186
Advances in Polymer Science

Advances in Polymer Science

Recently Published and Forthcoming Volumes

Enzyme-Catalyzed Synthesis of Polymers
Volume Editors: Kobayashi, S., Ritter, H., Kaplan, D.
Vol. 194, 2006

Polymer Therapeutics II
Polymers as Drugs, Conjugates and Gene Delivery Systems
Volume Editors: Satchi-Fainaro, R., Duncan, R.
Vol. 193, 2006

Polymer Therapeutics I
Polymers as Drugs, Conjugates and Gene Delivery Systems
Volume Editors: Satchi-Fainaro, R., Duncan, R.
Vol. 192, 2006

Interphases and Mesophases in Polymer Crystallization III
Volume Editor: Allegra, G.
Vol. 191, 2005

Block Copolymers II
Volume Editor: Abetz, V.
Vol. 190, 2005

Block Copolymers I
Volume Editor: Abetz, V.
Vol. 189, 2005

Intrinsic Molecular Mobility and Toughness of Polymers II
Volume Editor: Kausch, H. H.
Vol. 188, 2005

Intrinsic Molecular Mobility and Toughness of Polymers I
Volume Editor: Kausch, H. H.
Vol. 187, 2005

Polysaccharides I
Structure, Characterization and Use
Volume Editor: Heinze, T.
Vol. 186, 2005

Advanced Computer Simulation Approaches for Soft Matter Sciences II
Volume Editors: Holm, C., Kremer, K.
Vol. 185, 2005

Crosslinking in Materials Science
Vol. 184, 2005

Phase Behavior of Polymer Blends
Volume Editor: Freed, K.
Vol. 183, 2005

Polymer Analysis/Polymer Theory
Vol. 182, 2005

Interphases and Mesophases in Polymer Crystallization II
Volume Editor: Allegra, G.
Vol. 181, 2005

Interphases and Mesophases in Polymer Crystallization I
Volume Editor: Allegra, G.
Vol. 180, 2005

Inorganic Polymeric Nanocomposites and Membranes
Vol. 179, 2005

Polymeric and Inorganic Fibres
Vol. 178, 2005

Poly(arylene Ethynylenes)
From Synthesis to Application
Volume Editor: Weder C.
Vol. 177, 2005

Ring Opening Metathesis
Volume Editor: Buchmeister, M.
Vol. 176, 2005

Polymer Particles
Volume Editor: Okubo M.
Vol. 175, 2005

Polysaccharides I

Structure, Characterization and Use

Volume Editor: Thomas Heinze

With contributions by

H. Barsett · A. Ebringerová · S. E. Harding · T. Heinze
Z. Hromádková · C. Muzzarelli · R. A. A. Muzzarelli
B. S. Paulsen · O. A. El Seoud

Springer

The series *Advances in Polymer Science* presents critical reviews of the present and future trends in polymer and biopolymer science including chemistry, physical chemistry, physics and material science. It is adressed to all scientists at universities and in industry who wish to keep abreast of advances in the topics covered.
As a rule, contributions are specially commissioned. The editors and publishers will, however, always be pleased to receive suggestions and supplementary information. Papers are accepted for *Advances in Polymer Science* in English.
In references *Advances in Polymer Science* is abbreviated *Adv Polym Sci* and is cited as a journal.

Springer WWW home page: http://www.springeronline.com
Visit the APS content at http://www.springerlink.com/

Library of Congress Control Number: 2005926094

ISSN 0065-3195
ISBN-10 3-540-26112-5 Springer Berlin Heidelberg New York
ISBN-13 978-3-540-26112-4 Springer Berlin Heidelberg New York
DOI 10.1007/b136812

Springer is a part of Springer Science+Business Media

springeronline.com

Printed in Germany

Cover design: *Design & Production* GmbH, Heidelberg
Typesetting and Production: LE-TEX Jelonek, Schmidt & Vöckler GbR, Leipzig

Printed on acid-free paper 02/3141 YL – 5 4 3 2 1 0

Volume Editor

Prof. Dr. Thomas Heinze
Kompetenzzentrum Polysaccharidforschung
Friedrich-Schiller-Universität Jena
Humboldtstraße 10
07743 Jena, Germany
Thomas.Heinze@uni-jena.de

Editorial Board

Advances in Polymer Science
Also Available Electronically

For all customers who have a standing order to Advances in Polymer Science, we offer the electronic version via SpringerLink free of charge. Please contact your librarian who can receive a password or free access to the full articles by registering at:

springerlink.com

If you do not have a subscription, you can still view the tables of contents of the volumes and the abstract of each article by going to the SpringerLink Homepage, clicking on "Browse by Online Libraries", then "Chemical Sciences", and finally choose Advances in Polymer Science.

