

# Contents

## 1 Atomic-Scale Chains: Fabrication and Evaluation Technologies

<i>Zhen-Chao Dong and Hitoshi Nejo</i> .....	1
1.1 Introduction .....	1
1.1.1 Areas Covered in This Chapter .....	2
1.1.2 Fabrication Strategy .....	3
1.2 Adsorption and Tunneling of Atomic-Scale Lines of In and Pb on Si(100) .....	4
1.2.1 Introduction .....	4
1.2.2 Results and Discussion .....	5
1.2.3 Conclusion .....	14
1.3 Atomic-Scale Pb Chains on Si(100) .....	16
1.3.1 Introduction .....	16
1.3.2 Conclusion .....	23
1.4 Indium Ad-dimer Manipulation by a Scanning Tunneling Microscope Tip .....	23
1.4.1 Introduction .....	23
1.4.2 Results and Discussion .....	24
1.5 Conductance Measurements Through a ML of Pb Films on Si(111) .....	29
1.6 Transfer of Au Cusp Clusters on Si(111) $7 \times 7$ Surfaces from a Pure Au Tip of a Scanning Tunneling Microscope .....	33
1.6.1 Introduction .....	33
1.6.2 Transfer of Au Cusp Clusters .....	34
1.7 Submicrometer Transmission Mask Fabrication .....	39
1.7.1 Introduction .....	39
1.7.2 Procedure for Fabrication .....	40
1.7.3 Submicrometer Transmission Mask .....	42
1.8 An UHV Dual-Tip Scanning Tunneling Microscope .....	44
1.8.1 Introduction .....	44
1.8.2 Inertial Stepper Performance .....	45
1.8.3 Single-Tip Scanning Tunneling Microscope Performance ...	45

VIII Contents

1.8.4	STM Performance at Low Temperatures	46
1.8.5	DSTM Performance	46
1.9	Fabrication and Lateral Electronic Transport Measurements of Au Nanowires	47
1.10	Conclusion	55
	References	57

**2 Nanolithography**

	<i>Duncan Rogers</i>	65
2.1	Introduction	65
2.2	Adsorbate Manipulation with Electrons, Photons and Electric Fields	66
2.2.1	Adsorbate Excitation	66
2.2.2	Adsorbate Manipulation with the STM Tip	69
2.3	Methods of Nanolithography	74
2.3.1	Silicon: the Substrate for Nanolithography	74
2.3.2	Hydrogen Passivated Si	78
2.3.3	Template Formation on Hydrogen Passivated Si	80
2.3.4	Adsorption on the Surface Template	83
2.3.5	Adsorbate-Surface Reactions	91
2.4	Conclusion	93
	References	94

**3 Adsorption Behavior of Single Molecules on Surfaces  
Formed by Molecular Assemblies Studied by Scanning  
Tunneling Microscopy**

	<i>C. Wang, Q.D. Zeng, S.B. Lei, Y.L. Yang, D.X. Wu and X.H. Kong</i>	99
3.1	Introduction	99
3.2	Selective Adsorption Behavior of Molecular Surfaces	100
3.2.1	Physisorption of Single Molecules on Molecular Surfaces	101
3.2.2	Hydrogen-Bond Assisted Selective Adsorption	107
3.3	Inclusive Adsorption Behavior of Molecular Surfaces	108
3.3.1	Rigid Supramolecular Networks for Inclusive Adsorptions	112
3.3.2	Flexible Supramolecular Networks	112
3.4	Future Perspectives	119
	References	120

**4 Fabricating Nanostructures via Organic Molecular  
Templates**

	<i>Yunshen Zhou and Bing Wang</i>	123
4.1	Introduction	123
4.2	0-D Nanostructures	124
4.3	1-D Nanostructures	131
4.4	2-D Nanostructures	138

