
Contents – Volume XII

9	Direct Force Measurements of Receptor–Ligand Interactions on Living Cells	
	<i>Robert H. Eibl</i>	1
9.1	Introduction	2
9.2	Procedure	8
9.2.1	Principle of AFM Force Spectroscopy	9
9.2.2	Cell–Cell Interactions	9
9.2.3	Cell–Substrate Measurements	12
9.2.4	Specificity and Blocking Antibodies	14
9.2.5	Activation by SDF-1	17
9.3	Protocols	20
9.3.1	Cantilever Functionalization	20
9.3.2	AFM Measurement on Living Cells	22
9.3.3	Inhibition with Blocking Antibodies, Peptidomimetic Inhibitors or EDTA	25
9.3.4	Activation with Mg^{2+} , Mn^{2+} Ions, Activating Antibodies, Phorbol ester or Chemokines	26
9.3.5	AFM Measurement—Cell Free	26
9.4	Conclusion and Future Developments	27
	References	29
10	Imaging Chemical Groups and Molecular Recognition Sites on Live Cells Using AFM	
	<i>David Alsteens, Vincent Dupres, Etienne Dague, Claire Verbelen, Guillaume André, Grégory Francius, Yves F. Dufrêne</i>	33
10.1	Introduction	33
10.2	Chemical Force Microscopy	34
10.2.1	Methods	34
10.2.2	Probing Hydrophobic Forces	35
10.2.3	Chemical Force Microscopy of Live Cells	38
10.3	Molecular Recognition Imaging	42
10.3.1	Spatially Resolved Force Spectroscopy	43

10.3.2	Immunogold Imaging	45
10.4	Conclusions	47
	References	47
11	Applications of Scanning Near-Field Optical Microscopy in Life Science <i>Pietro Giuseppe Gucciardi</i>	49
11.1	Introduction	50
11.2	Experimental Techniques in Near-Field Optical Microscopy	51
11.2.1	Principles of Near-Field Optical Microscopy	51
11.2.2	Fluorescence Near-Field Optical Microscopy	53
11.2.3	Near-Field Optical Microscopy in Liquid	55
11.2.4	Tip-Enhanced Near-Field Optical Microscopy	57
11.3	Applications of Near-Field Optical Microscopy in Life Science	58
11.3.1	Infrared Imaging of Tobacco Mosaic Virus with Nanoscale Resolution	58
11.3.2	Co-Localization of Malarial and Host Skeletal Proteins in Infected Erythrocytes by Dual-Color Near-Field Fluorescence Microscopy	59
11.3.3	Co-Localization of α -Sarcoglycan and β 1D-Integrin in Human Muscle Cells by Near-Field Fluorescence Microscopy	61
11.3.4	Single Molecule Near-Field Fluorescence Microscopy of Dendritic Cells	62
11.3.5	Chemical Information of Bacterial Surfaces and Detection of DNA Nucleobases by Tip-Enhanced Raman Spectroscopy	64
11.4	Conclusions	65
	References	66
12	Adhesion and Friction Properties of Polymers at Nanoscale: Investigation by AFM <i>Sophie Bistac, Marjorie Schmitt</i>	69
12.1	Introduction	69
12.2	Experimental Part	72
12.3	Nano-Adhesion Investigation	73
12.4	Nano-Friction Investigation	75
12.5	Relation Between Adhesion and Friction at Nanoscale	78
12.6	Comparison with Macroscale Results	79
	References	83
13	Mechanical Characterization of Materials by Micro-Indentation and AFM Scanning <i>Gabriella Bolzon, Massimiliano Bocciarelli, Enzo J. Chiarullo</i>	85
13.1	Introduction	85

13.2	Experimental Techniques	89
13.2.1	Micro-Indentation	89
13.2.2	AFM Scanning	90
13.3	Inverse Analysis for Materials Characterization	94
13.3.1	Simulation of the Test	94
13.3.2	Optimization Procedures	100
13.4	Applications	102
13.4.1	On the Role of Friction	103
13.4.2	Tests Concerning HHM and DP Models	104
13.4.3	Anisotropic Materials	105
13.4.4	Self Stresses	109
13.4.5	Coatings and Layered Systems	110
	References	116
14	Mechanical Properties of Metallic Nanocontacts <i>G. Rubio-Bollinger, J.J. Riquelme, S.Vieira, N. Agrait</i>	121
14.1	Introduction	122
14.2	Experimental Tools	123
14.2.1	The Scanning Tunneling Microscope Supplemented with a Force Sensor	125
14.2.2	The Mechanically Controllable Break-Junction Technique	126
14.3	Electron Transport Through Metallic Nanocontacts	128
14.4	Mechanical Properties of Metallic Nanocontacts	129
14.4.1	Fabrication of Metallic Nanocontacts	129
14.4.2	Elasticity and Fracture of Metallic Nanocontacts	131
14.4.3	The Shape of Metallic Nanocontacts	132
14.4.4	Inelastic Scattering by Phonons in Nanocontacts	134
14.5	Suspended Chains of Single Gold Atoms	135
14.5.1	Fabrication of Chains of Atoms Using Local Probes	136
14.5.2	Mechanical Processes During Formation of Atomic Chains	137
14.5.3	Phonons in Atomic Chains	140
14.6	Metallic Adhesion in Atomic-Sized Tunneling Junctions	144
	References	146
15	Dynamic AFM in Liquids: Viscous Damping and Applications to the Study of Confined Liquids <i>Abdelhamid Maali, Touria Cohen-Bouhacina, Cedric Hurth, Cédric Jai, R. Boisgard, Jean-Pierre Aimé</i>	149
15.1	Introduction	149

