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# Advances in Polymer Science

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B. S. Paulsen · O. A. El Seoud

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 addressed to all scientists at universities and in industry who wish to keep abreast of advances in the topics covered.

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## Volume Editor

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

## Editorial Board

Prof. Akihiro Abe  
Department of Industrial Chemistry  
Tokyo Institute of Polytechnics  
1583 Iiyama, Atsugi-shi 243-02, Japan  
*aabe@chem.t-kougei.ac.jp*

Prof. A.-C. Albertsson  
Department of Polymer Technology  
The Royal Institute of Technology  
10044 Stockholm, Sweden  
*aila@polymer.kth.se*

Prof. Ruth Duncan  
Welsh School of Pharmacy  
Cardiff University  
Redwood Building  
King Edward VII Avenue  
Cardiff CF 10 3XF  
United Kingdom  
*duncan@cf.ac.uk*

Prof. Karel Dušek  
Institute of Macromolecular Chemistry,  
Czech  
Academy of Sciences of the Czech Republic  
Heyrovský Sq. 2  
16206 Prague 6, Czech Republic  
*dusek@imc.cas.cz*

Prof. Dr. W. H. de Jeu  
FOM-Institute AMOLF  
Kruislaan 407  
1098 SJ Amsterdam, The Netherlands  
*dejeu@amolf.nl*  
and Dutch Polymer Institute  
Eindhoven University of Technology  
PO Box 513  
5600 MB Eindhoven, The Netherlands

Prof. Jean-François Joanny  
Physicochimie Curie  
Institut Curie section recherche  
26 rue d'Ulm  
75248 Paris cedex 05, France  
*jean-francois.joanny@curie.fr*

Prof. Hans-Henning Kausch  
EPFL SB ISIC GGEC  
J2 492 Bâtiment CH  
Station 6  
1015 Lausanne, Switzerland  
*kausch.cully@bluewin.ch*

Prof. S. Kobayashi  
R & D Center for Bio-based Materials  
Kyoto Institute of Technology  
Matsugasaki, Sakyo-ku  
Kyoto 606-8585, Japan  
*kobayashi@kit.ac.jp*

**Prof. Kwang-Sup Lee**

Department of Polymer Science & Engineering  
Hannam University  
133 Ojung-Dong Taejon  
300-791, Korea  
*kslee@mail.hannam.ac.krr*

**Prof. L. Leibler**

Matière Molle et Chimie  
Ecole Supérieure de Physique  
et Chimie Industrielles (ESPCI)  
10 rue Vauquelin  
75231 Paris Cedex 05, France  
*ludwik.leibler@espci.fr*

**Prof. Timothy E. Long**

Department of Chemistry  
and Research Institute  
Virginia Tech  
2110 Hahn Hall (0344)  
Blacksburg, VA 24061, USA  
*telong@vt.edu*

**Prof. Ian Manners**

School of Chemistry  
University of Bristol  
Cantock's Close  
BS8 1TS Bristol, UK  
*r.musgrave@bristol.ac.uk*

**Prof. Dr. Martin Möller**

Deutsches Wollforschungsinstitut  
an der RWTH Aachen e.V.  
Pauwelsstraße 8  
52056 Aachen, Germany  
*moeller@dwi.rwth-aachen.de*

**Prof. Oskar Nuyken**

Lehrstuhl für Makromolekulare Stoffe  
TU München  
Lichtenbergstr. 4  
85747 Garching, Germany  
*oskar.nuyken@ch.tum.de*

**Dr. E. M. Terentjev**

Cavendish Laboratory  
Madingley Road  
Cambridge CB 3 OHE  
United Kingdom  
*emt1000@cam.ac.uk*

**Prof. Brigitte Voit**

Institut für Polymerforschung Dresden  
Hohe Straße 6  
01069 Dresden, Germany  
*voit@ipfdd.de*

**Prof. Gerhard Wegner**

Max-Planck-Institut  
für Polymerforschung  
Ackermannweg 10  
Postfach 3148  
55128 Mainz, Germany  
*wegner@mpip-mainz.mpg.de*

**Prof. Ulrich Wiesner**

Materials Science & Engineering  
Cornell University  
329 Bard Hall  
Ithaca, NY 14853  
USA  
*ubw1@cornell.edu*

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## 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 led 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 Kreuzel (desk editor, Chemistry) of Springer for their efficiency and their conscientious efforts to ensure timely completion of this book.

Jena, July 2005

*Thomas Heinze*

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