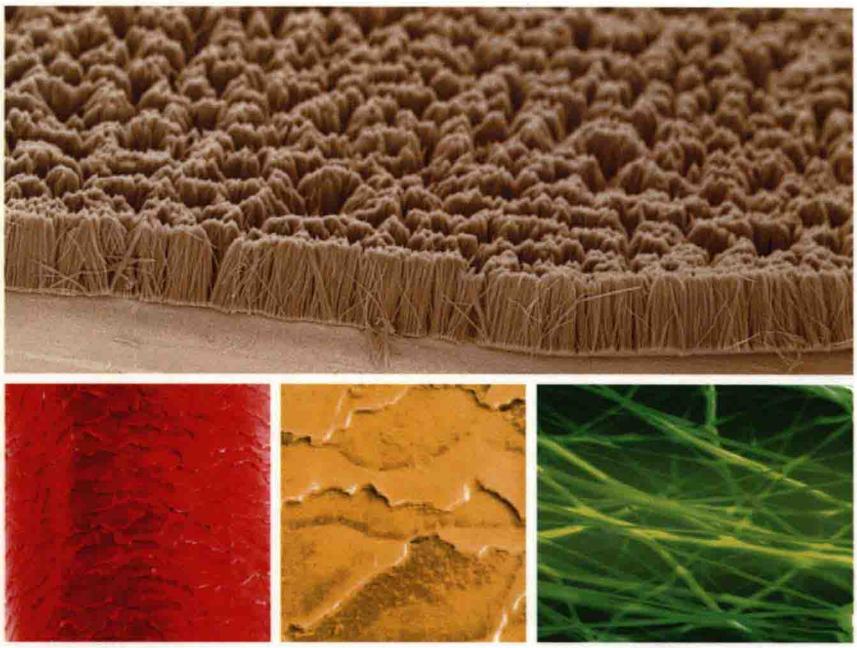
Micro- and Nanostructured **POLYMER SYSTEMS**

From Synthesis to Applications



Editors
Sabu Thomas, PhD, Robert A. Shanks, PhD, Jithin Joy

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From Synthesis to Applications

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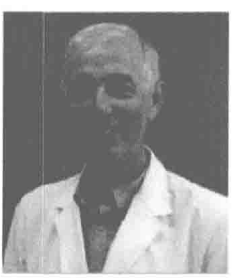
Prof. Sabu Thomas is a Professor of Polymer Science and Engineering at the School of Chemical Sciences and Director of the International and Inter University Centre for Nanoscience and Nanotechnology at Mahatma Gandhi University, Kottayam, Kerala, India. He received his BSc degree (1980) in Chemistry from the University of Kerala, B.Tech. (1983) in Polymer Science and Rubber Technology from the Cochin University of Science and Technology, and PhD (1987) in Polymer Engineering from the Indian Institute of Technology, Kharagpur. The research activities of Professor Thomas include surfaces and interfaces in multiphase polymer blend and composite systems, phase separation in polymer blends, compatibilization of immiscible polymer blends, thermoplastic elastomers, phase transitions in polymers, nanostructured polymer blends, macro-, micro- and nanocomposites, polymer rheology, recycling, reactive extrusion, processing–morphology–property relationships in multiphase polymer systems, double networking of elastomers, natural fibers and green composites, rubber vulcanization, interpenetrating polymer networks, diffusion and transport and polymer scaffolds for tissue engineering. He has supervised 66 PhD thesis, 40 MPhil thesis, and 45 Masters theses. He has three patents to his credit. He also received the coveted Sukumar Maithy Award as the best polymer researcher in the country for the year 2008. Very recently, Professor Thomas received the MRSI and CRSI medals for his excellent work. With over 600 publications to his credit and over 17,000 citations, with an h-index of 67, Dr. Thomas has been ranked fifth in India as one of the most productive scientists.



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Dr. Robert Shanks is an Emeritus Professor of Polymer Science at the Royal Melbourne Institute of Technology (RMIT University) in Melbourne, Australia. He is the author of over 230 refereed journal papers, 22 book chapters, eight patents, and 378 conference papers on or related to polymer science. He is the recipient of many awards, including the BHERT (Business Higher Education Round Table) Award for academic-industry collaboration, 2005; RACI Polymer Division Citation, 1990; the Cooperative Research Centres' (CRC) Association Award and CRC Award for

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LIST OF ABBREVIATIONS

AA	acrylic acid
AFM	atomic force microscope
AgNPs	silver nanoparticles
APS	ammonium per sulfate
BC	bacterial cellulose
BCNC	bacterial cellulose nanocrystals
BER	bulk electrical resistivity
BFE	basalt fabric reinforced epoxy
BFP	basalt fabric reinforced polyester composite
BM	batch mixer
BNN-PS	barium sodium niobate-polystyrene
CF	carbon fibers
CNCs	cellulose nanocrystals
CNFs	carbon nanofibers
CNTs	carbon nanotubes
COD	chemical oxygen demand
CP/MASNMR	crossed polarization and magic angle spinning nuclear magnetic resonance
CPE	chlorinated polyethylene
CT	computer tomography
CVD	chemical vapor deposition
DIDP	di-isodecyl phthalate
DMM	digital multi-meter
DSC	differential scanning calorimeter
DSM	twin-screw micro-compounder
EAPaP	"smart material" or "electroactive paper"
EM SE	electromagnetic shielding effectiveness
EMC	electromagnetic compatibility
EMI	electromagnetic interference
ENR	epoxidized natural rubber
ESD	electrostatic discharge
ESD	electrostatic dissipation
ETFE	ethylene tetrafluoroethylene
FTIR	fourier transform infrared
FWHM	full width at half maximum
GC	gas chromatography

