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Continued after index

Edward A. Rietman

Molecular Engineering of Nanosystems

With 108 Illustrations

Springer

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“We are all lying in the gutter, but some of us are gazing at the stars.”
—Oscar Wilde

This book is dedicated to the bodhisattvas helping us reach for the stars.

Series Preface

The field of biological physics is a broad, multidisciplinary, and dynamic one, touching on many areas of research in physics, biology, chemistry and medicine. New findings are published in a large number of publications within these disciplines, making it difficult for students and scientists working in the biological physics to keep up with advances occurring in disciplines other than their own. The Biological Physics Series is intended therefore to be a comprehensive one covering a broad range of topics important to the study of biological physics. Its goals is to provide scientists and engineers with text books, monographs and reference books to address the growing need for information.

Books in the series will emphasize frontier areas of science including molecular, membrane, and mathematical biophysics; photosynthetic energy harvesting and conversion; information processing; physical principles of genetics; sensory communications; automata networks, neural networks, and cellular automata. Equally important will be coverage of current and potential applied aspects of biological physics such as biomolecular electronic components and devices, biosensors, medicine, imaging, physical principles of renewable energy production, and environmental control and engineering.

We are fortunate to have a distinguished roster of consulting editors on the Editorial Board, reflecting the breadth of biological physics. We believe that the Biological Physics Series can help advance the knowledge in the field by providing a home for publications in the field and that scientists and practitioners from many disciplines will find much to learn from the upcoming volumes.

Oak Ridge, Tennessee

ELIAS GREENBAUM
Series Editor-in-Chief

Preface and Acknowledgments

Molecular nanotechnology allows us to build materials and systems with atomic and molecular precision. It posits molecular-scale machines that can manipulate individual atoms and molecules to build entirely new types of materials and molecular-scale machines. It points to biological life as existence proof that this level of technology is possible. For example, ribosomes are molecular-scale machines that read RNA as if it were a molecular-scale tape. From this coded information, it manufactures proteins and then assists in folding of the protein to make sure the newly assembled molecular part conforms to the correct three-dimensional configuration.

There are several scientific fields converging on developing nanotechnology. Some key fields of science that are having an impact on nanotechnology are physics, chemistry, and biology. This book will mostly discuss the chemical physics associated with designing and understanding molecular systems. Other areas discussed, briefly, are proximity probe methods and genetic engineering. These, along with chemical methods, will converge for the first generation of molecular nanotechnology. I hope the book will be useful to computer and system scientists as a tool in modeling molecular systems.

Several people have helped in the preparation of this book. First, and foremost, I thank my wife, Suzanne Harvey. This was not an easy book to produce, and she exhibited great patience with me when I needed to work on the manuscript. Then, at other times, when she wanted me out of the way, she reminded me that I had a book to write. Together, we got it done. While doing all this, she taught me kindness.

Libraries are the most important repository of information for a civilization, and library scientists have one of the most important jobs in any civilization—helping us navigate through the labyrinths of the knowledge base. I thank Liz Zimmerman, a library scientist at Bell Labs, for many sources and conversations. Without her help, this book would not have been possible.

After the manuscript was finished, Dr. J. Stross Hall, of the Institute for Molecular Manufacturing, read many of the chapters and made helpful comments on ways to improve the manuscript.

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Edward A. Rietman
Brussels, Belgium
January, 2001

Contents

Series Preface	vii
Preface and Acknowledgments	ix
Chapter 1. Enabling Technologies for Molecular Nanosystems ...	1
1.1. Engines of Creation	1
1.2. Selected Reviews of Nanotechnology	3
1.3. Scanning Probe Methods	6
1.4. The Major Classes of Biopolymers	7
1.4.1. Proteins	8
1.4.2. Nucleic Acids	8
1.4.3. Polysaccharides	9
1.5. Supramolecular Chemistry	10
1.6. Summary and Comments	11
Chapter 2. Solution-Phase Chemistry	14
2.1. Introduction	14
2.2. Statistical Thermodynamics	15
2.3. Thermodynamics Properties from the Partition Function ...	17
2.4. Relevance of Spectroscopy to Chemistry	18
2.5. Introduction to Molecular Geometry	19
2.6. Chemical Kinetics	23
2.7. Quantum Chemistry	25
2.8. Molecular Mechanics and Molecular Dynamics	34
2.9. Structure–Activity and Structure–Property Relations	37
2.10. Organic Synthesis	40
2.11. Combinatorial Synthesis	41
2.12. Summary	49
Chapter 3. Dynamics of Brownian Assembly	52
3.1. Introduction	52
3.2. Supramolecular Assemblies	53