15.2	Viscous Hydrodynamic Damping of the Cantilever in a Water Medium	150
15.3	Improving the Acoustic Excitation of the Cantilever-Tip	153
15.4	Theoretical Description of the Motion of an Acoustically Driven Cantilever in Liquid	155
15.5	Atomic Force Microscopy Study of the Molecular Ordering of a Confined Liquid	160
15.6	Conclusion	163
	References	163
16	Microtensile Tests Using In Situ Atomic Force Microscopy <i>Udo Lang, Jurg Dual</i>	165
16.1	Introduction	166
16.2	Literature Review	166
16.2.1	Organic Samples	166
16.2.2	Anorganic Samples	170
16.2.3	Summary	172
16.3	Recent Developments at the Center of Mechanics of ETH Zurich ...	172
16.3.1	Setup	172
16.3.2	Results	176
16.3.3	Outlook	179
16.4	Conclusions	180
	References	180
17	Scanning Tunneling Microscopy of the Si(111)-7×7 Surface and Adsorbed Ge Nanostructures <i>Haiming Guo, Yeliang Wang, Hongjun Gao</i>	183
17.1	Introduction	184
17.2	STM Imaging on Si(111)-7×7: Resolving the Rest Atoms	185
17.2.1	The Familiarity: Si(111)-7×7 Structure and STM	185
17.2.2	The Simultaneous Imaging of the Rest Atoms and Adatoms	187
17.2.3	Voltage-Dependent Imaging of Rest Atoms	188
17.2.4	First-Principles Calculations	191
17.3	Atomic Manipulation on Si(111)-7×7 Surfaces with STM	193
17.3.1	Introduction	193
17.3.2	Fabricating Groove Nanostructures on Si(111)-7×7 Surfaces	193
17.3.3	The Modification Mechanism	195
17.4	Ge Nanostructure Growth on Si(111)-7×7 Surfaces	197
17.4.1	Introduction	197

17.4.2	Experimental Aspects	198
17.4.3	Initial Adsorption of Ge Atoms on the Si(111)-7×7 Surface	198
17.4.4	Temperature Dependence of Formation and Arrangement of Ge Clusters	205
17.4.5	Electronic Structures of Ge Clusters and Evolution of the Hexagonal Superlattice	208
17.4.6	Formation of Ge Islands and Ge–Si Intermixing at High Temperature	212
17.5	Conclusions	216
	References	217
	Subject Index	221

Contents – Volume XI

1	Oscillation Control in Dynamic SPM with Quartz Sensors	
	<i>Johann Jersch, Harald Fuchs</i>	1
1.1	Introduction	1
1.2	Definition and Measurement of Signal Parameters	3
1.3	Connection Between Oscillation Parameters and Tip–Sample Interactions	7
1.4	Oscillation Control for QCR, Technical Realization	8
1.5	Applications of the Oscillation Controllers	12
1.6	Summary	13
	References	14
2	Atomic Force Microscope Cantilevers Used as Sensors for Monitoring Microdrop Evaporation	
	<i>Elmar Bonaccorso, Dmytro S. Golovko, Paolo Bonanno, Roberto Raiteri, Thomas Haschke, Wolfgang Wiechert, Hans-Jürgen Butt</i> ...	17
2.1	Introduction	18
2.2	Background, Materials and Methods	19
2.2.1	Drop in Equilibrium	19
2.2.2	Evaporating Drop	21
2.2.3	Experimental Setup	22
2.3	Evaporation Results on Microdrops	24
2.3.1	Evaporation Curve	24
2.3.2	Force Model	24
2.3.3	Negative Inclination	26
2.3.4	Mass and Inclination	28
2.3.5	Vaporization Heat	30
2.4	Further Applications of Drops on Cantilevers	31
2.4.1	Spring Constant Calibration	31
2.4.2	Contamination Control of Cantilevers	33

