267
Advances in Polymer Science

Aims and Scope

The series Advances in Polymer Science presents critical reviews of the present and future trends in polymer and biopolymer science. It covers all areas of research in polymer and biopolymer science including chemistry, physical chemistry, physics, material science.

The thematic volumes are addressed to scientists, whether at universities or in industry, who wish to keep abreast of the important advances in the covered topics.

Advances in Polymer Science enjoys a longstanding tradition and good reputation in its community. Each volume is dedicated to a current topic, and each review critically surveys one aspect of that topic, to place it within the context of the volume. The volumes typically summarize the significant developments of the last 5 to 10 years and discuss them critically, presenting selected examples, explaining and illustrating the important principles, and bringing together many important references of primary literature. On that basis, future research directions in the area can be discussed. Advances in Polymer Science volumes thus are important references for every polymer scientist, as well as for other scientists interested in polymer science - as an introduction to a neighboring field, or as a compilation of detailed information for the specialist.

Review articles for the individual volumes are invited by the volume editors. Single contributions can be specially commissioned.

Readership: Polymer scientists, or scientists in related fields interested in polymer and biopolymer science, at universities or in industry, graduate students.

Special offer:
For all clients with a standing order we offer the electronic form of Advances in Polymer Science free of charge.

More information about this series at
http://www.springer.com/series/12

Susheel Kalia • Yuvaraj Haldorai
Editors

Organic-Inorganic Hybrid Nanomaterials

With contributions by

A.C.S. Alcântara · P. Aranda · A. Celli · Q. Chen · M. Darder · A. Fahmi · M.L. Focarete · M. Gallei · C. Gualandi · Y. Haldorai · K. Haraguchi · R.Y. Hong · E. Ionescu · S. Kalia · S. Kango · S. Kaur · B. Kumari · B. Lund · D. Pathania · R. Reit · E. Ruiz-Hitzky · J.-J. Shim · P. Thakur · W. Voit · B. Wicklein · A. Zucchelli

Springer

Editors
Susheel Kalia
Department of Chemistry
Bahra University
Waknaghat, Dist. Solan (H.P.)
India

Yuvaraj Haldorai
Yeungnam University
School of Chemical Engineering
Gyeongbuk
Korea, Republic of (South Korea)

ISSN 0065-3195 ISSN 1436-5030 (electronic)
ISBN 978-3-319-13592-2 ISBN 978-3-319-13593-9 (eBook)
DOI 10.1007/978-3-319-13593-9
Springer Cham Heidelberg New York Dordrecht London

Library of Congress Control Number: 2014956549

Printed on acid-free paper

Springer is part of Springer Science+Business Media (www.springer.com)

Preface

Organic–inorganic hybrid nanomaterials made up of inorganic nanoparticles and organic polymers represent a new class of materials that exhibit improved performance compared with their individual constituents. These hybrid materials combine the unique properties of organic and inorganic components in one material and are used in sensors and in photocatalytic, antibacterial, electronic, and biomedical applications. Inorganic nanoparticles have a strong tendency to form aggregates; therefore, to improve the stability of dispersions and compatibility of inorganic nanofiller with organic solvents or polymer matrices, the surfaces of inorganic nanofiller should be modified either by grafting polymers onto them or by absorption of small molecules such as silane coupling agents. Surface modification improves the interfacial interactions between inorganic nanofiller and polymer matrix, which results in unique properties such as very high mechanical properties, even at low loadings of inorganic reinforcement, and other optical and electronic properties. This volume provides full information about the fabrication of hybrid nanomaterials, surface functionalization of inorganic nanoparticles, and applications of organic–inorganic nanocomposite materials in various fields.

The various review articles in this volume were contributed by prominent researchers from industry, academia, and research laboratories across the world. This interesting book will prove to be a very useful tool for undergraduate and post-graduate students, scientists, academics, research scholars, materials engineers, and for industry. This volume covers the following topics in the area of hybrid nanomaterials:

In the chapter "Dispersion of Inorganic Nanoparticles in Polymer Matrices: Challenges and Solutions," the synthesis, properties, and applications of nanoparticles; their surface modification; and preparation of polymer–inorganic nanocomposites are reviewed in detail. The chapter "Recent Advances on Fibrous Clay-Based Nanocomposites" reviews recent results on nanocomposite materials derived from the fibrous clay silicates sepiolite and palygorskite and combined with diverse types of polymers, from typical thermoplastics to biopolymers such as polysaccharides, proteins, lipids, and nucleic acids. The chapter "Nanohybrid Materials by Electrospinning" highlights recent progress and current issues in the production of

hybrid nanofibers using the electrospinning technique. Hybrid nanomaterials based on polymer–ceramic are discussed in the chapter "Polymer–Ceramic Nanohybrid Materials." Some advanced applications of polymer–ceramic hybrid nanomaterials are also addressed and compared with those of their polymeric counterparts.

Soft nanohybrid materials with novel organic–inorganic network structures, such as nanohydrogels, soft nanocomposites (solid), and their derivatives are described in the chapter "Soft Nanohybrid Materials Consisting of Polymer–Clay Networks." Synthesis of polymer hybrids based on metal-oxide nanoparticles are discussed in "Fabrication of Metal Oxide–Polymer Hybrid Nanocomposites." Some properties and applications of these hybrid nanocomposites are also discussed in this chapter.

The chapter "Semiconductor-Polymer Hybrid Materials" deals with the synthesis, properties, and applications of semiconductor nanoparticles and semiconductor polymer nanocomposites. Synthesis of semiconductor polymer nanocomposites by melt blending and in situ polymerization is discussed in detail. The properties and some applications of these nanocomposites are also discussed. The chapter "Shape Memory Polymer–Inorganic Hybrid Nanocomposites" discusses methods of preparing shape memory polymer inorganic nanocomposites as well as the effects of fillers on the biological, electromagnetic, and mechanical properties of the resulting nanocomposites. "Frontiers in Nanofabrication via Self-Assembly of Hybrid Materials into Low Dimensional Nanostructures" reviews the different concepts for fabrication of one-dimensional nanostructures based on hybrid materials via directed self-assembly. The concepts describe how different types of self-assembled organic phases drive the unidirectional assembly of the inorganic moieties.

The Editors would like to express their gratitude to all contributors of this book, who have provided excellent contributions.

Susheel Kalia would like to thank his students, who helped him in the editorial work. Finally, we gratefully acknowledge permissions to reproduce copyrighted materials from a number of sources.

Shimla Hills, India — Susheel Kalia
Gyeongsan, Republic of Korea — Yuvaraj Haldorai

Contents