4.5	Summary .....	143
	References .....	143

## 5 Carbon Nanotubes

	<i>Lisa Vaccari, Dimitrios Tasis, Andrea Goldoni and Maurizio Prato</i> ....	151
5.1	Introduction .....	151
5.2	Historical Background .....	151
5.3	Atomic Structure of CNTs .....	152
	5.3.1 Structure and Symmetry of SWCNTs .....	154
	5.3.2 Structure and Symmetry of MWCNTs .....	159
5.4	Electronic Structure of CNTs .....	159
	5.4.1 Electronic Structure of Graphite .....	160
	5.4.2 Electronic Structure of SWCNTs .....	162
	5.4.3 Electronic Structure of MWCNTs .....	166
5.5	Handling of CNTs .....	166
	5.5.1 Purification of CNTs .....	167
	5.5.2 Random Approach .....	170
	5.5.3 Microfluidic Approach and AC-Electrophoresis .....	174
	5.5.4 Self-Assembly of CNTs .....	179
5.6	Applications of Carbon Nanotubes .....	191
	5.6.1 CNT Electronic Devices .....	192
	5.6.2 Chemical Sensors .....	199
	5.6.3 Field Emission .....	203
	5.6.4 CNTs in Microscopy .....	205
	References .....	206

## 6 Calculating Transport Properties of Nanometer-Scale Systems: Nanodevice Applications of Carbon Nanotubes and Organic Molecules

	<i>Amir A. Farajian, Rodion V. Belosludov, Olga V. Pupyshcheva, Hiroshi Mizuseki and Yoshiyuki Kawazoe</i> .....	217
6.1	Introduction .....	217
6.2	Landauer Formalism .....	219
	6.2.1 Landauer Formula: an Overview .....	220
	6.2.2 Derivation of the Landauer Formula for Two- and Four-Probe Measurements .....	222
6.3	Calculation of Transport for Contact–Junction–Contact Systems .....	225
	6.3.1 General Assumptions .....	225
	6.3.2 Closing the Open System: Surface Green Functions .....	226
	6.3.3 Matching at the Junction .....	228
	6.3.4 Determination of the Fermi Energy .....	229
	6.3.5 Conductance and Current .....	230
6.4	The Contact Issue .....	230
	6.4.1 Attachment to Contact as Viewed at Nanoscale .....	231

6.4.2	Contact Modeling Effects on Transport Properties . . . . .	232
6.5	Applications of the Method . . . . .	235
6.5.1	Screening at Carbon Nanotube Junctions . . . . .	236
6.5.2	Transport Through Bent Carbon Nanotubes . . . . .	239
6.5.3	Transport Characteristics of a Polythiophene-Based Nanodevice . . . . .	244
6.6	Conclusions . . . . .	246
	References . . . . .	246
<b>7 Molecular Wires</b>		
	<i>Hitoshi Nejo</i> . . . . .	251
7.1	Introduction . . . . .	251
7.2	1-Dodecanethiol Molecules on Graphite . . . . .	253
7.3	Two-Dimensional Ordering of Octadecanethiol Molecules on Graphite . . . . .	256
7.4	Silver Deposited Octanethiol Self-Assembled Monolayers . . . . .	256
7.5	Linear Chain Polymerization . . . . .	261
7.6	Self-Assembly of Cyanine Fibers on Conducting Substrates . . . . .	261
7.7	Inclusion Complex of Polyaniline Covered by Cyclodextrins for Molecular Devices . . . . .	269
7.8	Manipulation of Insulated Molecular Wire with an Atomic Force Microscope . . . . .	271
7.9	Production of Individual Suspended Single-Walled Carbon Nanotubes . . . . .	272
7.10	Low-Energy Electron Point Source Microscope: As a Tool for Transport Measurements of Free-Standing Nanometer-Scale Objects . . . . .	276
	References . . . . .	278
	<b>Index</b> . . . . .	287



<http://www.springer.com/978-3-540-37577-7>

Nanostructures

Fabrication and Analysis

Nejo, H. (Ed.)

2007, XII, 292 p., Hardcover

ISBN: 978-3-540-37577-7