

219

Advances in Polymer Science

Editorial Board:

**A. Abe · A.-C. Albertsson · R. Duncan · K. Dušek · W. H. de Jeu
H.-H. Kausch · S. Kobayashi · K.-S. Lee · L. Leibler · T. E. Long
I. Manners · M. Möller · O. Nuyken · E. M. Terentjev
B. Voit · G. Wegner · U. Wiesner**

Advances in Polymer Science

Recently Published and Forthcoming Volumes

Self-Assembled Nanomaterials II

Nanotubes

Volume Editor: Shimizu, T.

Vol. 220, 2008

Self-Assembled Nanomaterials I

Nanofibers

Volume Editor: Shimizu, T.

Vol. 219, 2008

Interfacial Processes and Molecular Aggregation of Surfactants

Volume Editor: Narayanan, R.

Vol. 218, 2008

New Frontiers in Polymer Synthesis

Volume Editor: Kobayashi, S.

Vol. 217, 2008

Polymers for Fuel Cells II

Volume Editor: Scherer, G. G.

Vol. 216, 2008

Polymers for Fuel Cells I

Volume Editor: Scherer, G. G.

Vol. 215, 2008

Photoresponsive Polymers II

Volume Editors: Marder, S. R., Lee, K.-S.

Vol. 214, 2008

Photoresponsive Polymers I

Volume Editors: Marder, S. R., Lee, K.-S.

Vol. 213, 2008

Polyfluorenes

Volume Editors: Scherf, U., Neher, D.

Vol. 212, 2008

Chromatography for Sustainable Polymeric Materials

Renewable, Degradable and Recyclable

Volume Editors: Albertsson, A.-C.,

Hakkarainen, M.

Vol. 211, 2008

Wax Crystal Control · Nanocomposites Stimuli-Responsive Polymers

Vol. 210, 2008

Functional Materials and Biomaterials

Vol. 209, 2007

Phase-Separated Interpenetrating Polymer Networks

Authors: Lipatov, Y. S., Alekseeva, T.

Vol. 208, 2007

Hydrogen Bonded Polymers

Volume Editor: Binder, W.

Vol. 207, 2007

Oligomers · Polymer Composites Molecular Imprinting

Vol. 206, 2007

Polysaccharides II

Volume Editor: Klemm, D.

Vol. 205, 2006

Neodymium Based Ziegler Catalysts – Fundamental Chemistry

Volume Editor: Nuyken, O.

Vol. 204, 2006

Polymers for Regenerative Medicine

Volume Editor: Werner, C.

Vol. 203, 2006

Self-Assembled Nanomaterials I

Nanofibers

Volume Editor: Toshimi Shimizu

With contributions by

B.-K. Cho · Y.-W. Chung · A. Greiner · N. Higashi · H.-J. Kim
N. Kimizuka · T. Koga · B.-I. Lee · M. Lee · J. H. Wendorff

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.

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: springer.com

Visit the APS content at springerlink.com

ISBN 978-3-540-85102-8

e-ISBN 978-3-540-85103-5

DOI 10.1007/978-3-540-85103-5

Advances in Polymer Science ISSN 0065-3195

Library of Congress Control Number: 2008933503

© 2008 Springer-Verlag Berlin Heidelberg

This work is subject to copyright. All rights are reserved, whether the whole or part of the material is concerned, specifically the rights of translation, reprinting, reuse of illustrations, recitation, broadcasting, reproduction on microfilm or in any other way, and storage in data banks. Duplication of this publication or parts thereof is permitted only under the provisions of the German Copyright Law of September 9, 1965, in its current version, and permission for use must always be obtained from Springer. Violations are liable to prosecution under the German Copyright Law.

The use of general descriptive names, registered names, trademarks, etc. in this publication does not imply, even in the absence of a specific statement, that such names are exempt from the relevant protective laws and regulations and therefore free for general use.

Cover design: WMXDesign GmbH, Heidelberg

Typesetting and Production: le-tex publishing services oHG, Leipzig

Printed on acid-free paper

9 8 7 6 5 4 3 2 1 0

springer.com

Volume Editor

Prof. Dr. Toshimi Shimizu

Nanoarchitectonics Research Center (NARC)
National Inst. of Advanced Industrial Science and Technology (AIST)
1-1-1 Higashi, Tsukuba
Ibaraki 305-8565, Japan
tshnz-shimizu@aist.go.jp

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, UK
DuncanR@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. Wim H. de Jeu

Polymer Science and Engineering
University of Massachusetts
120 Governors Drive
Amherst MA 01003, USA
dejeu@mail.pse.umass.edu

Prof. Hans-Henning Kausch

Ecole Polytechnique Fédérale de Lausanne
Science de Base
Station 6
1015 Lausanne, Switzerland
kausch.cully@bluewin.ch

Prof. Shiro Kobayashi

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

Prof. Kwang-Sup Lee

Department of Advanced Materials
Hannam University
561-6 Jeonmin-Dong
Yuseong-Gu 305-811
Daejeon, South Korea
kslee@hnu.kr

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
ian.manners@bristol.ac.uk

Prof. Martin Möller

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

Prof. Oskar Nuyken

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

Prof. E. M. Terentjev

Cavendish Laboratory
Madingley Road
Cambridge CB 3 0HE, UK
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
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

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 springer.com using the search function.