2.5	Conclusions	36
	References	36
3	Mechanical Diode-Based Ultrasonic Atomic Force Microscopies	
	<i>M. Teresa Cuberes</i>	39
3.1	Introduction: Acoustic Microscopy in the Near Field	39
3.1.1	Acoustic Microscopy: Possibilities and Limitations	39
3.1.2	Ultrasonic Atomic Force Microscopies	41
3.2	Ultrasonic Force Microscopy: The Mechanical Diode Effect	44
3.2.1	The Mechanical Diode Effect	44
3.2.2	Experimental Implementation of UFM	46
3.2.3	Information from UFM Data	47
3.2.4	Applications of UFM in Nanofabrication	52
3.3	Mechanical Diode Ultrasonic Friction Force Microscopy	54
3.3.1	The Lateral Mechanical Diode Effect	54
3.3.2	Experimental Implementation of MD-UFFM	56
3.3.3	Comparison of MD-UFFM with UFFM and TRmode AFM	56
3.3.4	Information from MD-UFFM Data	58
3.4	Heterodyne Force Microscopy: Beats at Nanocontacts	62
3.4.1	Beats at Nanocontacts	62
3.4.2	Experimental Implementation of HFM	64
3.4.3	Comparison of HFM with UFM	65
3.4.4	Information from HFM: Time Resolution	66
	References	68
4	Contact Atomic Force Microscopy: A Powerful Tool in Adhesion Science	
	<i>Maurice Brogly, Houssein Awada, Olivier Noel</i>	73
4.1	Introduction	73
4.2	Adhesion Science	74
4.2.1	Adhesion and Adhesive Strength	74
4.2.2	Adhesion at a Local Scale	75
4.3	Force vs. Distance Measurements with an AFM	76
4.4	AFM Calibration	77
4.4.1	Selection of Tips	77
4.4.2	Determination of the Spring Constant of the Cantilever	78
4.4.3	Determination of the Tip Radius	78
4.4.4	Nonlinearity of the Quadrant of Photodiodes	79
4.4.5	Scan Rate of the Cantilever	79
4.4.6	Systematic Check	79
4.4.7	Estimation of the Uncertainties Related to the Experimental Pull-Off Force Measurements	79

4.5	Adhesion Forces and Surface Energies	80
4.5.1	Materials	80
4.5.2	Preparation of Oxidized Silica Surface	80
4.5.3	Grafting of Functionalized SAMs on Silicon Wafer	81
4.5.4	Characterization of the SAMs	81
4.5.5	Force-Distance Curves on Rigid Systems Having Controlled Surface Chemistry	82
4.5.6	Influence of Capillary Forces on Adhesion Forces	84
4.6	Adhesion Forces Measurements on Polymers	85
4.6.1	Cross-Linking and Functionalization of PDMS Networks	85
4.6.2	Force-Distance Curves on Soft Polymer Surfaces	86
4.6.3	Real Indentation of the AFM Tip Inside a Soft Polymer	88
4.7	AFM Nano-Indentation Experiments on Polymer Networks	89
4.7.1	Force-Indentation Curves	89
4.7.2	Nano-Indentation and Nano-Adhesion on Soft Polymers Having Controlled Surface Chemistry and Mechanical Properties	91
4.8	Conclusion	94
	References	94

5	Contact Resonance Force Microscopy Techniques for Nanomechanical Measurements <i>Donna C. Hurley</i>	97
5.1	Introduction	99
5.2	Cantilevers for Contact Resonance Force Microscopy	101
5.3	Data Acquisition Techniques	103
5.4	Data Analysis Methods	107
5.4.1	Model for Cantilever Dynamics	107
5.4.2	Model for Contact Mechanics	111
5.5	Survey of Contact Resonance Force Microscopy Measurements . . .	113
5.6	Theoretical Principles for Optimizing Experiments	116
5.6.1	Cantilever Dynamics: Which Modes?	116
5.6.2	Contact Mechanics: What Forces?	119
5.6.3	An Example	121
5.7	Practical Issues for Optimizing Experiments	122
5.7.1	Exciting and Detecting the Cantilever's Resonant Modes	122
5.7.2	Tip Shape and Tip Wear	124
5.8	Imaging with Contact Resonance Force Microscopy	127
5.9	The Road Ahead	132
	References	135

6	AFM Nanoindentation Method: Geometrical Effects of the Indenter Tip	
	<i>Lorenzo Calabri, Nicola Pugno, Sergio Valeri</i>	139
6.1	Introduction	139
6.2	Experimental Configuration	144
6.2.1	FIB Nanofabrication	145
6.2.2	Tip Radius of Curvature Characterization	148
6.2.3	Nanoindentation Experimental Setup	149
6.3	Numerical Model	150
6.4	Theoretical Model: A Shape/Size-Effect Law for Nanoindentation	151
6.5	Deconvolution of the Indentation Impressions	157
6.6	Results	157
6.7	Conclusion	162
	References	163
7	Local Mechanical Properties by Atomic Force Microscopy Nanoindentations	
	<i>Davide Tranchida, Stefano Piccarolo</i>	165
7.1	Introduction	166
7.2	The Scale of AFM Nanoindentations	169
7.3	The Relationship with Microhardness and Analysis of the Unloading Curve	173
7.4	Models to Describe the Force Curves	178
7.5	Final Remarks on Loading History, Adhesion, Roughness Effects	187
7.6	Selected Applications	190
	References	195
8	Thermal Activation Effects in Dynamic Force Spectroscopy and Atomic Friction	
	<i>Mykhaylo Evstigneev</i>	199
8.1	Introduction	200
8.1.1	Determination of Bond Strength of Biological Complexes	201
8.1.2	Atomic Friction	202
8.2	Standard Method of Data Analysis	204
8.2.1	Rate Equation Approach	204
8.2.2	Most Probable Rupture Force	206
8.2.3	DFS Pulling Experiments: Mean Rupture Force	209
8.2.4	Atomic Friction: Average Force in the Stick-Slip Regime	210
8.3	Alternative Method of Data Analysis	213

8.4	Application to DFS Pulling Experiments	216
8.5	Application to Atomic Friction	219
8.6	Conclusions	225
	References	226
	Subject Index	231

