Advances in Polymer Materials and Technology

Edited by
Anandhan Srinivasan • Sri Bandyopadhyay

CRC Press
Taylor & Francis Group

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CRC Press
Taylor & Francis Group
Boca Raton London New York

CRC Press is an imprint of the
Taylor & Francis Group, an **Informa** business

CRC Press
Taylor & Francis Group
6000 Broken Sound Parkway NW, Suite 300
Boca Raton, FL 33487-2742

Printed on acid-free paper
Version Date: 20160405

International Standard Book Number-13: 978-1-4987-1881-3 (Hardback)

Library of Congress Cataloging-in-Publication Data

Names: Srinivasan, Anandhan, editor. | Bandyopadhyay, Sri, editor.
Title: Advances in polymer materials and technology / editors, Anandhan Srinivasan and Sri Bandyopadhyay.
Description: Boca Raton : Taylor & Francis, CRC Press, 2016. | Includes bibliographical references and index.
Identifiers: LCCN 2016002568 | ISBN 9781498718813 (alk. paper)
Subjects: LCSH: Polymers. | Polymeric composites. | Plastics.
Classification: LCC TA455.P58 A324 2016 | DDC 620.1/92--dc23
LC record available at https://lccn.loc.gov/2016002568

Visit the Taylor & Francis Web site at
http://www.taylorandfrancis.com

and the CRC Press Web site at
http://www.crcpress.com

Printed and bound by CPI Group (UK) Ltd, Croydon, CR0 4YY

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Preface

Polymers have occupied an indispensable position in our everyday lives. They are one of the most important engineering materials used in a spectrum of applications, ranging from food to space. Although polymers were previously considered as low-strength materials with low stiffness/toughness, recent research has totally changed that notion. In fact, now polymers are the only materials that can act as matrices for incorporation of the widest range of ceramics, nanotubes, nanoparticles, and short as well as continuous fibers of various kinds to create new building and structural materials. At the same time, polymers are very important materials that can be used as biomaterials, sensors, and in electrical and electronic materials as insulators, conductors, or semiconductors.

This book highlights recent advancements in the field of polymeric materials and technology. Frontier areas such as polymers based on bio-sources, polymer-based ferroelectrics, polymer nanocomposites for capacitors, food packaging, and electronic packaging, organic field emission transistors, superhydrophobic materials, and electrospinning are discussed in this book. We do believe that this book will be suitable for a wide range of audiences working in various interdisciplinary fields of polymer technology.

The chapters are broadly organized into six sections of polymer materials and technology. Section I, "Novel Polymer Composites," discusses new developments in the field of functional nanofillers, layered double hydroxide-based nanocomposites, thermoset nanocomposites, hybrid composites, and fly ash-based composites. Section II, "Nanopolymer Technology," provides an overview of the fundamentals and applications of electrospinning, patterning of polymeric surfaces, electrospun polymer-based piezoelectric sensors, and superhydrophobic polymers. Section III, "Micro-, Macro-, Nanotesting and Characterization of Polymers," presents an analysis of the dynamic properties of polymers by split Hopkinson pressure bar apparatus, thermal conductivity and stability of exfoliated graphite nanoplatelets-based nanocomposites, effect of multiwall carbon nanotubes on miscibility and stability of specialty polymer blends, and effects of strain rate and temperature on mechanical properties of thermosets and their composites. Section IV, "Specialty Polymers," describes shape memory polymers, thermoplastic elastomers, multiferroic characteristics of poly(vinylidene fluoride), novel thiophene-based conducting polymers, and polymer-based dielectrics for capacitors. Section V, "Bio-Based and Biocompatible Polymer Materials," consists of chapters on biopolymers for endovascular applications, thermosets from natural resources, synthesis and properties of gum polysaccharides-based graft copolymers, rheological properties and self-assembly of cellulose nanowhiskers

in biocomposites, and nanocellulose-based bio-nanocomposites. Finally, Section VI, "New Polymer Applications," discusses applications of polymer nanocomposites in biomedical applications, sensitive electronic device packaging, and food packaging. This section also features a novel topic on polymer quenchants for industrial heat treatment.

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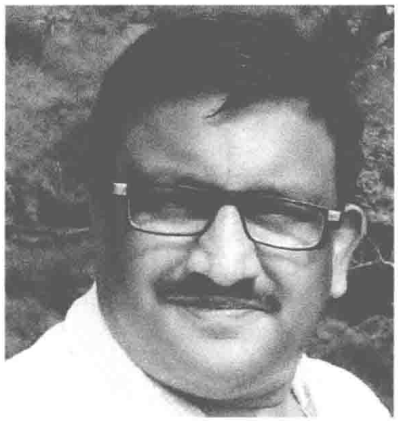
Acknowledgments

We sincerely thank Dr. Gagandeep Singh, Taylor & Francis Group (CRC Press), for inviting us to edit this book and making its publication a reality. We also thank Marsha Pronin, Taylor & Francis Group (CRC Press), Boca Raton, Florida, for her constant support and assistance during various stages of the manuscript preparation.

In addition, we express our deep sense of gratitude to all contributors of the 26 chapters in the diverse but interconnected science and technology areas of polymers/plastics as materials and technology components. The contributors are renowned experts in their respective fields and hail from various academic institutes and industries around the world. We are grateful to them for their time and efforts to make this venture successful. We also appreciate their patience in waiting for the book to be published.

