
Contents

Preface to <i>Progress in Nano Electro-Optics</i>	v
Preface to Volume VI	vii
List of Contributors	xiii
1 Optical Interaction of Light with Semiconductor Quantum Confined States at the Nanoscale	
<i>T. Saiki</i>	1
1.1 Introduction	1
1.2 Near-Field Scanning Optical Microscope	2
1.2.1 General Description	2
1.2.2 Aperture-NSOM Probe	3
1.3 Spatial Resolution of NSOM Studied by Single Molecule Imaging	5
1.3.1 Single-Molecule Imaging with Aperture Probes	6
1.3.2 Numerical Simulation of NSOM Resolution	8
1.4 Single Quantum Dot Spectroscopy and Imaging	11
1.5 NSOM Spectroscopy of Single Quantum Dots	13
1.5.1 Type II Quantum Dot	13
1.5.2 NSOM Spectroscopy of Single GaSb QDs	13
1.6 Real-Space Mapping of Electron Wavefunction	18
1.6.1 Light–Matter Interaction at the Nanoscale	18
1.6.2 Interface Fluctuation QD	20
1.6.3 Real-Space Mapping of Exciton Wavefunction Confined in a QD	22
1.7 Real-Space Mapping of Local Density of States	25
1.7.1 Field-Induced Quantum Dot	26
1.7.2 Mapping of Local Density of States in a Field Induces QD	28
1.8 Carrier Localization in Cluster States in GaNAs	31

1.8.1 Dilute Nitride Semiconductors	31
1.8.2 Imaging Spectroscopy of Localized and Delocalized States	32
1.9 Perspectives	36
References	37
2 Localized Photon Model Including Phonons' Degrees of Freedom	
K. Kobayashi, Y. Tanaka, T. Kawazoe and M. Ohtsu	41
2.1 Introduction	41
2.2 Quantum Theoretical Approach to Optical Near Fields	42
2.2.1 Localized Photon Model	42
2.2.2 Photodissociation of Molecules and the EPP Model	44
2.3 Localized Phonons	48
2.3.1 Lattice Vibration in a Pseudo One-Dimensional System	48
2.3.2 Quantization of Vibration	50
2.3.3 Vibration Modes: Localized vs. Delocalized	51
2.4 Model	51
2.4.1 Optically Excited Probe System	53
2.4.2 Davydov Transformation	54
2.4.3 Quasiparticle and Coherent State	56
2.4.4 Localization Mechanism	58
Contribution from the Diagonal Part	58
Contribution from the Off-Diagonal Part	61
2.5 Conclusions	64
References	64
3 Visible Laser Desorption/Ionization Mass Spectrometry Using Gold Nanostructure	
L.C. Chen, H. Hori and K. Hiraoka	67
3.1 Introduction	67
3.1.1 Matrix-Assisted Laser Desorption/Ionization Mass Spectrometry ..	67
3.1.2 Laser Desorption/Ionization with Inorganic Matrix and Nanostructure ..	69
3.1.3 Time-of-Flight Mass Spectrometry	69
3.2 Surface Plasmon–Polariton	70
3.2.1 Plasmon-Induced Desorption	72
Desorption of Metallic Ions	72
3.3 Visible Laser Desorption/Ionization on Gold Nanostructure	73
3.3.1 Fabrication of Gold-Coated Porous Silicon	74
3.3.2 Gold Nanorod Arrays	77
Reflectivity of the Gold Nanorods	79
3.4 Experimental Details	80
3.4.1 Time-of-Flight Mass Spectrometer	80
3.4.2 Sample Preparation	82
3.5 Mass Spectra from Gold Nanostructure	83
3.5.1 Mass Spectra from Gold-Coated Porous Silicon	83

3.5.2 Mass Spectra from Gold Nanorods	84
3.5.3 Gold Nanoparticle-Assisted Excitation of UV-absorbing MALDI Matrix by Visible Laser	90
3.6 Discussion and Conclusion	94
References	95

4 Near-Field Optical Photolithography

<i>M. Naya</i>	99
4.1 Introduction	99
4.2 Near-Field Optical Photolithography (NFOL)	100
4.2.1 Principle of NFOL	100
4.2.2 NFOL with Bilayer Resist Process	100
4.3 Experiments	101
4.3.1 Experimental Set-up	101
4.3.2 Patterning Experiment of Monolayer Resist	104
4.3.3 Patterning Experiment of Bilayer Resist Process	104
4.4 Simulations	107
4.4.1 Dependency of Thickness of Resist Layer	107
4.4.2 Dependency of Pitch	108
4.4.3 Dependency on Polarization	109
4.5 Application	110
4.6 Summary	113
References	113

5 Nano-Optical Manipulation Using Resonant Radiation Force

<i>T. Iida and H. Ishihara</i>	115
5.1 Introduction	115
5.1.1 Techniques Using Radiation Force	115
5.1.2 Previous Theoretical Studies	116
5.1.3 Potentiality in Using Resonant Radiation Force in a Nanoscale Regime	120
5.2 Theoretical Bases	121
5.2.1 Lorentz Force and Maxwell Stress Tensor	122
5.2.2 Microscopic Response Field	123
5.2.3 Derivation of General Expressions	126
5.2.4 Expressions for Simple Cases	128
5.3 Radiation Force on a Single Nanoparticle Confining Excitons	132
5.3.1 Size Dependence	135
5.3.2 Several Types of Forces	143
5.3.3 Proposal of Size-Selective Manipulation	150
5.4 Theoretical Proposal of Nano-Optical Chromatography in Superfluid He ⁴	153
5.4.1 For a Laser with Finite Line Width	155
5.4.2 Spatial Displacement of Nanoparticles	157
5.5 Experiment of Optical Transport of Nanoparticles	159
5.5.1 Introduction of Nanoparticles into Superfluid He ⁴	160

5.5.2 Optical Transport of Nanoparticles Using Resonant Light	160
5.6 Summary and Future Prospects	162
References	166
Index	169