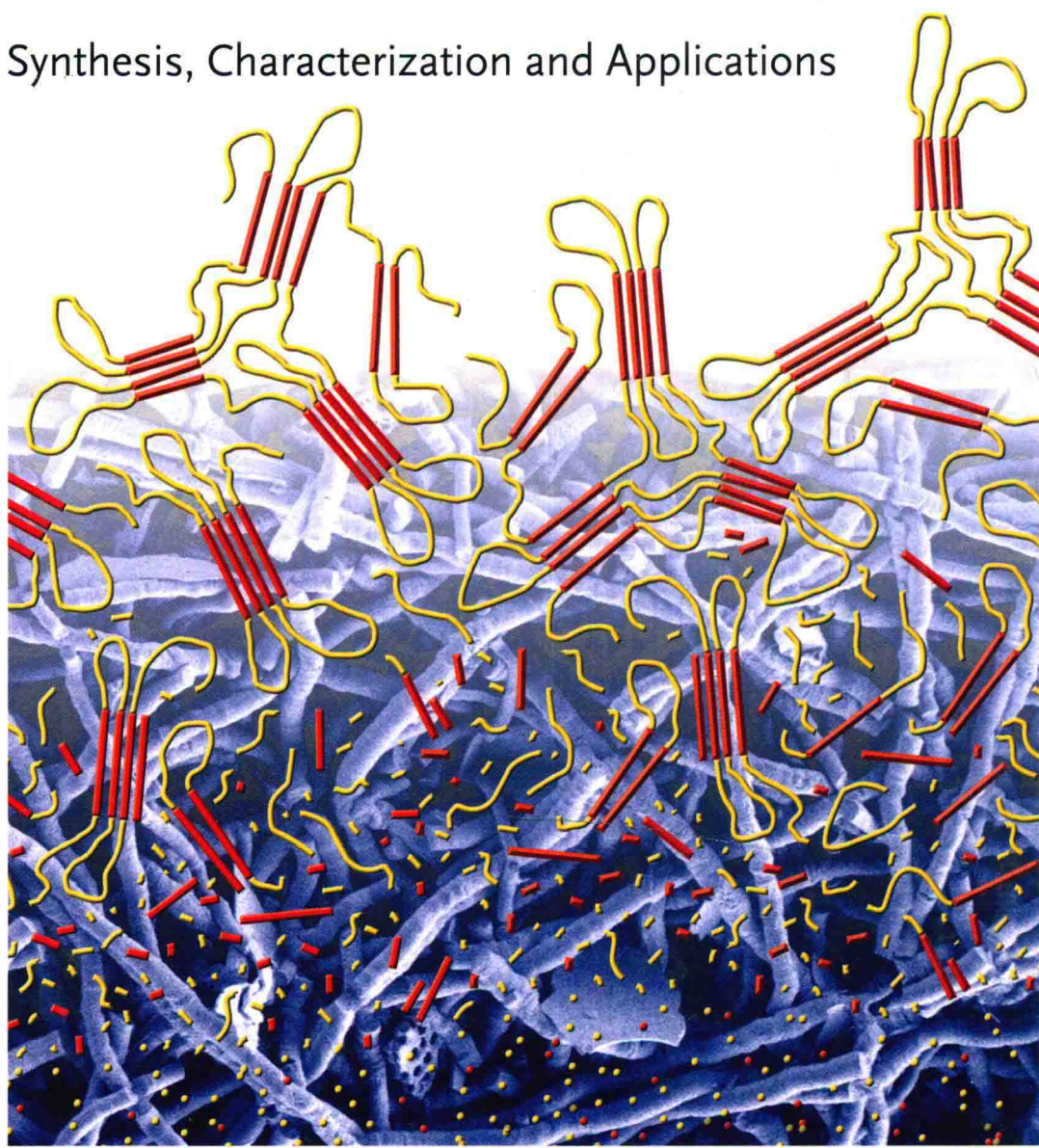


Edited by
Andreas Lendlein and Adam Sisson

 WILEY-VCH

Handbook of Biodegradable Polymers

Synthesis, Characterization and Applications



Edited by Andreas Lendlein and Adam Sisson

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Synthesis, Characterization and Applications



WILEY-VCH Verlag GmbH & Co. KGaA

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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

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

© 2011 Wiley-VCH Verlag & Co. KGaA,
Boschstr. 12, 69469 Weinheim, Germany

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Cover Design Grafik-Design Schulz, Fußgönheim

