical Applications	54
2.4.2	Biological Applications	55
2.4.3	Nanoparticles	56
2.4.4	Sensors	57
2.4.5	Templates	57
	References.	58
3	Self-organized Anodic TiO₂ Nanotubes: Functionalities and Applications Due to a Secondary Material.	65
	Jan M. Macak	
3.1	Introduction	66
3.2	TiO ₂ Nanotubes as Functional Supports.	68
3.3	TiO ₂ Nanotube Modifications by a Secondary Material	70
3.3.1	Electrodeposition.	70
3.3.2	Deposition from a Chemical Bath	75
3.3.3	Nanoparticle Deposition from a Colloidal Suspension.	79
3.3.4	Spincoating	81
3.3.5	Atomic Layer Deposition.	83
3.3.6	Sputtering	86
3.3.7	Special Cases of Functionalizations of TiO ₂ Nanotube Layers.	88
3.4	Summary and Outlook.	89
	References.	90
4	Porous Silicon Biosensors Employing Emerging Capture Probes.	93
	Katharina Urmann, Elena Tenenbaum, Johanna-Gabriela Walter and Ester Segal	
4.1	Introduction	93
4.2	Emerging Bioreceptors.	95
4.2.1	Natural Bioreceptors	95
4.2.2	Synthetic Receptors.	98
4.2.3	Today's Use of Bioreceptors and Future Perspectives	101

4.3	Porous Silicon-Based Biosensors	102
4.3.1	Optical Biosensors	104
4.3.2	Electrochemical Biosensors	108
4.4	Conclusions	110
	References	111
5	Biomedical Uses of Porous Silicon	117
	Steven J.P. McInnes and Rachel D. Lowe	
5.1	Introduction	117
5.2	pSi Fabrication and Properties	118
5.2.1	Fabrication Procedures	118
5.2.2	Porous Structure	119
5.2.3	Optical Properties	119
5.2.4	Biocompatibility	120
5.3	pSi Functionalization	120
5.3.1	Surface Passivation	120
5.3.2	Silanisation	121
5.3.3	Hydrosilylation	121
5.3.4	Linking Biomolecules	121
5.3.5	Polymers	122
5.3.6	Dual Functionalization	122
5.4	pSi in Biomedical Applications	124
5.4.1	Biomolecular Detection Platforms	124
5.4.2	pSi Delivery and Tracking Systems	130
5.4.3	Tissue Engineering Scaffolds	141
5.5	Conclusions and Future Trends	146
	References	147
6	Porous Silicon in Drug Delivery Applications	163
	Joakim Riikonen, Wujun Xu and Vesa-Pekka Lehto	
6.1	Introduction	163
6.2	Enhanced Dissolution	165
6.3	Sustained Release	169
6.4	Targeting	173
6.4.1	Passive Targeting	173
6.4.2	Active Targeting	175
6.4.3	Environment-Responsive Nanoparticles	177
6.5	Miscellaneous	178
6.6	Safety Aspects	179
6.7	Future Prospects	180
	References	181