Contents – Volume XIII

18	Visualization of Epicuticular Grease on the Covering Wings in the Colorado Potato Beetle: A Scanning Probe Approach	
	<i>D. Voigt, H. Peisker, S. Gorb</i>	1
18.1	Introduction	2
18.1.1	Epicuticular Grease: Introductory Remarks	2
18.1.2	Covering Wings and Mating Behaviour	3
18.2	Methods	4
18.2.1	Insects and Sample Preparation	4
18.2.2	Scanning Probe Microscopy	5
18.2.3	Cryo-SEM	6
18.3	Results	7
18.3.1	Elytra Topography and Grease Visualization	7
18.3.2	Adhesive Properties of the Elytra Surface	9
18.4	Discussion	10
18.5	Conclusions	13
	References	13
19	A Review on the Structure and Mechanical Properties of Mollusk Shells – Perspectives on Synthetic Biomimetic Materials	
	<i>Francois Barthelat, Jee E. Rim, Horacio D. Espinosa*</i>	17
19.1	Introduction	17
19.1.1	Mollusk Shells: Overview	18
19.2	Cross-Laminar Shells: The Pink or Queen Conch (<i>Strombus gigas</i>) . .	19
19.2.1	Structure	19
19.2.2	Mechanisms of Toughening	21
19.3	Nacreous Shells	24
19.3.1	Overview of Nacre	26
19.3.2	Structure	26
19.3.3	The Deformation of Nacre	27

19.3.4	The Fracture of Nacre	32
19.4	Artificial Shell Materials	34
19.4.1	Large-Scale “Model Materials”	34
19.4.2	Ice Templatation	36
19.4.3	Layer-by-Layer Deposition	38
19.4.4	Thin Film Deposition: MEMS-Based Structure	39
19.5	Conclusions	41
	References	41
20	Electro-Oxidative Lithography and Self-Assembly Concepts for Bottom-Up Nanofabrication	
	<i>Stephanie Hoeppener, Ulrich S. Schubert</i>	45
20.1	Introduction	45
20.2	Chemically Active Surface Templates	46
20.2.1	Locally Confined Self-Assembled Monolayers	46
20.2.2	Electrical Structuring Techniques of SAMs	48
20.3	Conclusions	66
	References	67
21	Application of SPM and Related Techniques to the Mechanical Properties of Biotoool Materials	
	<i>Thomas Schöberl, Ingomar L. Jäger, Helga C. Lichtenegger</i>	71
21.1	Introduction	72
21.2	Typical Biotoool Materials	74
21.2.1	Chemistry	74
21.2.2	Structures	76
21.2.3	Mechanical Properties	78
21.3	Experimental Methods and Setups	79
21.3.1	SPM and Indentation	79
21.3.2	Scratch and Wear Tests	81
21.3.3	Dynamic Modes	82
21.3.4	Fracture Toughness Tests	83
21.4	Samples	84
21.4.1	Choice	84
21.4.2	Storage	85
21.4.3	Preparation	86
21.5	Experimental Conditions	87
21.5.1	Moisture	87
21.5.2	Temperature	88
21.5.3	Probe Tips	88

21.5.4	Test Velocity	89
21.6	Results	89
21.6.1	Sources of Error	89
21.6.2	Interpretation	94
21.7	Examples from the Literature	95
References	98

22	Nanomechanics and Microfluidics as a Tool for Unraveling Blood Clotting Disease <i>D.M. Steppich, S. Thalhammer, A. Wixforth, M.F. Schneider</i>	105
22.1	Introduction	105
22.2	Topography	106
22.2.1	Little Story of Blood Clotting	107
22.2.2	High-Resolution Imaging	110
22.3	Lab-on-a-Chip	117
22.3.1	Nanomechanical Diagnostics	118
22.3.2	Mimicking Blood Flow Conditions on a Surface Acoustic Wave-Driven Biochip	120
22.4	The Lab on a Chip – AFM – Hybrid	122
22.4.1	Experimental Setup	122
22.4.2	Bundle Relaxation	124
22.4.3	Stream Line Manipulation and Flow Sensoring	128
22.5	Summary and Outlook	132
References	133

23	Atomic Force Microscopic Study of Piezoelectric Polymers <i>Hyungoo Lee · Ke Wang · Taekwon Jee · Hong Liang</i>	137
23.1	Piezoelectric Materials	137
23.2	Atomic Force Microscopy	138
23.3	Atomic Force Microscope Measurement	139
23.3.1	Sample Materials	141
23.3.2	Surface Image Analysis	141
23.3.3	Surface Force Measurements	143
23.3.4	Nano-Piezoelectricity	146
23.3.5	Conductivity Measurement of PVDF Samples	149
23.3.6	Time-Dependent Study	149
References	152

