

# Contents

1. Fundamentals of Scanning Electron Microscopy (SEM) . . . . .	1
<i>Weilie Zhou, Robert Apkarian, Zhong Lin Wang, and David Joy</i>	
1. Introduction . . . . .	1
2. Configuration of Scanning Electron Microscopes . . . . .	9
3. Sample Preparation . . . . .	32
4. Summary . . . . .	39
2. Backscattering Detector and EBSD in Nanomaterials Characterization . . . . .	41
<i>Tim Maitland and Scott Sitzman</i>	
1. Introduction . . . . .	41
2. Data Measurement . . . . .	51
3. Data Analysis . . . . .	54
4. Applications . . . . .	61
5. Current Limitations and Future . . . . .	74
6. Conclusion . . . . .	75
3. X-ray Microanalysis in Nanomaterials . . . . .	76
<i>Robert Anderhalt</i>	
1. Introduction . . . . .	76
2. Monte Carlo Modeling of Nanomaterials . . . . .	87
3. Case Studies . . . . .	91
4. Summary . . . . .	100

4.	Low kV Scanning Electron Microscopy . . . . .	101
	<i>M. David Frey</i>	
1.	Introduction . . . . .	101
2.	Electron Generation and Accelerating Voltage . . . . .	103
3.	“Why Use Low kV?” . . . . .	105
4.	Using Low kV . . . . .	112
5.	Conclusion . . . . .	119
5.	E-beam Nanolithography Integrated with Scanning Electron Microscope . . . . .	120
	<i>Joe Nability, Lesely Anglin Campbell, Mo Zhu, and Weilie Zhou</i>	
1.	Introduction . . . . .	120
2.	Materials and Processing Preparation . . . . .	127
3.	Pattern Generation . . . . .	132
4.	Pattern Processing . . . . .	137
5.	Applications . . . . .	143
6.	Summary . . . . .	148
6.	Scanning Transmission Electron Microscopy for Nanostructure Characterization . . . . .	152
	<i>S. J. Pennycook, A. R. Lupini, M. Varela, A. Borisevich, Y. Peng, M. P. Oxley, K. Van Benthem, M. F. Chisholm</i>	
1.	Introduction . . . . .	152
2.	Imaging in the STEM . . . . .	155
3.	Spectroscopic Imaging . . . . .	173
4.	Three-Dimensional Imaging . . . . .	176
5.	Recent Applications to Nanostructure Characterization . . . . .	177
6.	Future Directions . . . . .	188
7.	Introduction to In-Situ Nanomanipulation for Nanomaterials Engineering . . . . .	192
	<i>Rishi Gupta and Richard E. Stallcup, II</i>	
1.	Introduction . . . . .	192
2.	SEM Contamination . . . . .	193
3.	Types of Nanomanipulators . . . . .	197
4.	End Effectors . . . . .	200
5.	Applications of Nanomanipulators . . . . .	205
6.	Summary . . . . .	223

8.	Applications of FIB and DualBeam for Nanofabrication . . . . .	225
	<i>Brandon Van Leer, Lucille A. Giannuzzi, and Paul Anzalone</i>	
1.	Introduction . . . . .	225
2.	Onboard Digital Patterning with the Ion Beam . . . . .	226
3.	FIB Milling or CVD Deposition with Bitmap Files . . . . .	230
4.	Onboard Digital Patterning with the Electron Beam . . . . .	231
5.	Automation for Nanometer Control . . . . .	233
6.	Direct Fabrication of Nanoscale Structures . . . . .	234
7.	Summary . . . . .	234
9.	Nanowires and Carbon Nanotubes . . . . .	237
	<i>Jianye Li and Jie Liu</i>	
1.	Introduction . . . . .	237
2.	III-V Compound Semiconductors Nanowires . . . . .	237
3.	II-VI Compound Semiconductors Nanowires . . . . .	250
4.	Elemental Nanowires . . . . .	260
5.	Carbon Nanotubes . . . . .	267
6.	Conclusions . . . . .	278
10.	Photonic Crystals and Devices . . . . .	281
	<i>Xudong Wang and Zhong Lin Wang</i>	
1.	Introduction . . . . .	281
2.	SEM Imaging of Photonic Crystals . . . . .	289
3.	Fabrication of Photonic Crystals in SEM . . . . .	298
4.	Summary . . . . .	302
11.	Nanoparticles and Colloidal Self-assembly . . . . .	306
	<i>Gabriel Caruntu, Daniela Caruntu, and Charles J. O'Connor</i>	
1.	Introduction . . . . .	306
2.	Metal Nanoparticles . . . . .	307
3.	Mesoporous and Nanoporous Metal Nanostructures . . . . .	322
4.	Nanocrystalline Oxide . . . . .	329
5.	Nanostructured Semiconductor and Thermoelectric Materials . . .	347
6.	Conclusions . . . . .	353

xiv Contents

12.	Nano-building Blocks Fabricated through Templates . . . .	357
	<i>Feng Li and John B. Wiley</i>	
	1. Introduction . . . . .	357
	2. Materials and Methods . . . . .	358
	3. Nano-Building Blocks . . . . .	361
	4. Conclusions . . . . .	380
13.	One-dimensional Wurtzite Semiconducting Nanostructures . . . . .	384
	<i>Pu Xian Gao and Zhong Lin Wang</i>	
	1. Introduction . . . . .	384
	2. Synthesis and Fabrication of 1D Nanostructures . . . . .	384
	3. One-Dimensional Metal Oxide Nanostructures . . . . .	389
	4. Growth Mechanisms . . . . .	414
	5. Summary . . . . .	423
14.	Bio-inspired Nanomaterials . . . . .	427
	<i>Peng Wang, Guobao Wei, Xiaohua Liu, and Peter X. Ma</i>	
	1. Introduction . . . . .	427
	2. Nanofibers . . . . .	429
	3. Nanoparticles . . . . .	444
	4. Surface Modification . . . . .	455
	5. Summary . . . . .	462
15.	Cryo-Temperature Stages in Nanostructural Research . . . . .	467
	<i>Robert P. Apkarian</i>	
	1. Introduction . . . . .	467
	2. Terminology Used in Cryo-HRSEM of Aqueous Systems . . . . .	468
	3. Liquid Water, Ice, and Vitrified Water . . . . .	469
	4. History of Low Temperature SEM . . . . .	472
	5. Instrumentation and Methods . . . . .	473
	Author Index . . . . .	491
	Subject Index . . . . .	513



<http://www.springer.com/978-0-387-33325-0>

Scanning Microscopy for Nanotechnology  
Techniques and Applications

Zhou, W.; Wang, Z.L. (Eds.)

2007, XIV, 522 p. 399 illus., Hardcover

ISBN: 978-0-387-33325-0