Gd_2O_3	gadolinium (III) oxide
GPC	gel permeation chromatography
HALS	hindered amine light stabilizer
HR-TEM	high resolution transmission electron Microscopy
HPLC	high performance liquid chromatography
HPMC	hydroxypropyl methylcellulose
HT	thermal treatment
IDT	initial decomposition temperature
i-PMMA	PMMA isotactic
IPN	inter penetrating network
KGM	starch-konjac glucomannan
KOH	potassium hydroxide
LLDPE	linear, low-density polyethylene
LSPR	localized surface plasmon resonance
MA	maleic acid
MB	methylene blue
MBTS	mercaptobenzothiazyl disulfide
mCPBA	*m*-chloroperoxybenzoic acid
MEKP	methyl ethyl ketone peroxide
MFA	multifunctional acrylates
MWNT	multi-walled carbon nanotubes
MWS	Maxwell-Wagner-Sillars polarization
nano-$CaCO_3$	nanoscale calcium carbonate
NBR	acrylonitrile-butadiene rubber
NMBA	N,N'-methylenebisacrylamide
NRF	National Research Foundation
OM	optical microscopy
PAAAM	poly(acrylate- acrylic acid-co maleic acid)
PAM	polyacrylamide
PAMA	poly(n-amyl methacrylate)
PBA	poly(butyl acrylate)
PBMA	poly(butyl methacrylate)
PCP	polychloroprene
PDMDPS	polydimethyldiphenylsiloxane
PDPS	polydiphenylsiloxane
PE	polyethylene
PEA	poly(ethyl acrylate)
PEG	polyethylene glycol
PEMA	poly(ethyl methacrylate)
PEO	polyethylene oxide
PHO	poly(β-hydrox-yoctanoate)
PIB	poly(iso butylene)

PLA	polylactic acid
PMMA	poly(methyl methacrylate)
POE	polyolefin elastomer
POM	polyoxymethylene
PPy	polypyrrole
PVA	poly(vinyl alcohol)
PVC	poly(vinyl chloride)
PVP	poly (vinyl pyrrolidone)
RGA	residual gas analyzer
SAP	superabsorbent polymers
SAXS	small-angle x-ray scattering
SCE	saturated calomel electrode
SEI	secondary electron image
SEM	scanning electron micrographs
SEM-EDX	scanning electron microscopy-energy dispersive X-ray
SERS	surface enhancing Raman scattering
SICART	sophisticated instrument center for applied research and testing
SMA	styrene maleic anhydride
SP/s	seaweed polysaccharide/s
SPHs	SUPERPOROUS hydrogels
s-PMMA	syndiotactic
TEM	transmission electron microscopy
TG	thermogravimetry
TGA	thermo gravimetric analyzer
TMTD	tetramethylthiuram disulfide
ToF-SIMS	time of flight secondary ion mass spectrometry
TPS	thermoplastic starch
TPU	thermoplastic polyurethane
UHV	ultra-high vacuum
UPVC	unplasticized poly(vinyl chloride)
USEPA	US Environmental Protection Agency
UV/Vis	UV/visible spectroscopy
WHO	World Health Organization
WVTR	water vapor transmission rate
XRD	X-ray diffraction
X-RD	X-ray diffractometry

PREFACE

This book, **Micro- and Nanostructured Polymer Systems: From Synthesis to Applications**, describes the recent advances in the development and characterization of multicomponent polymer blends and composites. It covers occurrence, synthesis, isolation and production, properties and applications, modification, and also the relevant analysis techniques to reveal the structures and properties of polymer systems. Bio-based polymer blends and composites occupy a unique position in the dynamic world of new biomaterials. Natural polymers have attained their cutting-edge technology through various platforms; yet, there is a lot of novel information about them, that is discussed in this book.

This book covers topics such as biopolymer-synthetic systems, nanomaterial-polymer structures, multi-characterization techniques, polymer blends, composites, polymer gels, polyelectrolytes and many other interesting aspects. It is written in a systematic and comprehensive manner. The content of the present book is unique. It covers an up-to-date record on the major findings and observations in the field of micro- and nanostructured polymer systems.

This book will be a very valuable reference source for university and college faculties, professionals, post-doctoral research fellows, senior graduate students, polymer technologists, and researchers from R&D laboratories working in the area of nanoscience, nanotechnology, and polymer technology.

Finally, the editors would like to express their sincere gratitude to all the contributors of this book, who extended excellent support to the successful completion of this venture. We are grateful to them for the commitment and the sincerity they have shown toward their contribution in the book. Without their enthusiasm and support, the compilation of this volume could not have been possible. We would like to thank all the reviewers who have taken their valuable time to make critical comments on each chapter. We also thank the publisher Apple Academic Press for recognizing the demand for such a book and for realizing the increasing importance of the area of micro- and nanostructured polymer systems and for starting such a new project.

—Sabu Thomas, Robert A. Shanks, and Jithin Joy

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