Advanced Polymeric Materials

Structure Property Relationships

Edited by
Gabriel O. Shonaike
Suresh G. Advani

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Preface

A book on advanced polymeric materials could not possibly be written by the two editors alone. The areas that we have covered here are currently undergoing explosive growth, and it is imperative that these topics be addressed by scientists at the vanguard of their specialties. Therefore, *Advanced Polymeric Materials: Structure Property Relationships* is presented as a contributed volume and has been segmented into four major sections: fiber-reinforced composites, nanocomposites, polymer blends, and bioengineering. It contains fourteen chapters written by polymer researchers and scientists from various laboratories worldwide.

The bioengineering section covers a wide range focusing on the application of both synthetic polymers such as poly(α-hydroxyesters) poly(anhydrides) in tissue engineering and drug delivery. Polymerization, structure, and properties and applicability of the polymers are discussed in detail. The book also addresses the recent advances in nano materials which have led to the development of nano-structured biomaterials for tissue engineering. The increasing demand for absorbable biodegradable polymeric materials for biomedicine where the material absorbs *in vivo* but degrades *in vitro* is well explained via mechanisms which may be enzymatic and/or hydrolytic.

One of the major problems associated with thermoset composites, and particularly vinyl ester resin composites, is their brittle behavior. The book explains how to overcome this problem through the use of pre-formed core-shell rubber particles produced through emulsion polymerization. The dependency of mechanical, thermal, physical, and chemical properties on copolymer composition and degree of cross-linking of IPN-like systems made of LDPE and vinyl polymers are fully analyzed.

Advanced Polymeric Materials: Structure Property Relationships also discusses the recent advances in barrier polymers, which are increasingly in demand and are replacing the traditional materials in the packaging, medical, and automotive industries. The success of these materials based on their properties and processing techniques, including multi-layered structures, are well documented.

Fiber-reinforced composites, which are still in great demand, especially in aerospace application, are examined. Various processing techniques — particularly close mold and manufacturing of Z-pinned composites — along with the design optimization are discussed to accentuate their versatility. A review of nanotechnology is presented, with chapters on carbon nanotubes and their properties, and also on nanocomposites based on clay.

Advanced Polymeric Materials: Structure Property Relationships addresses the issues, characterization, durability, processing, and properties of advanced polymeric materials in various applications.

Editors

Gabriel O. Shonaike is a consultant associated with Borden Chemical Inc., Oilfield Products Research Laboratory, Houston, Texas. He earned his master's degree at the University of Strathclyde, Glasgow, Scotland. A three-year research led to the award of a Ph.D. in materials science at the University of London in 1986.

Dr. Shonaike has worked in both academia and private industry, lecturing at institutions in three countries. He has been an advisor at Nippon Gohsei, Japan, and has worked as a senior scientist at Noltex LLC, Houston, and Borden Chemical. He also worked at Omron Corporation, Kyoto. He has taught at Kyoto Institute of Technology, Kyoto, University Sains, Malaysia, and Himeji Institute of Technology, Japan. Dr. Shonaike is the author or coauthor of over 100 research papers and book chapters in the areas of polymer blends and composites. He also co-edited the book *Polymer Blends and Alloys* (Mercel Dekker, N.Y., 1999).

Dr. Shonaike is a chartered engineer (Engineering Council, UK) and member of various professional institutions, including the Institute of Materials (UK), the Textile Institute (UK), and the Society of Plastics Engineers (USA). His research activities include studies on deformation of polymeric materials, structure–property relationship, fabrication and characterization of mechanical properties of thermoplastic composites, polymer blends, and coatings.

Suresh G. Advani is a professor in the Mechanical Engineering Department and associate director of the Center for Composite Materials at the University of Delaware. He received his B. Tech. Degree in mechanical engineering from the Idian Institute of Technology, Bombay in 1982 and his Ph.D. in mechanical engineering from University of Illinois at Urbana–Champaign in 1987. His research interests are in rheology; fluid mechanics and heat transfer as applied to manufacturing processes especially for polymers, nano composites, and polymer composite processing. He has co-authored over 200 journal and conference proceedings articles and has contributed chapters to and co-edited over 20 books. He has also co-authored a recent text, *Process Modeling in Composites Manufacturing (Manufacturing Engineering and Materials Processing, 59)* (Marcel Dekker, 2002). Advani is a Fellow of the American Society of Mechanical Engineers and was recently appointed as the North American editor for the journal *Composites A: Applied Science and Manufacturing*. Professor Advani also serves on the Scientific Advisory Committee of the *Journal of Forming Processes* and the International Conference on Flow Processes in Composites Manufacturing. He is a member of Amer-

ican Society of Mechanical Engineers, Society of Plastic Engineers, Society of Rheology, and Society for Advancement of Materials and Processes.

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Gabriel O. Shonaike
Suresh G. Advani

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Dedication

To my parents, Kamla and Gopaldas Advani, my brother, Dr. Devidas Advani, and my family, Yolanda, Machu, and Diana.

S. Advani

To my parents, Edward and Comfort Shonaike and my family, Garrett, Kennett, Amy, and Victoria.

G.O. Shonaike

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Design Optimization of Composite Laminates under Deterministic and Uncertain Conditions

Sarp Adali

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