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and Jonathan W. Steed

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Organic Nanostructures



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Cover illustration

The front cover shows a space-filling image illustrating the packing of the ligands in the optically pure cage complex $[\text{Zn}_4(\text{L}^{\text{o-Ph}^*})_6(\text{ClO}_4)](\text{ClO}_4)_7$ and is adapted from Figure 9.5 with the permission of Michael Ward. The structure is superimposed on an SEM image of the helical fibrous structure of a chiral supramolecular xerogel.

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Library of Congress Card No.: applied for

British Library Cataloguing-in-Publication Data

A catalogue record for this book is available from the British Library.

Bibliographic information published by the Deutsche Nationalbibliothek

Die Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available in the Internet at <http://dnb.d-nb.de>.

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Typesetting Thomson Digital, Noida, India

Printing Strauss GmbH, Mörlenbach

Binding Litges & Dopf GmbH, Heppenheim

Printed in the Federal Republic of Germany

Printed on acid-free paper

ISBN: 978-3-527-31836-0

*In memory of Professor Dimitry M. Rudkevich
(1963–2007)*

Contents

Preface XIII

List of Contributors XV

1	Artificial Photochemical Devices and Machines	1
	<i>Vincenzo Balzani, Alberto Credi, and Margherita Venturi</i>	
1.1	Introduction	1
1.2	Molecular and Supramolecular Photochemistry	2
1.2.1	Molecular Photochemistry	2
1.2.2	Supramolecular Photochemistry	4
1.3	Wire-Type Systems	5
1.3.1	Molecular Wires for Photoinduced Electron Transfer	5
1.3.2	Molecular Wires for Photoinduced Energy Transfer	9
1.4	Switching Electron-Transfer Processes in Wire-Type Systems	11
1.5	A Plug–Socket Device Based on a Pseudorotaxane	13
1.6	Mimicking Electrical Extension Cables at the Molecular Level	14
1.7	Light-Harvesting Antennas	17
1.8	Artificial Molecular Machines	19
1.8.1	Introduction	19
1.8.2	Energy Supply	20
1.8.3	Light Energy	21
1.8.4	Threading–Dethreading of an Azobenzene-Based Pseudorotaxane	21
1.8.5	Photoinduced Shuttling in Multicomponent Rotaxanes: a Light-Powered Nanomachine	23
1.9	Conclusion	27
	References	28
2	Rotaxanes as Ligands for Molecular Machines and Metal–Organic Frameworks	33
	<i>Stephen J. Loeb</i>	
2.1	Interpenetrated and Interlocked Molecules	33
2.1.1	Introduction	33

2.1.2	Templating of [2]Pseudorotaxanes	33
2.1.3	[2]Rotaxanes	36
2.1.4	Higher Order [n]Rotaxanes	37
2.1.5	[3]Catenanes	40
2.2	Molecular Machines	41
2.2.1	Introduction	41
2.2.2	Controlling Threading and Unthreading	41
2.2.3	Molecular Shuttles	42
2.2.4	Flip Switches	44
2.3	Interlocked Molecules and Ligands	46
2.3.1	[2]Pseudorotaxanes as Ligands	46
2.3.2	[2]Rotaxanes as Ligands	46
2.4	Materials from Interlocked Molecules	48
2.4.1	Metal–Organic Rotaxane Frameworks (MORFs)	48
2.4.2	One-dimensional MORFs	49
2.4.3	Two-dimensional MORFs	51
2.4.4	Three-dimensional MORFs	51
2.4.5	Controlling the Dimensionality of a MORF	54
2.4.6	Frameworks Using Hydrogen Bonding	57
2.5	Properties of MORFs: Potential as Functional Materials	57
2.5.1	Robust Frameworks	57
2.5.2	Porosity and Internal Properties	59
2.5.3	Dynamics and Controllable Motion in the Solid State	59
	References	59
3	Strategic Anion Templatation for the Assembly of Interlocked Structures	63
	<i>Michał J. Chmielewski and Paul D. Beer</i>	
3.1	Introduction	63
3.2	Precedents of Anion-directed Formation of Interwoven Architectures	64
3.3	Design of a General Anion Templatation Motif	70
3.4	Anion-templated Interpenetration	72
3.5	Probing the Scope of the New Methodology	74
3.6	Anion-templated Synthesis of Rotaxanes	79
3.7	Anion-templated Synthesis of Catenanes	82
3.8	Functional Properties of Anion-templated Interlocked Systems	88
3.9	Summary and Outlook	93
	References	94
4	Synthetic Nanotubes from Calixarenes	97
	<i>Dmitry M. Rudkevich and Voltaire G. Organo</i>	
4.1	Introduction	97
4.2	Early Calixarene Nanotubes	98
4.3	Metal Ion Complexes with Calixarene Nanotubes	99

