

Key Engineering Materials

Volume II

Interdisciplinary Concepts and Research

Editors

François Kajzar, PhD

Eli M. Pearce, PhD

Nikolai A. Turovskij, PhD

Omari V. Mukbaniani, DSc



Apple Academic Press



CRC Press
Taylor & Francis Group

KEY ENGINEERING MATERIALS

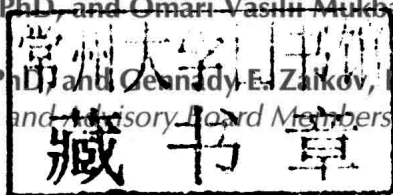
Volume II: Interdisciplinary Concepts and Research

Edited by

François Kajzar, PhD, Eli M. Pearce, PhD,
Nikolai A. Turovskij, PhD, and Omari Vasilii Mukhaniani, DSc

A. K. Haghi, PhD, and Genady E. Zarkov, DSc

Reviewers and Advisory Board Members



Apple Academic Press

TORONTO NEW JERSEY

Apple Academic Press Inc. 3333 Mistwell Crescent Oakville, ON L6L 0A2 Canada	Apple Academic Press Inc. 9 Spinnaker Way Waretown, NJ 08758 USA
---	---

©2014 by Apple Academic Press, Inc.
Exclusive worldwide distribution by CRC Press, a member of Taylor & Francis Group

No claim to original U.S. Government works
Printed in the United States of America on acid-free paper

International Standard Book Number-13: 978-1-926895-74-1 (Hardcover)

This book contains information obtained from authentic and highly regarded sources. Reprinted material is quoted with permission and sources are indicated. Copyright for individual articles remains with the authors as indicated. A wide variety of references are listed. Reasonable efforts have been made to publish reliable data and information, but the authors, editors, and the publisher cannot assume responsibility for the validity of all materials or the consequences of their use. The authors, editors, and the publisher have attempted to trace the copyright holders of all material reproduced in this publication and apologize to copyright holders if permission to publish in this form has not been obtained. If any copyright material has not been acknowledged, please write and let us know so we may rectify in any future reprint.

Trademark Notice: Registered trademark of products or corporate names are used only for explanation and identification without intent to infringe.

Library of Congress Control Number: 2013956108

Library and Archives Canada Cataloguing in Publication

Key engineering materials.

Includes bibliographical references and index.

Contents: v. 1. Current state of the art on novel materials/edited by Devrim Balköse, PhD, Daniel Horak, PhD, and Ladislav Šoltés, DSc; A. K. Haghi, PhD, and G. E. Zaikov, DSc, reviewers and advisory board members -- v. 2. Interdisciplinary concepts and research/edited by François Kajzar, PhD, Eli M. Pearce, PhD, Nikolai A. Turovskij, PhD, and Omari Vasilii Mukbaniani, DSc; A. K. Haghi, PhD, and Gennady E. Zaikov, DSc, reviewers and advisory board members.
ISBN 978-1-926895-74-1 (v. 2: bound)

1. Materials. I. Balköse, Devrim, editor of compilation II. Horák, D. (Daniel), editor of compilation III. Šoltés, Ladislav, editor of compilation IV. Title: Current state of the art on novel materials. V. Title: Interdisciplinary concepts and research.

TA403.K49 2014

620.1'1

C2013-908007-4

Apple Academic Press also publishes its books in a variety of electronic formats. Some content that appears in print may not be available in electronic format. For information about Apple Academic Press products, visit our website at www.appleacademicpress.com and the CRC Press website at www.crcpress.com

KEY ENGINEERING MATERIALS

Volume II: Interdisciplinary Concepts and Research

ABOUT THE EDITORS

François Kajzar, PhD

François Kajzar, PhD, is currently Associate Research Director at the University of Angers in France. He has taught and lectured at Jagellonian University, Kraków, Poland; the Academy of Mining and Metallurgy, Kraków; and the National Research Council-Institute of Structure of Matter (ISM-CNR), Bologna, Italy, among other places. He was the Research Director and Senior Scientist at the Atomic Energy and Alternative Energies Commission, France. He has won numerous awards for his work and has written over 450 papers, books and book chapters, and conference presentations. He is also the editor of several journals and is on the editorial review boards of several others. His specialization fields include nonlinear optics, materials research, biomaterials, and biophotonics.