Typesetting Toppan Best-set Premedia Limited, Hong Kong

Printing and Binding Fabulous Printers Pte Ltd, Singapore

Printed in Singapore

Printed on acid-free paper

ISBN: 978-3-527-32441-5

ePDF ISBN: 978-3-527-63583-2

ePub ISBN: 978-3-527-63582-5

Mobi ISBN: 978-3-527-63584-9

oBook ISBN: 978-3-527-63581-8

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Handbook of
Biodegradable Polymers

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Preface

Degradable polyesters with valuable material properties were pioneered by Carothers at DuPont by utilizing ring-opening polymerization approaches for achieving high molecular weight aliphatic poly(lactic acid)s in the 1930s. As a result of various oil crises, biotechnologically produced poly(hydroxy alkanooates) were keenly investigated as greener, non-fossil fuel based alternatives to petrochemical based commodity plastics from the 1960s onwards. Shortly afterwards, the first copolyesters were utilized as slowly drug releasing matrices and surgical sutures in the medical field. In the latter half of the 20th century, biodegradable polymers developed into a core field involving different scientific disciplines such that these materials are now an integral part of our everyday lives. This field still remains a hotbed of innovation today. There is a burning interest in the use of biodegradable materials in clinical settings. Perusal of the literature will quickly reveal that such materials are the backbone of modern, biomaterial-based approaches in regenerative medicine. Equally, this technology is central to current drug delivery research through biodegradable nanocarriers, microparticles, and erodible implants, which enable sophisticated controlled drug release and targeting. Due to the long historic legacy of polymer research, this field has been able to develop to a point where material compositions and properties can be refined to meet desired, complex requirements. This enables the creation of a highly versatile set of materials as a key component of new technologies. This collected series of texts, written by experts, has been put together to showcase the state of the art in this ever-evolving area of science.

The chapters have been divided into three groups with different themes. Chapters 1–8 introduce specific materials and cover the major classes of polymers that are currently explored or utilized. Chapters 9–14 describe applications of biodegradable polymers, emphasizing the exciting potential of these materials. In the final chapters, 15–16, characterization methods and modelling techniques of biodegradation processes are depicted.

Materials: Lendlein *et al.*, then Ienczak and Aragão, start with up-to-date reviews of the seminal polyesters and biotechnologically produced polyesters, respectively. Other chapters concern polymers with different scission moieties and behaviors. Domb *et al.* provide a comprehensive review of polyanhydrides, which is followed by an excellent overview of poly(ortho esters) contributed by Heller. Amino

acid-based materials and degradable polyurethanes make up the subject of the next two chapters by Katsarava and Gomurashvili, then Puiggali *et al.*, respectively. Synthetic polysaccharides, which are related to many naturally occurring biopolymers, are then described at length by Dumitriu, Dräger *et al.* To conclude the individual polymer-class section, biodegradable polyolefins, which are degraded oxidatively, and are intended as degradable commodity plastics, are covered by Wiles *et al.*

Applications: The two chapters by Ikada and Shakesheff give a critical update on the status of biodegradable materials applied in regenerative therapy and then in drug delivery systems. From there, further exciting applications are described; shape-memory polymers and their potential as implant materials in minimally invasive surgery are discussed by Lendlein *et al.*; Huh *et al.* highlight the importance of biodegradable hydrogels for tissue expander applications; Franke *et al.* cover how implants can be used to aid regenerative treatment of mucosal defects in surgery; Khandare and Kumar review the relevance of biodegradable dendrimers and dendritic polymers to the medical field.

Methods: Van der Zee gives a description of the methods used to quantify biodegradability and the implications of biodegradability as a whole; Watanabe and Kawai go on to explain methods used to explore degradation through modelling and simulations.

The aim of this handbook is to provide a reference guide for anyone practising in the exploration or use of biodegradable materials. At the same time, each chapter can be regarded as a stand alone work, which should be of great benefit to readers interested in each specific field. Synthetic considerations, physical properties, and erosion behaviours for each of the major classes of materials are discussed. Likewise, the most up to date innovations and applications are covered in depth. It is possible upon delving into the provided information to really gain a comprehensive understanding of the importance and development of this field into what it is today and what it can become in the future.