4.4	Nanotubes for NO _x Gases	101
4.5	Self-assembling Structures	107
4.6	Conclusions and Outlook	108
	References	109
5	Molecular Gels – Nanostructured Soft Materials	111
	<i>David K. Smith</i>	
5.1	Introduction to Molecular Gels	111
5.2	Preparation of Molecular Gels	114
5.3	Analysis of Molecular Gels	115
5.3.1	Macroscopic Behavior – “Table-Top” Rheology	115
5.3.1.1	Tube Inversion Methodology	116
5.3.1.2	Dropping Ball Method	116
5.3.2	Macroscopic Behavior – Rheology	117
5.3.3	Macroscopic Behavior – Differential Scanning Calorimetry	117
5.3.4	Nanostructure – Electron Microscopy	118
5.3.5	Nanostructure – X-Ray Methods	120
5.3.6	Molecular Scale Assembly – NMR Methods	120
5.3.7	Molecular Scale Assembly – Other Spectroscopic Methods	122
5.3.8	Chirality in Gels – Circular Dichroism Spectroscopy	123
5.4	Building Blocks for Molecular Gels	124
5.4.1	Amides, Ureas, Carbamates (–XCONH– Groups, Hydrogen Bonding)	125
5.4.2	Carbohydrates (Multiple –OH Groups, Hydrogen Bonding)	127
5.4.3	Steroids/Bile Salts (Hydrophobic Surfaces)	129
5.4.4	Nucleobases (Hydrogen Bonding and π – π Stacking)	130
5.4.5	Long-chain Alkanes (van der Waals Interactions)	132
5.4.6	Dendritic Gels	133
5.4.7	Two-component Gels	137
5.5	Applications of Molecular Gels	141
5.5.1	Greases and Lubricants	142
5.5.2	Napalm	142
5.5.3	Tissue Engineering – Nerve Regrowth Scaffolds	142
5.5.4	Drug Delivery – Responsive Gels	144
5.5.5	Capturing (Transcribing) Self-assembled Architectures	145
5.5.6	Sensory Gels	147
5.5.7	Conductive Gels	147
5.6	Conclusions	148
	References	148
6	Nanoporous Crystals, Co-crystals, Isomers and Polymorphs from Crystals	155
	<i>Dario Braga, Marco Curzi, Stefano L. Giaffreda, Fabrizia Grepioni, Lucia Maini, Anna Pettersen, and Marco Polito</i>	
6.1	Introduction	155