3.3.	Brownian Motion	54
3.4.	Thermodynamics of Intermolecular Forces	58
3.5.	Covalent and Coulomb Forces	59
3.6.	Polar Molecules	64
3.7.	Polarization of Molecules	67
3.8.	van der Waals Forces	71
3.9.	Repulsive Forces	74
3.10.	Hydrogen Bonding	77
3.11.	Particle–Surface Dynamics	77
3.12.	Solvation and Hydration Forces	83
3.13.	Thermodynamics of Self-Assembly	86
3.14.	Particle Capture and Assembly	88
3.15.	Summary and Comments	91
Chapter 4. Molecular Systems by Brownian Assembly		93
4.1.	Introduction	93
4.2.	Molecular-System Examples	94
4.2.1.	Pyridine Compounds	96
4.2.2.	Crown Ethers	99
4.2.3.	Siderophores	105
4.2.4.	Π -Spherands	105
4.2.5.	Catenanes	107
4.2.6.	Cyclodextrins	114
4.2.7.	Bioorganic Model Compounds	118
4.2.8.	Dendrimers	119
4.2.9.	Zeolites	124
4.2.10.	Fullerenes	130
4.2.11.	Complex Crystal Packings	137
4.3.	Supramolecular Device	139
4.3.1.	Organic Semiconductors	140
4.3.2.	Molecular Electronics	142
4.3.3.	Soliton Networks	144
4.3.4.	Molecular Photonics and Electrochemistry	146
4.3.5.	Molecular “Legos” and “Tinkertoys”	148
4.4.	Chemical Physics of Inclusion	149
4.4.1.	Measurement of Binding Constants	152
4.4.2.	Models of Ligand–Substrate Binding	153
4.4.3.	Spectroscopic Methods	154
4.4.4.	Thermodynamic Methods	154
4.5.	Molecular Cluster	155
Chapter 5. Large Secondary Bonded Systems		158
5.1.	Introduction	158
5.2.	Langmuir–Blodgett Films	158

5.2.1.	LB Film Preparation	159
5.2.2.	LB Film Electrical Properties	162
5.2.3.	LB Film Optical Properties	163
5.2.4.	LB Film Materials	165
5.3.	A Few Examples of LB Systems	167
5.3.1.	LB Systems for Electronic Studies	167
5.3.2.	LB Systems for Optical Studies	169
5.3.3.	LB Systems for Packing Studies	170
5.4.	Protein-Based LB Systems	171
5.5.	Micelles	172
5.6.	Self-Assembly: Statistical Thermodynamics	175
5.7.	Membrane Transitions	180
5.8.	Large-System Assembly Examples	182
Chapter 6. Protein and DNA Engineering		186
6.1.	Introduction	186
6.2.	Noncovalent Bonding in Biopolymers	186
6.3.	Molecular Biophysics	188
6.3.1.	Protein Structure	188
6.3.2.	Protein Folding	189
6.3.3.	Loops, Random Walks, and Dynamics	191
6.3.4.	Fractals and Multifractals	196
6.4.	Protein Engineering	201
6.4.1.	Protein Synthesis	201
6.4.2.	Design by Mutation	202
6.4.3.	Artificial Proteins with (Mostly) Natural Amino Acids	202
6.4.4.	Protein-like Building Blocks	203
6.5.	Nucleic Acid Engineering	204
6.5.1.	Gene Manipulation	206
6.5.2.	DNA as Programmable Matter	209
6.5.3.	DNA Computing	212
6.6.	Encoded Walks and Correlation Sequences	214
References		216
Index		245