24	Quantitative Analysis of Surface Morphology and Applications	
	<i>Maria Cecília Salvadori</i>	153
24.1	Introduction	153
24.2	Quantifying Morphology	154
24.3	Applications of Quantitative Morphological Surface Analysis	157
24.3.1	Dynamic Growth of Thin Films	157
24.3.2	Periodicity Analysis of Lines Nanolithographed by AFM in PMMA	161
24.3.3	Electrical Resistivity of Nanostructured Thin Films	167
24.3.4	Morphological and Crystallographic Grain Sizes	173
24.4	Final Remarks	178
	References	178
25	Nanotribological Characterization of Carbonaceous Materials: Study of Diamond Coatings and Graphite	
	<i>Marjorie Schmitt, Sophie Bistac</i>	181
25.1	Introduction	182
25.2	Nanotribology of Carbonaceous Materials: State of the Art	182
25.2.1	Role of the Scanning Velocity	185
25.2.2	Role of the Environment	185
25.2.3	Role of the Contact Load	186
25.2.4	Role of the Chemistry	187
25.2.5	Role of the Chemistry – Bulk Chemistry	187
25.2.6	Role of the Chemistry—Superficial Chemistry	188
25.3	Experimental Details	188
25.3.1	Diamond Coatings: The Flame Process	188
25.3.2	Graphite Pins	189
25.3.3	Atomic Force Microscopy	189
25.3.4	Tribometer for Macroscopic Tests	190
25.3.5	Modification of the Superficial Energy of Silicon Wafers	190
25.4	Nanofriction Results	191
25.4.1	Diamond Coatings (Obtained by Flame Process)	191
25.4.2	Graphite	194
25.5	Conclusions	200
	References	201
26	Atomic Force Microscopy Studies of Aging Mechanisms in Lithium-Ion Batteries	
	<i>Shrikant C. Nagpure, Bharat Bhushan</i>	203
26.1	Introduction	203
26.1.1	Battery Types	206

26.2	Lithium-Ion Batteries	212
26.2.1	Electrochemistry of Lithium-Ion Batteries	212
26.2.2	Different Shapes of Lithium-Ion Batteries	213
26.2.3	Types of Lithium-Ion Batteries	214
26.2.4	Requirements in Modern Lithium-Ion Batteries	217
26.3	Aging of Lithium-Ion Batteries	217
26.3.1	Anode	218
26.3.2	Cathode	224
26.4	Closure	230
	References	231
	Subject Index	235

Contents – Volume I

Part I Scanning Probe Microscopy

1	Dynamic Force Microscopy <i>André Schirmeisen, Boris Anczykowski, Harald Fuchs</i>	3
2	Interfacial Force Microscopy: Selected Applications <i>Jack E. Houston</i>	41
3	Atomic Force Microscopy with Lateral Modulation <i>Volker Scherer, Michael Reinstädler, Walter Arnold</i>	75
4	Sensor Technology for Scanning Probe Microscopy <i>Egbert Oesterschulze, Rainer Kassing</i>	117
5	Tip Characterization for Dimensional Nanometrology <i>John S. Villarrubia</i>	147

Part II Characterization

6	Micro/Nanotribology Studies Using Scanning Probe Microscopy <i>Bharat Bhushan</i>	171
7	Visualization of Polymer Structures with Atomic Force Microscopy <i>Sergei Magonov</i>	207
8	Displacement and Strain Field Measurements from SPM Images <i>Jürgen Keller, Dietmar Vogel, Andreas Schubert, Bernd Michel . . .</i>	253
9	AFM Characterization of Semiconductor Line Edge Roughness <i>Ndubuisi G. Orji, Martha I. Sanchez, Jay Raja, Theodore V. Vorburger</i>	277
10	Mechanical Properties of Self-Assembled Organic Monolayers: Experimental Techniques and Modeling Approaches <i>Redhouane Henda</i>	303

11	Micro-Nano Scale Thermal Imaging Using Scanning Probe Microscopy <i>Li Shi, Arun Majumdar</i>	327
12	The Science of Beauty on a Small Scale. Nanotechnologies Applied to Cosmetic Science <i>Gustavo Luengo, Frédéric Leroy</i>	363

Part III Industrial Applications

13	SPM Manipulation and Modifications and Their Storage Applications <i>Sumio Hosaka</i>	389
14	Super Density Optical Data Storage by Near-Field Optics <i>Jun Tominaga</i>	429
15	Capacitance Storage Using a Ferroelectric Medium and a Scanning Capacitance Microscope (SCM) <i>Ryoichi Yamamoto</i>	439
16	Room-Temperature Single-Electron Devices formed by AFM Nano-Oxidation Process <i>Kazuhiko Matsumoto</i>	459

Contents – Volume II

1	Higher Harmonics in Dynamic Atomic Force Microscopy <i>Robert W. Stark, Martin Stark</i>	1
2	Atomic Force Acoustic Microscopy <i>Ute Rabe</i>	37
3	Scanning Ion Conductance Microscopy <i>Tilman E. Schäffer, Boris Anczykowski, Harald Fuchs</i>	91
4	Spin-Polarized Scanning Tunneling Microscopy <i>Wulf Wulfhekel, Uta Schlickum, Jürgen Kirschner</i>	121
5	Dynamic Force Microscopy and Spectroscopy <i>Ferry Kienberger, Hermann Gruber, Peter Hinterdorfer</i>	143
6	Sensor Technology for Scanning Probe Microscopy and New Applications <i>Egbert Oesterschulze, Leon Abelmann, Arnout van den Bos, Rainer Kassing, Nicole Lawrence, Gunther Wittstock, Christiane Ziegler</i>	165
7	Quantitative Nanomechanical Measurements in Biology <i>Małgorzata Lekka, Andrzej J. Kulik</i>	205
8	Scanning Microdeformation Microscopy: Subsurface Imaging and Measurement of Elastic Constants at Mesoscopic Scale <i>Pascal Vairac, Bernard Cretin</i>	241
9	Electrostatic Force and Force Gradient Microscopy: Principles, Points of Interest and Application to Characterisation of Semiconductor Materials and Devices <i>Paul Girard, Alexander Nikolaevitch Titkov</i>	283
10	Polarization-Modulation Techniques in Near-Field Optical Microscopy for Imaging of Polarization Anisotropy in Photonic Nanostructures <i>Pietro Giuseppe Gucciardi, Ruggero Micheletto, Yoichi Kawakami, Maria Allegrini</i>	321