6.2	Nanoporous Coordination Network Crystals for Uptake/Release of Small Molecules	156
6.3	Hybrid Organic–organometallic and Inorganic-organometallic Co-crystals	161
6.4	Crystal Isomers and Crystal Polymorphs	167
6.5	Dynamic Crystals – Motions in the Nano-world	170
6.6	Conclusions	172
	References	173
7	Supramolecular Architectures Based On Organometallic Half-sandwich Complexes	179
	<i>Thomas B. Rauchfuss and Kay Severin</i>	
7.1	Introduction	179
7.2	Macrocycles	180
7.3	Coordination Cages	187
7.3.1	Cyanometallate Cages	187
7.3.1.1	Electroactive Boxes	189
7.3.1.2	Defect Boxes $\{[(C_5R_5)M(CN)_3]_4[Cp^*M]_3\}^z$	190
7.3.2	Expanded Organometallic Cyano Cages	191
7.3.3	Cages Based on <i>N</i> -Heterocyclic Ligands	193
7.4	Expanded Helicates	198
7.5	Clusters	200
7.6	Conclusions	200
	References	201
8	Endochemistry of Self-assembled Hollow Spherical Cages	205
	<i>Takashi Murase and Makoto Fujita</i>	
8.1	Introduction	205
8.2	Biomacromolecular Cages	206
8.3	Polymer Micelles	207
8.4	$M_{12}L_{24}$ Spheres	207
8.4.1	Self-assembly of $M_{12}L_{24}$ Spheres	207
8.4.2	Endohedral Functionalization of $M_{12}L_{24}$ Spheres	209
8.4.3	Fluorous Nanodroplets	210
8.4.4	Uptake of Metal Ions into a Cage	212
8.4.5	Polymerization in a Nutshell	213
8.4.6	Photoresponsive Molecular Nanoballs	216
8.4.7	Peptide-confined Chiral Cages	217
8.5	Conclusions and Outlook	219
	References	220
9	Polynuclear Coordination Cages	223
	<i>Michael D. Ward</i>	
9.1	Introduction	223
9.2	Complexes Based on Poly(pyrazolyl)borate Ligands	225

9.3	Complexes Based on Neutral Ligands with Aromatic Spacers	227
9.3.1	Complexes Based on L^{o-Ph} and $L^{12-naph}$	227
9.3.2	Larger Tetrahedral Cages Based on L^{biph}	234
9.3.3	Higher Nuclearity Cages Based on Other Ligands	235
9.4	Mixed-ligand Complexes: Opportunities for New Structural Types	243
	References	248
10	Periodic Nanostructures Based on Metal–Organic Frameworks (MOFs): En Route to Zeolite-like Metal–Organic Frameworks (ZMOFs)	251
	<i>Mohamed Eddaoudi and Jarrod F. Eubank</i>	
10.1	Introduction	251
10.2	Historical Perspective	252
10.2.1	Metal–Cyanide Compounds	252
10.2.2	Werner Complexes	254
10.2.3	Expanded Nitrogen-donor Ligands	255
10.2.4	Carboxylate-based Ligands	258
10.3	Single-metal Ion-based Molecular Building Blocks	261
10.3.1	Discrete, 2D and 3D Metal–Organic Assemblies	262
10.3.2	Zeolite-like Metal–Organic Frameworks (ZMOFs)	264
10.3.2.1	<i>sod</i> -ZMOF	265
10.3.2.2	<i>rho</i> -ZMOF	266
10.4	Conclusion	270
	References	271
11	Polyoxometalate Nanocapsules: from Structure to Function	275
	<i>Charalampos Moiras and Leroy Cronin</i>	
11.1	Introduction	275
11.2	Background and Classes of Polyoxometalates	277
11.3	Wells–Dawson $\{M_{18}O_{54}\}$ Capsules	278
11.4	Isopolyoxometalate Nanoclusters	280
11.5	Keplerate Clusters	282
11.6	Surface-Encapsulated Clusters (SECs): Organic Nanostructures with Inorganic Cores	285
11.7	Perspectives	287
	References	287
12	Nano-capsules Assembled by the Hydrophobic Effect	291
	<i>Bruce C. Gibb</i>	
12.1	Introduction	291
12.2	Synthesis of a Water-soluble, Deep-cavity Cavitand	292
12.2.1	Structure of the Cavitand (What It Is and What It Is Not)	292
12.2.2	Assembly Properties of the Cavitand	294
12.2.3	Photophysics and Photochemistry Within Nano-capsules	299
12.2.4	Hydrocarbon Gas Separation Using Nano-capsules	301