We wish to thank all of the participating authors for their excellent contributions towards such a comprehensive work. We would particularly like to pay tribute to two very special authors who sadly passed away during the production time of this handbook. Jorge Heller was a giant in the biomaterials field and pioneered the field of poly(ortho esters). Severian Dumitriu is well known for his series of books on biodegradable materials, which served to inspire and educate countless scientists in this area. Our sincerest thanks go to Gloria Heller and Daniela Dumitriu for their cooperation in completing these chapters. We also acknowledge the untiring administrative support of Karolin Schmälzlin, Sabine Benner and Michael Schroeter, and the expert cooperation from the publishers at Wiley, especially Elke Maase and Heike Nöthe.

Teltow, September 2010

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Contents

Preface XV

List of Contributors XVII

1	Polyesters	1
	<i>Adam L. Sisson, Michael Schroeter, and Andreas Lendlein</i>	
1.1	Historical Background	1
1.1.1	Biomedical Applications	1
1.1.2	Poly(Hydroxycarboxylic Acids)	2
1.2	Preparative Methods	3
1.2.1	Poly(Hydroxycarboxylic Acid) Syntheses	3
1.2.2	Metal-Free Synthetic Processes	6
1.2.3	Polyanhydrides	6
1.3	Physical Properties	7
1.3.1	Crystallinity and Thermal Transition Temperatures	7
1.3.2	Improving Elasticity by Preparing Multiblock Copolymers	9
1.3.3	Covalently Crosslinked Polyesters	11
1.3.4	Networks with Shape-Memory Capability	11
1.4	Degradation Mechanisms	12
1.4.1	Determining Erosion Kinetics	12
1.4.2	Factors Affecting Erosion Kinetics	13
1.5	Beyond Classical Poly(Hydroxycarboxylic Acids)	14
1.5.1	Alternate Systems	14
1.5.2	Complex Architectures	15
1.5.3	Nanofabrication	16
	References	17
2	Biotechnologically Produced Biodegradable Polyesters	23
	<i>Jaciane Lutz Ienczak and Gláucia Maria Falcão de Aragão</i>	
2.1	Introduction	23
2.2	History	24
2.3	Polyhydroxyalkanoates – Granules Morphology	26
2.4	Biosynthesis and Biodegradability of Poly(3-Hydroxybutyrate) and Other Polyhydroxyalkanoates	29

2.4.1	Polyhydroxyalkanoates Biosynthesis on Microorganisms	29
2.4.2	Plants as Polyhydroxyalkanoates Producers	32
2.4.3	Microbial Degradation of Polyhydroxyalkanoates	33
2.5	Extraction and Recovery	34
2.6	Physical, Mechanical, and Thermal Properties of Polyhydroxyalkanoates	36
2.7	Future Directions	37
	References	38

3 Polyanhydrides 45

Avi Domb, Jay Prakash Jain, and Neeraj Kumar

3.1	Introduction	45
3.2	Types of Polyanhydride	46
3.2.1	Aromatic Polyanhydrides	46
3.2.2	Aliphatic–Aromatic Polyanhydrides	49
3.2.3	Poly(Ester-Anhydrides) and Poly(Ether-Anhydrides)	49
3.2.4	Fatty Acid-Based Polyanhydrides	49
3.2.5	RA-Based Polyanhydrides	49
3.2.6	Amino Acid-Based Polyanhydrides	51
3.2.7	Photopolymerizable Polyanhydrides	52
3.2.8	Salicylate-Based Polyanhydrides	53
3.2.9	Succinic Acid-Based Polyanhydrides	54
3.2.10	Blends	55
3.3	Synthesis	55
3.4	Properties	58
3.5	<i>In Vitro</i> Degradation and Erosion of Polyanhydrides	63
3.6	<i>In Vivo</i> Degradation and Elimination of Polyanhydrides	64
3.7	Toxicological Aspects of Polyanhydrides	65
3.8	Fabrication of Delivery Systems	67
3.9	Production and World Market	68
3.10	Biomedical Applications	68
	References	71

4 Poly(Ortho Esters) 77

Jorge Heller

4.1	Introduction	77
4.2	POE II	79
4.2.1	Polymer Synthesis	79
4.2.1.1	Rearrangement Procedure Using an $\text{Ru}(\text{PPh}_3)_3\text{Cl}_2 \text{ Na}_2\text{CO}_3$ Catalyst	80
4.2.1.2	Alternate Diketene Acetals	80
4.2.1.3	Typical Polymer Synthesis Procedure	80
4.2.2	Drug Delivery	81
4.2.2.1	Development of Ivermectin Containing Strands to Prevent Heartworm Infestation in Dogs	81
4.2.2.2	Experimental Procedure	81