11	Focused Ion Beam as a Scanning Probe: Methods and Applications	
	<i>Vittoria Raffa, Piero Castrataro, Arianna Menciassi, Paolo Dario .</i>	361

Contents – Volume III

12	Atomic Force Microscopy in Nanomedicine <i>Dessy Nikova, Tobias Lange, Hans Oberleithner, Hermann Schillers, Andreas Ebner, Peter Hinterdorfer</i>	1
13	Scanning Probe Microscopy: From Living Cells to the Subatomic Range <i>Ille C. Gebeshuber, Manfred Drack, Friedrich Aumayr, Hannspeter Winter, Friedrich Franek</i>	27
14	Surface Characterization and Adhesion and Friction Properties of Hydrophobic Leaf Surfaces and Nanopatterned Polymers for Superhydrophobic Surfaces <i>Zachary Burton, Bharat Bhushan</i>	55
15	Probing Macromolecular Dynamics and the Influence of Finite Size Effects <i>Scott Sills, René M. Overney</i>	83
16	Investigation of Organic Supramolecules by Scanning Probe Microscopy in Ultra-High Vacuum <i>Laurent Nony, Enrico Gnecco, Ernst Meyer</i>	131
17	One- and Two-Dimensional Systems: Scanning Tunneling Microscopy and Spectroscopy of Organic and Inorganic Structures <i>Luca Gavioli, Massimo Sancrotti</i>	183
18	Scanning Probe Microscopy Applied to Ferroelectric Materials <i>Oleg Tikhomirov, Massimiliano Labardi, Maria Allegrini</i>	217
19	Morphological and Tribological Characterization of Rough Surfaces by Atomic Force Microscopy <i>Renato Buzio, Ugo Valbusa</i>	261
20	AFM Applications for Contact and Wear Simulation <i>Nikolai K. Myshkin, Mark I. Petrokovets, Alexander V. Kovalev</i>	299
21	AFM Applications for Analysis of Fullerene-Like Nanoparticles <i>Lev Rapoport, Armen Verdyan</i>	327

22	Scanning Probe Methods in the Magnetic Tape Industry	
	<i>James K. Knudsen</i>	343

Contents – Volume IV

23	Scanning Probe Lithography for Chemical, Biological and Engineering Applications <i>Joseph M. Kinsella, Albena Ivanisevic</i>	1
24	Nanotribological Characterization of Human Hair and Skin Using Atomic Force Microscopy (AFM) <i>Bharat Bhushan, Carmen LaTorre</i>	35
25	Nanofabrication with Self-Assembled Monolayers by Scanning Probe Lithography <i>Jayne C. Garno, James D. Batteas</i>	105
26	Fabrication of Nanometer-Scale Structures by Local Oxidation Nanolithography <i>Marta Tello, Fernando García, Ricardo García</i>	137
27	Template Effects of Molecular Assemblies Studied by Scanning Tunneling Microscopy (STM) <i>Chen Wang, Chunli Bai</i>	159
28	Microfabricated Cantilever Array Sensors for (Bio-)Chemical Detection <i>Hans Peter Lang, Martin Hegner, Christoph Gerber</i>	183
29	Nano-Thermomechanics: Fundamentals and Application in Data Storage Devices <i>B. Gotsmann, U. Dürig</i>	215
30	Applications of Heated Atomic Force Microscope Cantilevers <i>Brent A. Nelson, William P. King</i>	251

Contents – Volume V

1	Integrated Cantilevers and Atomic Force Microscopes <i>Sadik Hafizovic, Kay-Uwe Kirstein, Andreas Hierlemann</i>	1
2	Electrostatic Microscanner <i>Yasuhisa Ando</i>	23
3	Low-Noise Methods for Optical Measurements of Cantilever Deflections <i>Tilman E. Schäffer</i>	51
4	Q-controlled Dynamic Force Microscopy in Air and Liquids <i>Hendrik Hölscher, Daniel Ebeling, Udo D. Schwarz</i>	75
5	High-Frequency Dynamic Force Microscopy <i>Hideki Kawakatsu</i>	99
6	Torsional Resonance Microscopy and Its Applications <i>Chanmin Su, Lin Huang, Craig B. Prater, Bharat Bhushan</i>	113
7	Modeling of Tip-Cantilever Dynamics in Atomic Force Microscopy <i>Yaxin Song, Bharat Bhushan</i>	149
8	Combined Scanning Probe Techniques for In-Situ Electrochemical Imaging at a Nanoscale <i>Justyna Wiedemair, Boris Mizaikoff, Christine Kranz</i>	225
9	New AFM Developments to Study Elasticity and Adhesion at the Nanoscale <i>Robert Szoszkiewicz, Elisa Riedo</i>	269
10	Near-Field Raman Spectroscopy and Imaging <i>Pietro Giuseppe Gucciardi, Sebastiano Trusso, Cirino Vasi, Salvatore Patanè, Maria Allegrini</i>	287