7	Sensing and Biosensing Applications of Nanoporous Anodic Alumina	187
	Tushar Kumeria and Abel Santos	
7.1	Introduction	187
7.2	Optical Sensors Based on NAA	188
7.2.1	Photoluminescence Spectroscopy (PL)	188
7.2.2	Surface Plasmon Resonance (SPR) and Localized Surface Plasmon Resonance (LSPR)	191
7.2.3	Surface-Enhanced Raman Scattering Spectroscopy (SERS)	196
7.2.4	Reflectometric Interference Spectroscopy (RIfS)	198
7.3	NAA Based Electrochemical Sensors	204
7.3.1	Voltammetric and Amperometric NAA Sensors	204
7.3.2	Impedance, Capacitance, Conductance, and Resistance Based NAA Sensors	207
7.4	Miscellaneous NAA Based Sensing Systems	210
7.4.1	Matrix Assisted Laser Desorption/Ionization and Electrospray Ionization	210
7.4.2	Surface Acoustic Wave and Quartz Crystal Microbalance Nanosensors	212
7.5	Conclusions	212
	References	213
8	Chemical and Structural Modifications of Nanoporous Alumina and Its Optical Properties	219
	Agnieszka Brzózka, Anna Brudzisz, Katarzyna Hnida and Grzegorz D. Sulka	
8.1	Introduction	219
8.2	Structural Engineering of AAO	221
8.3	Optical Response of AAO to Light	227
8.3.1	Reflection and Transmission in AAO	227
8.4	Photoluminescence Properties of AAO	233
8.4.1	The Origin of Optical Centers in AAO	233
8.4.2	Factors Affecting PL of AAO	236
8.4.3	Applications of AAO Photoluminescence	249
8.5	Photonic Crystals and Bragg Reflectors	250
8.6	Chemical Modification of AAO	255
8.6.1	Nanowires in AAO	256
8.6.2	Nanoparticles in AAO	263
8.6.3	Xerogels in AAO	267
8.6.4	Metallic and Other Layers Deposited on the AAO Surface	267
8.6.5	Other Guest Molecules and Compounds in AAO	271
	References	272

9	Titania Nanotubes for Solar Cell Applications	289
	Naoum Vaenas, Thomas Stergiopoulos and Polycarpus Falaras	
9.1	Electrochemical Synthesis of the TiO_2 Nanotubes	289
9.1.1	Titanium Dioxide (TiO_2)	289
9.1.2	Brief Review on the Electrochemical Synthesis of the TiO_2 Nanotubes	290
9.1.3	Anodic Oxidation of Titanium	291
9.2	Dye Solar Cell (DSC)	296
9.2.1	Front Side Illuminated DSCs	296
9.2.2	Back Side Illuminated DSCs	299
	References.	302
10	Titania Nanotubes for Local Drug Delivery from Implant Surfaces	307
	Karan Gulati, Masakazu Kogawa, Shaheer Maher, Gerald Atkins, David Findlay and Dusan Losic	
10.1	Introduction	307
10.2	Surface Modification of Conventional Bone Implants	309
10.2.1	Surface Roughness	310
10.2.2	Biological Enhancements	311
10.2.3	Drug Releasing Implants	311
10.2.4	Research Gap: Combining Roughness, Bioactivity and Drug Release	312
10.2.5	Electrochemically Anodised Implant Surfaces	313
10.3	Titania Nanotubes (TNTs)	313
10.3.1	Applications of TNTs	313
10.3.2	Fabrication of TNTs	314
10.3.3	Substrate Choice	315
10.3.4	TNTs' Suitability for LDD Applications	318
10.4	Therapeutic Release from TNT/Ti Implants	318
10.4.1	Modulating Immune Responses.	319
10.4.2	Preventing Bacterial Infection	321
10.4.3	Enhancing Osseointegration	325
10.5	Advanced LDD Systems Using TNTs	328
10.5.1	Controlling Drug Release	328
10.5.2	Triggered Release	334
10.5.3	Multiple Therapies from TNTs	337
10.5.4	TNTs with In-Built Bio-sensing	337
10.6	Additional Investigations for TNT DD.	338
10.6.1	Ex Vivo	338
10.6.2	In Vivo	339

10.7	Alternate Therapies Using TNTs	341
10.7.1	Dental Applications	341
10.7.2	Anti-cancer Therapy	342
10.7.3	Localized Brain Drug Delivery	344
10.8	Challenges with TNT DD	345
10.8.1	Mechanical Stability	345
10.8.2	Toxicity	345
10.9	Conclusion and Future Directions	346
	References	347
Index		357

Electrochemically Engineered Nanoporous Materials
Methods, Properties and Applications

Losic, D.; Santos, A. (Eds.)

2015, XV, 364 p. 144 illus., 50 illus. in color., Hardcover

ISBN: 978-3-319-20345-4