Eli M. Pearce, PhD

Dr. Eli M. Pearce was President of the American Chemical Society. He served as Dean of the Faculty of Science and Art at the Polytechnic Institute of New York University, as well as a professor of chemistry and chemical engineering. He was Director of the Polymer Research Institute, also in Brooklyn. At present, he consults for the Polymer Research Institute. A prolific author and researcher, he edited the *Journal of Polymer Science* (Chemistry Edition) for 25 years and was an active member of many professional organizations.

Nikolai A. Turovskij, PhD

Nikolai A. Turovskij, PhD, is currently Associate Professor, Physical Chemistry Department, Donetsk National University, Donetsk, Ukraine. He is the author of more than 200 scientific works and six author's certificates on invention. He is a supervisor of four candidates' theses, and the head of two scientific projects of the International Scientific Fund and two projects of the International Soros Science Education Program. Dr. Turovskij has worked in the L. M. Litvinenko Institute of Physical Organic and Coal Chemistry National Academy of Sciences of Ukraine in job titles of junior research fellow and senior scientific employee. His research interests include kinetics, structural chemistry, and molecular modeling of the supramolecular reactions of organic peroxides.

Omari Vasilii Mukbaniani, DSc

Omari Vasilii Mukbaniani, DSc, is Professor and Director of the Macromolecular Chemistry Department of the I. Javakhishvili Tbilisi State University, Tbilisi, Georgia. He is also the Director of the Institute of Macromolecular Chemistry of Academy of

Sciences of the Czech Republic. For several years he was a member of advisory board of the *Journal Proceedings of Iv. Javakhishvili Tbilisi State University* (Chemical Series), contributing editor of the journal *Polymer News* and the *Polymers Research Journal*. His research interests include polymer chemistry, polymeric materials, and chemistry of organosilicon compounds. He is an author more than 360 publication, 8 books, 3 monographs, and 10 inventions.

REVIEWERS AND ADVISORY BOARD MEMBERS

A. K. Haghi, PhD

A. K. Haghi, PhD, holds a BSc in urban and environmental engineering from University of North Carolina (USA); a MSc in mechanical engineering from North Carolina A&T State University (USA); a DEA in applied mechanics, acoustics and materials from Université de Technologie de Compiègne (France); and a PhD in engineering sciences from Université de Franche-Comté (France). He is the author and editor of 65 books as well as 1000 published papers in various journals and conference proceedings. Dr. Haghi has received several grants, consulted for a number of major corporations, and is a frequent speaker to national and international audiences. Since 1983, he served as a professor at several universities. He is currently Editor-in-Chief of the *International Journal of Chemoinformatics and Chemical Engineering* and *Polymers Research Journal* and on the editorial boards of many international journals. He is a member of the Canadian Research and Development Center of Sciences and Cultures (CRDCSC), Montreal, Quebec, Canada.

Gennady E. Zaikov, DSc

Gennady E. Zaikov, DSc, is Head of the Polymer Division at the N. M. Emanuel Institute of Biochemical Physics, Russian Academy of Sciences, Moscow, Russia, and Professor at Moscow State Academy of Fine Chemical Technology, Russia, as well as Professor at Kazan National Research Technological University, Kazan, Russia. He is also a prolific author, researcher, and lecturer. He has received several awards for his work, including the Russian Federation Scholarship for Outstanding Scientists. He has been a member of many professional organizations and on the editorial boards of many international science journals.



LIST OF CONTRIBUTORS

O. R. Abdurakhmonov

The Institute of General and Inorganic Chemistry, National Academy of Sciences, Uzbekistan.

Y. A. Antonov

N. M. Emanuel Institute of Biochemical Physics, Russian Academy of Sciences, Kosigin str. 4, Moscow-119334, Russia.

S. N. Bondarenko

Volzhsky Polytechnical Institute, branch of Federal State Budgetary Educational Institution of Higher Professional Education, Volgograd State Technical University, Engels str. 42a, Volzhsky-404121, Volgograd Region, Russia.

E-mail: d.provotorova@gmail.com; www.volpi.ru

A. V. Bychkova

Federal State Budgetary Institution of Science Emanuel Institute of Biochemical Physics of Russian Academy of Sciences, Kosygina str. 4, Moscow-119334, Russia.