4.2.2.3	Results	82
4.3	POE IV	82
4.3.1	Polymer Synthesis	82
4.3.1.1	Typical Polymer Synthesis Procedure	82
4.3.1.2	Latent Acid	83
4.3.1.3	Experimental Procedure	83
4.3.2	Mechanical Properties	83
4.4	Solid Polymers	86
4.4.1	Fabrication	86
4.4.2	Polymer Storage Stability	87
4.4.3	Polymer Sterilization	87
4.4.4	Polymer Hydrolysis	88
4.4.5	Drug Delivery	91
4.4.5.1	Release of Bovine Serum Albumin from Extruded Strands	91
4.4.5.2	Experimental Procedure	93
4.4.6	Delivery of DNA Plasmid	93
4.4.6.1	DNA Plasmid Stability	94
4.4.6.2	Microencapsulation Procedure	94
4.4.7	Delivery of 5-Fluorouracil	95
4.5	Gel-Like Materials	96
4.5.1	Polymer Molecular Weight Control	96
4.5.2	Polymer Stability	98
4.5.3	Drug Delivery	99
4.5.3.1	Development of APF 112 Mepivacaine Delivery System	99
4.5.3.2	Formulation Used	99
4.5.4	Preclinical Toxicology	100
4.5.4.1	Polymer Hydrolysate	100
4.5.4.2	Wound Instillation	100
4.5.5	Phase II Clinical Trial	100
4.5.6	Development of APF 530 Granisetron Delivery System	100
4.5.6.1	Preclinical Toxicology	100
4.5.6.2	Rat Study	101
4.5.6.3	Dog Study	101
4.5.6.4	Phase II and Phase III Clinical Trials	101
4.6	Polymers Based on an Alternate Diketene Acetal	102
4.7	Conclusions	104
	References	104

5 Biodegradable Polymers Composed of Naturally Occurring α -Amino Acids 107

Ramaz Katsarava and Zaza Gomurashvili

5.1	Introduction	107
5.2	Amino Acid-Based Biodegradable Polymers (AABBP)s	109
5.2.1	Monomers for Synthesizing AABBP)s	109
5.2.1.1	Key Bis-Nucleophilic Monomers	109
5.2.1.2	Bis-Electrophiles	111

5.2.2	AABBP's Synthesis Methods	111
5.2.3	AABBP's: Synthesis, Structure, and Transformations	115
5.2.3.1	Poly(ester amide)s	115
5.2.3.2	Poly(ester urethane)s	119
5.2.3.3	Poly(ester urea)s	119
5.2.3.4	Transformation of AABBP's	119
5.2.4	Properties of AABBP's	121
5.2.4.1	MW's, Thermal, Mechanical Properties, and Solubility	121
5.2.4.2	Biodegradation of AABBP's	121
5.2.4.3	Biocompatibility of AABBP's	123
5.2.5	Some Applications of AABBP's	124
5.2.6	AABBP's versus Biodegradable Polyesters	125
5.3	Conclusion and Perspectives	126
	References	127
6	Biodegradable Polyurethanes and Poly(ester amide)s	133
	<i>Alfonso Rodríguez-Galán, Lourdes Franco, and Jordi Puiggali</i>	
	Abbreviations	133
6.1	Chemistry and Properties of Biodegradable Polyurethanes	134
6.2	Biodegradation Mechanisms of Polyurethanes	140
6.3	Applications of Biodegradable Polyurethanes	142
6.3.1	Scaffolds	142
6.3.1.1	Cardiovascular Applications	143
6.3.1.2	Musculoskeletal Applications	143
6.3.1.3	Neurological Applications	144
6.3.2	Drug Delivery Systems	144
6.3.3	Other Biomedical Applications	145
6.4	New Polymerization Trends to Obtain Degradable Polyurethanes	145
6.4.1	Polyurethanes Obtained without Using Diisocyanates	145
6.4.2	Enzymatic Synthesis of Polyurethanes	146
6.4.3	Polyurethanes from Vegetable Oils	147
6.4.4	Polyurethanes from Sugars	147
6.5	Aliphatic Poly(ester amide)s: A Family of Biodegradable Thermoplastics with Interest as New Biomaterials	149
	Acknowledgments	152
	References	152
7	Carbohydrates	155
	<i>Gerald Dräger, Andreas Krause, Lena Möller, and Severian Dumitriu</i>	
7.1	Introduction	155
7.2	Alginate	156
7.3	Carrageenan	160
7.4	Cellulose and Its Derivatives	162
7.5	Microbial Cellulose	164
7.6	Chitin and Chitosan	165