Color figures are published in full color within the electronic version on SpringerLink.

Preface

Nanotechnology is the creation of useful materials, devices, and systems through the control of matter on the nanometer-length scale. This takes place at the scale of atoms, molecules, and supramolecular structures. In the world of chemistry, the rational design of molecular structures and optimized control of self-assembly conditions have enabled us to control the resultant self-assembled morphologies having 1 to 100-nm dimensions with single-nanometer precision. This current research trend applying the bottom-up approach to molecules remarkably contrasts with the top-down approach in nanotechnology, in which electronic devices are miniaturizing to smaller than 30 nm. However, even engineers working with state-of-the-art computer technology state that maintaining the rate of improvement based on Moore's law will be the most difficult challenge in the next decade.

On the other hand, the excellent properties and intelligent functions of a variety of natural materials have inspired polymer and organic chemists to tailor their synthetic organic alternatives by extracting the essential structural elements. In particular, one-dimensional structures in nature with sophisticated hierarchy, such as myelinated axons in neurons, tendon, protein tubes of tubulin, and spider webs, provide intriguing examples of integrated functions and properties.

Against this background, supramolecular self-assembly of one-dimensional architectures like fibers and tubes from amphiphilic molecules, bio-related molecules, and properly designed self-assembling polymer molecules has attracted rapidly growing interest. The intrinsic properties of organic molecules such as the diversity of structures, facile implementation of functionality, and the aggregation property, provide infinite possibilities for the development of new and interesting advanced materials in the near future. The morphologically variable characteristics of supramolecular assemblies can also function as pre-organized templates to synthesize one-dimensional hybrid nanocomposites. The obtained one-dimensional organic-inorganic, organic-bio, or organic-metal hybrid materials are potentially applicable to sensor/actuator arrays, nanowires, and opto-electric devices.

The present volumes on Self-Assembled Nanofibers (Volume 219) and Nanotubes (Volume 220) provides an overview on those aspects within eight chapters. Different points of view are reflected, featuring interesting aspects related

to (a) the self-assembly of supramolecular nanofibers comprising of organic, polymeric, inorganic and biomolecules (N. Kimizuka, in Volume 219, Chapter 1), (b) controlled self-assembly of artificial peptides and peptidomimetics into nanofiber architectures (N. Higashi, T. Koga, in Volume 219, Chapter 2), (c) self-assembled nanostructures from amphiphilic rod molecules (B.-K. Cho, H.-J. Kim, Y.-W. Chung, B.-I. Lee, M. Lee, in Volume 219, Chapter 3), (d) the production of functional self-assembled nanofibers by electrospinning (A. Greiner, J. H. Wendorff, in Volume 219, Chapter 4), (e) the synthesis of tailored π -electronic organic nanotubes and nanocoils (T. Yamamoto, T. Fukushima, T. Aida, in Volume 220, Chapter 1), (f) preparation and fundamental aspects of nanotubes self-assembled from block copolymers (G. Liu, in Volume 220, Chapter 2), (g) β -1,3-glucan that can act as unique natural nanotubes and incorporate conjugated polymers or molecular assemblies (M. Numata, S. Shinkai, in Volume 220, Chapter 3), and (h) the fabrication of self-assembled polymer nanotubes involving the use of a nanoporous hard template (M. Steinhart, in Volume 220, Chapter 4). A variety of nanofibers and nanotubes with well-defined morphologies and dimensions are discussed in terms of self-assembly of molecular and polymer building blocks in bulk solution or confined geometry like nanopores.

Current materials and manufacturing technologies strongly require technological advances for reducing environmental load combined with energy and resource savings in production. In order to develop such technologies for the development of a sustainable society, research on materials production based on the self-assembly technique is of great interest. Hopefully, these volumes will be beneficial to readers involved with self-organization in the field of bottom-up nanotechnology as well as those concerned with industrial fiber processing.

Tsukuba, June 2008

Toshimi Shimizu

Contents

Self-Assembly of Supramolecular Nanofibers N. Kimizuka	1
Self-Assembled Peptide Nanofibers N. Higashi · T. Koga	27
Self-Assembled Nanofibers and Related Nanostructures from Molecular Rods B.-K. Cho · H.-J. Kim · Y.-W. Chung · B.-I. Lee · M. Lee	69
Functional Self-Assembled Nanofibers by Electrospinning A. Greiner · J. H. Wendorff	107
Subject Index	173

Contents of Volume 220

Self-Assembled Nanomaterials II

Nanotubes

Volume Editor: Shimizu, T.

ISBN: 978-3-540-85104-2

**Self-Assembled Nanotubes and Nanocoils
from π -Conjugated Building Blocks**

T. Yamamoto · T. Fukushima · T. Aida

Block Copolymer Nanotubes Derived from Self-Assembly

G. Liu

**Self-Assembled Polysaccharide Nanotubes
Generated from β -1,3-Glucan Polysaccharides**

M. Numata · S. Shinkai

**Supramolecular Organization of Polymeric Materials
in Nanoporous Hard Templates**

M. Steinhart