E-mail: annb0005@yandex.ru

A. A. Dalinkevich

Central Scientific Research Institute of Special Machine-Building, Zavodskaya str. 1, Khotkovo-141371, Moscow region, Russia.

E-mail: dalinkevich@yandex.ru

K. S. Dibirova

Dagestan State Pedagogical University, Yaragskii str. 57, Makhachkala-367003, Russian Federation.

S. N. Gaidamaka

Moscow State University, Chemistry Faculty, Department of Chemical Enzymology, Leninskoye MSU 1/11, Moscow-119991, Russia, Phone: +7(495) 939-5083, Fax: +7(495) 939-5417.

E-mail: vp_murygina@mail.ru, vpm@enzyme.chem.msu.ru

K. Z. Gumargalieva

N. N. Semenov Institute of Chemical Physics, RAS, Kosygin str. 4, Moscow-119991, Russia.

E-mail: guklara@yandex.ru

A. K. Haghi

University of Guilan, Rasht, Iran.

N. V. Ilyashenko

Tver State University, Zheliabova str. 33, Tver-170100, Russia.

A. I. Ivanova

Tver State University, Zheliabova str. 33, Tver-170100, Russia.

V. F. Kablov

Volzhsky Polytechnical Institute, Branch of Federal State Budgetary Educational Institution of Higher Professional Education, Volgograd State Technical University, Engels str. 42a, Volzhsky-404121, Volgograd Region, Russia.

E-mail: d.provotorova@gmail.com; www.volpi.ru

N. A. Keibal

Volzhsky Polytechnical Institute, Branch of Federal State Budgetary Educational Institution of Higher Professional Education, Volgograd State Technical University, Engels str. 42a, Volzhsky-404121, Volgograd Region, Russia.

E-mail: d.provotorova@gmail.com; www.volpi.ru

G. V. Kozlov

N. M. Emanuel Institute of Biochemical Physics of Russian Academy of Sciences, Kosygin str. 4, Moscow-119334, Russian Federation.

S. M. Lomakin

N. M. Emanuel Institute of Biochemical Physics, Russian Academy of Sciences, Kosygin str. 4, Moscow-119334, Russia.

E-mail: Chembio@sky.chph.ras.ru

G. M. Magomedov

Dagestan State Pedagogical University, Makhachkala-367003, Yaragskii str. 57, Russian Federation.

S. S. Marakhovsky

«Armoproject» Company» LLC, dominion 27 Malakhitovaya str., Moscow-129128,

E-mail: cmc@aproject.ton.ru

T. I. Medintseva

Semenov Institute of Chemical Physics of Russian Academy of Sciences, Kosygin str. 4, Moscow-119991.

Y. P. Miroshnikov

Lomonosov Moscow State University for Fine Chemical Technology.

E-mail: ypm@mail.ru

P. Moldenaers

K. U. of Leuven, Department Chemical Engineering, Willem de Croylaan 46, Leuven- B-3001, Belgium.

V. P. Murygina

Moscow State University, Chemistry Faculty, Department of Chemical Enzymology, Leninskyye gory MSU, 1/11, Moscow-119991, Russia, Phone: +7(495) 939-5083, Fax: +7(495) 939-5417.

E-mail: vp_murygina@mail.ru, vpm@enzyme.chem.msu.ru

B. E. Murzabekov

JSC “Sea oil company”, “KazMunayTeniz”, Kazakhstan.

Yu. G. Oleneva

Tver State University, Zheliabova str., 33, Tver-170100, Russia.

Elena L. Pekhtasheva

G.V. Plekhanov Russian Economic University, 36 Stremyannyi way, Moscow-117997 Russia.

E-mail: pekhtashevael@mail.ru

M. A. Poldushov

Lomonosov Moscow State University for Fine Chemical Technology

E-mail: poldushov@mail.ru

D. A. Provotorova

Volzhsky Polytechnical Institute, branch of Federal State Budgetary Educational Institution of Higher Professional Education, Volgograd State Technical University, Engels str. 42a, Volzhsky-404121, Volgograd Region, Russia.

E-mail: d.provotorova@gmail.com; www.volpi.ru

E. V. Prut

Semenov Institute of Chemical Physics of Russian Academy of Sciences, Kosygin str. 4, Moscow-119991.

M. A. Rosenfeld

Federal state budgetary institution of science Emanuel Institute of Biochemical Physics of Russian Academy of Sciences, Kosygina str. 4, Moscow-119334, Russia.