You will find information about the

- Editorial Board
- Aims and Scope
- Instructions for Authors
- Sample Contribution

at springeronline.com using the search function.

Preface

There is a wide range of naturally occurring polysaccharides derived from renewable resources possessing magnificent structural diversity and functional versatility. These molecules are amongst the key substances that make up the fundamental components of life. Some of these polysaccharides – in particular cellulose, starch and semi-synthetic derivatives thereof – are actively used in commercial products today, although many others still remain underutilized. With the recent rapid advancements in molecular and supramolecular characterization, in developing adequate isolation procedures for structurally uniform samples, in understanding structure property relationships, in designing synthesis pathways for the controlled derivatization, and in adapting and developing analytical tools for these biopolymers, new opportunities for the use of polysaccharides and their semi-synthetic derivatives are now being considered.

The structural and functional properties of polysaccharides are often superior to synthetic polymers. The cell wall architecture of plants, which involves a unique composite of cellulose and hemicellulose (and lignin) together with the mechanical properties of films and fibres of chitin are two impressive examples. The growing acceptance of the knowledge acquired over hundreds of years by people still using so-called *traditional medicine* has lead to the discovery of various new bioactive polysaccharides. From the polymer chemist's point of view, the unique structures of polysaccharides combined with such promising properties like hydrophilicity, biocompatibility, biodegradability (at least in the original state), stereoregularity, multichirality, and polyfunctionality – i.e. reactive functions (mainly OH-, NH-, and COOH moieties) that can be modified by various chemical reactions – provides an additional and important argument for the study of polysaccharides as a valuable and renewable resource for the future.

In recent years the socio-economical situation has changed to make natural polymer once again worth consideration for many applications. The increasing industrial interest in the field of polysaccharides has been well manifested by the establishment of, for example, the Centre of Excellence for Polysaccharide Research at Jena-Rudolstadt. Bayer AG – Wolff Cellulosics GmbH & Co. KG, Borregaard Chemcell, Dow Deutschland GmbH & Co. OHG, Hercules GmbH – Division Aqualon, and Rhodia Acetow GmbH are the industrial partners in

this venture and have provided funding for a five-year period via project and programmatic support. The Centre is a joint project between the Friedrich Schiller University of Jena and the Thuringian Institute of Textile and Plastics Research located 40 km south of Jena in Rudolstadt. The aim of the Centre is to foster interdisciplinary fundamental research on polysaccharides and their application through active graduate student projects in the fields of carbohydrate chemistry, bioorganic chemistry, and structure analysis. The goal is also to encourage efficient international collaboration. As the director of the Centre, I would like to stress that the knowledge discussed in these review papers is not the final story. On the contrary, it is intended that the information summarized in this volume will stimulate scientists in academia and industry to continue with the search and development of new products and applications.

The collection of review papers in this volume addresses some of the current key concerns with regard the use of polysaccharides and their semi-synthetic derivatives. Thus the topics discussed focus on: hemicelluloses, bioactive pectic polysaccharides, cellulose esters synthesized via homogeneous conversions, chitin, and the modern analytical ultracentrifugation of polysaccharides. Although in terms of material design, cellulose and starch will always appear near the top of any list of polysaccharides, it is the editors opinion that consideration of the whole range of polysaccharides available is necessary to allow full advantage to be taken of this fascinating class of biopolymers. Starch will be considered in volume II of the special issue of *Advances in Polymer Science*. In this regard, as editor, I would like to take this opportunity to express my gratitude to the authors for their seminal and timely contributions.

I would also like, on behalf of the authors, to express my gratitude to Professor Nuyken, APS editorial board member, and to Springer, for agreeing to publish special issues with review papers on selected polysaccharide topics. In particular I would like to thank Dr. Marion Hertel (executive editor, Chemistry) and Ulrike Kreusel (desk editor, Chemistry) of Springer for their efficiency and their conscientious efforts to ensure timely completion of this book.

Jena, July 2005 *Thomas Heinze*

Contents