12.3	Conclusions	302
	References	303
13	Opportunities in Nanotechnology via Organic Solid-state Reactivity: Nanostructured Co-crystals and Molecular Capsules	305
	<i>Dejan-Krešimir Bučar, Tamara D. Hamilton, and Leonard R. MacGillivray</i>	
13.1	Introduction	305
13.2	Template-controlled [2 + 2] Photodimerization in the Solid State	305
13.3	Nanostructured Co-crystals	307
13.3.1	Organic Nanocrystals and Single Crystal-to-single Crystal Reactivity	308
13.4	Self-assembled Capsules Based on Ligands from the Solid State	309
13.5	Summary and Outlook	312
	References	313
14	Organic Nanocapsules	317
	<i>Scott J. Dalgarno, Nicholas P. Power, and Jerry L. Atwood</i>	
14.1	Introduction	317
14.2	First Generation Nanocapsules	317
14.3	Second Generation Nanocapsules	320
14.4	Third Generation Nanocapsules	323
14.5	Fourth Generation Nanocapsules	329
14.6	Fifth Generation Nanocapsules	331
14.7	Sixth Generation Nanocapsules	339
14.8	From Spheres to Tubes	342
14.9	Conclusions	344
	References	345
	Index	347

Preface

Current research in chemistry and materials science is now vigorously pushing the boundaries of the components studied firmly into the multi-nanometer length scale. In terms of traditional “molecules” a nanometer (10^{-9} m) is relatively large. As a result, it is only relatively recent advances in analytical instrumentation capable of delivering a molecular-level understanding of structure and properties in this kind of size regime that have allowed access to and the study of such large molecules and assemblies. The key interest in multi-nanometer-scale structures (nanostructures) is the fact that their size allows them to exhibit a significant degree of functionality and complexity – complexity that is mirrored in biological systems such as enzymes and polynucleotides, Nature’s own nanostructures. However, this functionality is compressed into a space that is very small on the human scale, sparking interest in fields such as molecular computing and molecular devices. Thus one of the great opening frontiers in molecular sciences is the upward synthesis, understanding of structure and application of molecules and molecular concepts into the nanoscale.

In compiling this book we have sought to bring together chapters from leading experts working on the cutting edge of this revolution on the nanoscale. Each chapter is a self-contained illustration of the way in which the nanoscale view is influencing current thinking and research across the molecular sciences. The focus is on the “organic” (loosely applied) since it is generally carbon-based building blocks that are the most versatile molecular components that can be induced to link into nanoscale structures. As chapters by Mohammed Eddaoudi and Lee Cronin show, however, hybrid organic–inorganic materials and well-defined inorganic building blocks as just as capable of assembling into well-defined and well-characterized discrete and polymeric nanostructures.

Crucial to the whole field of nanochemistry is the cross-fertilization between researchers from different disciplines that are approaching related structures from very different perspectives. It is with this aspect in mind that we have deliberately mixed together contributions from the solid-state materials community as in Dario Braga’s perspective on the crystal engineering of organic nanostructures and from experts in discrete molecular assemblies such as Dimitry Rudkevich, Kay Severin, Thomas Rauchfuss and Bruce Gibb. Of course, nanostructures are not

always so well defined and so these aspects are balanced nicely by David Smith's chapter on gel-phase materials – in some respects a “halfway house” between solution-phase and solid-state assemblies. We also felt it of key importance to illustrate ways to use small-scale molecular concepts in order to “synthesize-up” nanostructures. Chapters by Paul Beer, Steve Loeb and Len MacGillivray provide very different perspectives on templation and assembly in the field, while Makoto Fujita and Mike Ward deal with larger-scale self-assembly. Finally, all-important functional nanostructured devices are illustrated by Vincenzo Balzani's chapter.

Although a book of this size can only be illustrative of such a burgeoning field, it is our sincere hope that the juxtaposition of these different perspectives and systems in one place will stimulate and contribute to the ongoing process of cross-fertilization that is driving this fascinating and emerging area of molecular science. It has certainly been a fascinating and pleasurable experience to work on this project and we thank all of the authors wholeheartedly for their enthusiastic contributions to this project. We are grateful also to Manfred Köhl and Steffen Pauly at Wiley-VCH for their belief in the book and for their help in making it a reality. As this book went to press we learned of the sad and untimely death of Dimitry Rudkevich. We would like to dedicate this book to his memory and legacy to science.

December 2007

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