7.7	Dextran	169
7.8	Gellan	171
7.9	Guar Gum	174
7.10	Hyaluronic Acid (Hyaluronan)	176
7.11	Pullulan	180
7.12	Scleroglucan	182
7.13	Xanthan	184
7.14	Summary	186
	Acknowledgments	187
	In Memoriam	187
	References	187
8	Biodegradable Shape-Memory Polymers	195
	<i>Marc Behl, Jörg Zotzmann, Michael Schroeter, and Andreas Lendlein</i>	
8.1	Introduction	195
8.2	General Concept of SMPs	197
8.3	Classes of Degradable SMPs	201
8.3.1	Covalent Networks with Crystallizable Switching Domains, $T_{\text{trans}} = T_{\text{m}}$	202
8.3.2	Covalent Networks with Amorphous Switching Domains, $T_{\text{trans}} = T_{\text{g}}$	204
8.3.3	Physical Networks with Crystallizable Switching Domains, $T_{\text{trans}} = T_{\text{m}}$	205
8.3.4	Physical Networks with Amorphous Switching Domains, $T_{\text{trans}} = T_{\text{g}}$	208
8.4	Applications of Biodegradable SMPs	209
8.4.1	Surgery and Medical Devices	209
8.4.2	Drug Release Systems	210
	References	212
9	Biodegradable Elastic Hydrogels for Tissue Expander Application	217
	<i>Thanh Huyen Tran, John Garner, Yourong Fu, Kinam Park, and Kang Moo Huh</i>	
9.1	Introduction	217
9.1.1	Hydrogels	217
9.1.2	Elastic Hydrogels	217
9.1.3	History of Elastic Hydrogels as Biomaterials	218
9.1.4	Elasticity of Hydrogel for Tissue Application	219
9.2	Synthesis of Elastic Hydrogels	220
9.2.1	Chemical Elastic Hydrogels	220
9.2.1.1	Polymerization of Water-Soluble Monomers in the Presence of Crosslinking Agents	220
9.2.1.2	Crosslinking of Water-Soluble Polymers	221
9.2.2	Physical Elastic Hydrogels	222
9.2.2.1	Formation of Physical Elastic Hydrogels via Hydrogen Bonding	222

9.2.2.2	Formation of Physical Elastic Hydrogels via Hydrophobic Interaction	224
9.3	Physical Properties of Elastic Hydrogels	225
9.3.1	Mechanical Property	225
9.3.2	Swelling Property	227
9.3.3	Degradation of Biodegradable Elastic Hydrogels	229
9.4	Applications of Elastic Hydrogels	229
9.4.1	Tissue Engineering Application	229
9.4.2	Application of Elastic Shape-Memory Hydrogels as Biodegradable Sutures	230
9.5	Elastic Hydrogels for Tissue Expander Applications	231
9.6	Conclusion	233
	References	234

10 Biodegradable Dendrimers and Dendritic Polymers 237

Jayant Khandare and Sanjay Kumar

10.1	Introduction	237
10.2	Challenges for Designing Biodegradable Dendrimers	240
10.2.1	Is Biodegradation a Critical Measure of Biocompatibility?	243
10.3	Design of Self-Immolative Biodegradable Dendrimers	245
10.3.1	Cleavable Shells—Multivalent PEGylated Dendrimer for Prolonged Circulation	246
10.3.1.1	Polylysine-Core Biodegradable Dendrimer Prodrug	250
10.4	Biological Implications of Biodegradable Dendrimers	256
10.5	Future Perspectives of Biodegradable Dendrimers	259
10.6	Concluding Remarks	259
	References	260

11 Analytical Methods for Monitoring Biodegradation Processes of Environmentally Degradable Polymers 263

Maarten van der Zee

11.1	Introduction	263
11.2	Some Background	263
11.3	Defining Biodegradability	265
11.4	Mechanisms of Polymer Degradation	266
11.4.1	Nonbiological Degradation of Polymers	266
11.4.2	Biological Degradation of Polymers	267
11.5	Measuring Biodegradation of Polymers	267
11.5.1	Enzyme Assays	269
11.5.1.1	Principle	269
11.5.1.2	Applications	269
11.5.1.3	Drawbacks	270
11.5.2	Plate Tests	270
11.5.2.1	Principle	270
11.5.2.2	Applications	270
11.5.2.3	Drawbacks	270