Professor Anandhan Srinivasan is grateful to his PhD students, Dr. Gibin and Dr. Sachin, for their assistance throughout the final stages of preparation of this book. Professor Sri Bandyopadhyay particularly thanks Professor Paul Munroe, his head of school; Professor Merlin Crossley, deputy vice-chancellor (Education); Professor Les Field AM, vice president/senior deputy vice-chancellor; and Professor Ian Jacobs, president/vice chancellor of UNSW Australia, for their continued encouragement. The editors thank various authors, editors, and journals for permitting them to reproduce copyright materials. The editors also thank their respective families, acknowledging their valuable support. Last but not the least, the editors thank their colleagues and research staff for their support.

Editors



Anandhan Srinivasan earned his PhD in polymer science and technology from the Indian Institute of Technology, Kharagpur, India (IIT KGP), in 2004. He was a postdoctoral fellow and lecturer in the Department of Applied Organic Materials Engineering, Inha University, Incheon, South Korea, during 2004–2005. He was an assistant professor in the Department of Materials Science at the Asian Institute of Medicine, Science & Technology (AIMST) University, Bedong, Malaysia, during 2005–2008. He has been serving at the National Institute of Technology Karnataka, Mangaluru, India, since February 2009. He researches in the areas of advanced ceramic and polymeric nanofibers, polymer blends, polymer composites, thermoplastic elastomers, and waste materials and fly ash utilization. Four students have completed their doctoral research under his supervision and three more students are continuing their PhD studies under his supervision. He was a gold medalist in both BSc and MSc. The Australia–India Council fellowship and Department of Science and Technology (DST, Government of India) fast-track award are noteworthy among the awards that he has received. He is on the editorial board of the *International Journal of Energy Engineering*, Hong Kong. He has been a referee for a number of reputed international journals. He is an author of 50 international journal articles, 2 patents, 7 book chapters, and 30 conference papers. Dr. Srinivasan has delivered invited talks in a number of international conferences, workshops, and seminars. His PhD students have won first prizes for their paper/poster in two international conferences. His biography has been featured in the 11th and 12th editions of *Marquis Who's Who in Science and Engineering.*

Sri Bandyopadhyay is now a senior visiting fellow in the School of Materials Science and Engineering, Faculty of Science, University of New South Wales (UNSW), Australia. He is a researcher in the fields of composites and nanocomposites. In August 2013, Australia's Campus Review Management selected him as "One of Top Five Australian Innovators" for his reinvention of coal power fly ash.

Sri Bandyopadhyay has about 140 refereed research publications plus 4 provisional patents, and 4 easy access intellectual properties on new composite materials, including metal matrix composites, polymer matrix composites, fly ash recycling, and carbon nanotube composites.

He is the chair of composites conferences known as ACUN (Australia, Canada, United States, and New Zealand), which happened on six occasions between 1999 and 2012 in UNSW and Monash University, Melbourne, Australia. Some of the ACUN conferences were ranked among top 5–10 in the world by attending delegates from more than 20 countries.

Sri Bandyopadhyay is the editor-in-chief of the *International Journal of Energy Engineering*, published by the World Academic Publishing Company. He served as an academic researcher at UNSW, Australia. Prior to that, he worked at the Defence Science and Technology Organisation (DSTO), Department of Defence, Materials Research Laboratories, Melbourne, Australia, where he was given the Best Scientist Award for his innovative research on "In Situ SEM Deformation and Fracture Studies of Polymers and Polymer–Matrix Composites." He also worked at the Australian Dental Standards Laboratory, Abbotsford, Victoria, Australia, and Indian Space Research Organisation, Bengaluru, India.

Sri Bandyopadhyay was invited as a visiting professor/academic at (1) École Polytechnique Fédérale de Lausanne (EPFL), Lausanne, Switzerland; Polymer Laboratory (Host: Professor H.H. Kausch); (2) Center for Composite Materials (Host: Professor R.P. Wool), University of Delaware, Newark, Delaware; (3) NanoScience Technology Center (Host: Professor Sudipta Seal), University of Central Florida, Orlando, Florida; (4) School of Physical Sciences (Host: Professor H.B. Bohidar), Jawaharlal Nehru University, New Delhi, India; (5) Department of Metallurgy and Materials Science (Hosts: Professors M.K. Banerjee and N.R. Bandyopadhyay), Indian Institute of Engineering Science and Technology (erstwhile Bengal Engineering and Science University) Shibpur, India; (6) Materials Science Center (Host: Professor Ajit K. Banthia), IIT, Kharagpur, India; and (7) School of Materials Science & Nanotechnology, Jadavpur University, Kolkata, India (UGC fellow with Professor Siddhartha Mukherjee).

Professor Sri Bandyopadhyay initiated the concept of today's Australia–India Science Research Funded (AISRF) scheme project by approaching India's 11th President Dr. A.P.J. Abdul Kalam in 2004, and Dr. Kalam kindly followed it through the Department of Science and Technology (Government of India), which was then taken over by the Department of Industry, Innovation, Science and Research (Australian Government).

Professor Bandyopadhyay was allotted a targeted allocation project on "Nanocomposite Materials in Clean Energy: Generation, Storage and Savings," involving six Australian and six Indian research academics, between 2008 and 2012. This project generated 115 publications, including 85 refereed journal paper publications/submissions and 4 provisional patent applications.

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