Contents – Volume VI

11	Scanning Tunneling Microscopy of Physisorbed Monolayers: From Self-Assembly to Molecular Devices <i>Thomas Müller</i>	1
12	Tunneling Electron Spectroscopy Towards Chemical Analysis of Single Molecules <i>Tadahiro Komeda</i>	31
13	STM Studies on Molecular Assembly at Solid/Liquid Interfaces <i>Ryo Yamada, Kohei Uosaki</i>	65
14	Single-Molecule Studies on Cells and Membranes Using the Atomic Force Microscope <i>Ferry Kienberger, Lilia A. Chtcheglova, Andreas Ebner, Theeraporn Puntheeranurak, Hermann J. Gruber, Peter Hinterdorfer</i>	101
15	Atomic Force Microscopy of DNA Structure and Interactions <i>Neil H. Thomson</i>	127
16	Direct Detection of Ligand–Protein Interaction Using AFM <i>Małgorzata Lekka, Piotr Laidler, Andrzej J. Kulik</i>	165
17	Dynamic Force Microscopy for Molecular-Scale Investigations of Organic Materials in Various Environments <i>Hirofumi Yamada, Kei Kobayashi</i>	205
18	Noncontact Atomic Force Microscopy <i>Yasuhiro Sugawara</i>	247
19	Tip-Enhanced Spectroscopy for Nano Investigation of Molecular Vibrations <i>Norihiko Hayazawa, Yuika Saito</i>	257

20	Investigating Individual Carbon Nanotube/Polymer Interfaces with Scanning Probe Microscopy	
	<i>Asa H. Barber, H. Daniel Wagner, Sidney R. Cohen</i>	<i>287</i>

Contents – Volume VII

21	Lotus Effect: Roughness-Induced Superhydrophobicity <i>Michael Nosonovsky, Bharat Bhushan</i>	1
22	Gecko Feet: Natural Attachment Systems for Smart Adhesion <i>Bharat Bhushan, Robert A. Sayer</i>	41
23	Novel AFM Nanoprobes <i>Horacio D. Espinosa, Nicolaie Moldovan, K.-H. Kim</i>	77
24	Nanoelectromechanical Systems – Experiments and Modeling <i>Horacio D. Espinosa, Changhong Ke</i>	135
25	Application of Atom-resolved Scanning Tunneling Microscopy in Catalysis Research <i>Jeppe Vang Lauritsen, Ronny T. Vang, Flemming Besenbacher . . .</i>	197
26	Nanostructuration and Nanoimaging of Biomolecules for Biosensors <i>Claude Martelet, Nicole Jaffrezic-Renault, Yanxia Hou, Abdelhamid Errachid, François Bessueille</i>	225
27	Applications of Scanning Electrochemical Microscopy (SECM) <i>Gunther Wittstock, Malte Burchardt, Sascha E. Pust</i>	259
28	Nanomechanical Characterization of Structural and Pressure-Sensitive Adhesives <i>Martin Munz, Heinz Sturm</i>	301
29	Development of MOEMS Devices and Their Reliability Issues <i>Bharat Bhushan, Huiwen Liu</i>	349

Contents – Volume VIII

1	Background-Free Apertureless Near-Field Optical Imaging <i>Pietro Giuseppe Gucciardi, Guillaume Bachelier, Stephan J. Stranick, Maria Allegrini</i>	1
2	Critical Dimension Atomic Force Microscopy for Sub-50-nm Microelectronics Technology Nodes <i>Hao-Chih Liu, Gregory A. Dahlen, Jason R. Osborne</i>	31
3	Near Field Probes: From Optical Fibers to Optical Nanoantennas <i>Eugenio Cefali, Salvatore Patanè, Salvatore Spadaro, Renato Gardelli, Matteo Albani, Maria Allegrini</i>	77
4	Carbon Nanotubes as SPM Tips: Mechanical Properties of Nanotube Tips and Imaging <i>Sophie Marsaudon, Charlotte Bernard, Dirk Dietzel, Cattien V. Nguyen, Anne-Marie Bonnot, Jean-Pierre Aimé, Rodolphe Boisgard</i>	137
5	Scanning Probes for the Life Sciences <i>Andrea M. Ho, Horacio D. Espinosa</i>	183
6	Self-Sensing Cantilever Sensor for Bioscience <i>Hayato Sone, Sumio Hosaka</i>	219
7	AFM Sensors in Scanning Electron and Ion Microscopes: Tools for Nanomechanics, Nanoanalytics, and Nanofabrication <i>Vinzenz Friedli, Samuel Hoffmann, Johann Michler, Ivo Utke</i>	247
8	Cantilever Spring-Constant Calibration in Atomic Force Microscopy <i>Peter J. Cumpson, Charles A. Clifford, Jose F. Portoles, James E. Johnstone, Martin Munz</i>	289
9	Frequency Modulation Atomic Force Microscopy in Liquids <i>Suzanne P. Jarvis, John E. Sader, Takeshi Fukuma</i>	315

10	Kelvin Probe Force Microscopy: Recent Advances and Applications <i>Yossi Rosenwaks, Oren Tal, Shimon Saraf, Alex Schwarzman,</i> <i>Eli Lepkifker, Amir Boag</i>	351
11	Application of Scanning Capacitance Microscopy to Analysis at the Nanoscale <i>Štefan Lányi</i>	377
12	Probing Electrical Transport Properties at the Nanoscale by Current-Sensing Atomic Force Microscopy <i>Laura Fumagalli, Ignacio Casuso, Giorgio Ferrari,</i> <i>Gabriel Gomila</i>	421

Contents – Volume IX

13	Ultrathin Fullerene-Based Films via STM and STS <i>Luca Gavioli, Cinzia Cepek</i>	1
14	Quantitative Measurement of Materials Properties with the (Digital) Pulsed Force Mode <i>Alexander M. Gigler, Othmar Marti</i>	23
15	Advances in SPMs for Investigation and Modification of Solid-Supported Monolayers <i>Bruno Pignataro</i>	55
16	Atomic Force Microscopy Studies of the Mechanical Properties of Living Cells <i>Félix Rico, Ewa P. Wojcikiewicz, Vincent T. Moy</i>	89
17	Towards a Nanoscale View of Microbial Surfaces Using the Atomic Force Microscope <i>Claire Verbelen, Guillaume Andre, Xavier Haulot, Yann Gilbert, David Alsteens, Etienne Dague and Yves F. Dufrêne</i>	111
18	Cellular Physiology of Epithelium and Endothelium <i>Christoph Riethmüller, Hans Oberleithner</i>	127
19	Application of Atomic Force Microscopy to the Study of Expressed Molecules in or on a Single Living Cell <i>Hyonchol Kim, Hironori Uehara, Rehana Afrin, Hiroshi Sekiguchi, Hideo Arakawa, Toshiya Osada, Atsushi Ikai</i>	149
20	What Can Atomic Force Microscopy Say About Amyloid Aggregates? <i>Amalisa Relini, Ornella Cavalleri, Claudio Canale, Tiziana Svaldo-Lanero, Ranieri Rolandi, Alessandra Gliozzi</i>	177

21	Atomic Force Microscopy: Interaction Forces Measured in Phospholipid Monolayers, Bilayers and Cell Membranes <i>Zoya Leonenko, David Cramb, Matthias Amrein, Eric Finot</i>	207
22	Self-Assembled Monolayers on Aluminum and Copper Oxide Surfaces: Surface and Interface Characteristics, Nanotribological Properties, and Chemical Stability <i>E. Hoque, J. A. DeRose, B. Bhushan, H. J. Mathieu</i>	235
23	High Sliding Velocity Nanotribological Investigations of Materials for Nanotechnology Applications <i>Nikhil S. Tambe, Bharat Bhushan</i>	283
24	Measurement of the Mechanical Properties of One-Dimensional Polymer Nanostructures by AFM <i>Sung-Kyoung Kim, Haiwon Lee</i>	311
25	Evaluating Tribological Properties of Materials for Total Joint Replacements Using Scanning Probe Microscopy <i>Sriram Sundararajan, Kanaga Karuppiiah Kanaga Subramanian</i>	329
26	Near-Field Optical Spectroscopy of Single Quantum Constituents <i>Toshiharu Saiki</i>	351

Contents – Volume X

27	Gecko Feet: Natural Attachment Systems for Smart Adhesion— Mechanism, Modeling, and Development of Bio-Inspired Materials <i>Bharat Bhushan, Robert A. Sayer</i>	1
28	Carrier Transport in Advanced Semiconductor Materials <i>Filippo Giannazzo, Patrick Fiorenza, Vito Raineri</i>	63
29	Visualization of Fixed Charges Stored in Condensed Matter and Its Application to Memory Technology <i>Yasuo Cho</i>	105
30	Applications of Scanning Probe Methods in Chemical Mechanical Planarization <i>Toshi Kasai, Bharat Bhushan</i>	131
31	Scanning Probe Microscope Application for Single Molecules in a π-Conjugated Polymer Toward Molecular Devices Based on Polymer Chemistry <i>Ken-ichi Shinohara</i>	153
32	Scanning Probe Microscopy on Polymer Solar Cells <i>Joachim Loos, Alexander Alexeev</i>	183
33	Scanning Probe Anodization for Nanopatterning <i>Hiroyuki Sugimura</i>	217
34	Tissue Engineering: Nanoscale Contacts in Cell Adhesion to Substrates <i>Mario D’Acunto, Paolo Giusti, Franco Maria Montevocchi, Gianluca Ciardelli</i>	257
35	Scanning Probe Microscopy in Biological Research <i>Tatsuo Ushiki, Kazushige Kawabata</i>	285
36	Novel Nanoindentation Techniques and Their Applications <i>Jiping Ye</i>	309

37	Applications to Nano-Dispersion Macromolecule Material Evaluation in an Electrophotographic Printer	
	<i>Yasushi Kadota</i>	347
38	Automated AFM as an Industrial Process Metrology Tool for Nanoelectronic Manufacturing	
	<i>Tianming Bao, David Fong, Sean Hand</i>	359



<http://www.springer.com/978-3-540-85038-0>

Applied Scanning Probe Methods XII
Characterization

Bhushan, B.; Fuchs, H. (Eds.)

2009, LV, 224 p., Hardcover

ISBN: 978-3-540-85038-0