P. A. Sakharov

N. M. Emanuel Institute of Biochemical Physics, Russian Academy of Sciences, Kosygin str. 4, Moscow-119334, Russia.

E-mail: Chembio@sky.chph.ras.ru

Z. S. Salimov

The Institute of General and Inorganic Chemistry, National Academy of Sciences, Uzbekistan.

Sh. M. Saydakhmedov

The Institute of General and Inorganic Chemistry, National Academy of Sciences, Uzbekistan.

F. B. Shevlyakov

Ufa State Petroleum Technological University, Russia.

A. V. Soukhanov

«Armoproject» Company» LLC, dominion 27 Malakhitovaya str., Moscow-129128,

E-mail: cmc@aproject.ton.ru

S. Ya. Trofimov

Moscow State University, Chemistry Faculty, Department of Chemical Enzymology, Leninskoye MSU, 1/11, Moscow-19991, Russia, Phone: +7(495) 939-5083, Fax: +7(495) 939-5417.

E-mail: vp_murygina@mail.ru, vpm@enzyme.chem.msu.ru

T. G. Umergalin

Ufa State Petroleum Technological University, Russia.

G. E. Zaikov

N. M. Emanuel Institute of Biochemical Physics, Russian Academy of Sciences, Kosygin str. 4, Moscow-119334, Russia.

E-mail: Chembio@sky.chph.ras.ru

V. P. Zakharov

Bashkir State University, Russia.

E-mail: zaharovvp@mail.ru



LIST OF ABBREVIATIONS

AFM	Atomic force microscopy
ATP	Adenosine triphosphate
BGAF	Benzoguanamine formaldehyde resins
BSA	Bovine serum albumin
CNR	Chlorinated natural rubber
CP	Critical point
DC	Dupli-color
DEX	Dextran
DLS	Dynamic light scattering
DM	Dry matter
DSS	Dextran sulfate sodium
DTGS	Deuterated triglycine sulfate
EDX	Energy-dispersive X-ray
ELPP	Elastomeric polypropylene
EPDM	Ethylene propylene diene monomer
EPR	Ethylene propylene rubber
ESEM	Environment scanning electron microscope
ESR	Electron spin resonance
FG	Fibrinogen
FID	Flame ionization detector
FMR	Ferromagnetic resonance
FPLC	Fast protein liquid chromatography
FTIR	Fourier transform infrared
GAG	Glycosaminoglycan
GC	Gas chromatograph
GFU	Gas fractionation unit
HC	Hydrocarbons
HCO	Hydrocarbon oxidizing
HDPE	High density polyethylene
HPLC	High-performance liquid chromatography
HT	Heterotrophic bacteria
IEF	Iso-electric focusing
IPP	Isotactic polypropylene
IR	Infrared
IR MDCIR	Infrared microscopy of multiply disturbed complete inner reflection
LDPE	Low density polyethylene
MBTS	Dibenzothiazole disulfide
MFI	Melt flow index

MLR	Mass loss rates
MNPs	Magnetic nanoparticles
MNSs	Magnetically targeted nanosystems
MPN	Most probably number
NMR MAS	Nuclear magnetic resonance, magic-angle spinning
OM	Optical microscopy
OSR	Oxidized starch reagent
PE	Polyethylenes
PEG	Poly(ethylene glycol)
PIB	Polyisobutylene
PMPA	Polyelectrolyte-mediated protein adsorption
PMPAS	Polyelectrolyte mediated protein association
PP	Polypropylene
PVC	Polyvinyl chloride
RHR	Rate of heat release
SA	Sodium alginate
SALS	Small angle light scattering
SBR	Styrene-butadiene rubber
SBS	Styrene-butadiene-styrene
SC	Sodium caseinate
SA	sodium alginate
SEM	Scanning electron microscopy
SiH	Silicon hydride
SLS	Static light scattering
SP	Softening point
TEAT	Triethanolaminotitanate
TMTD	Tetramethylthiuram disulfide
TPEs	Thermoplastic elastomers
TPV	Thermoplastic vulcanizates
Trp	Tryptophan
WS	Water steam
XPS	X-Ray photoelectron spectroscopy

PREFACE

This book, *Key Engineering Materials: Volume II: Interdisciplinary Concepts and Research*, provides both a rigorous view and a more practical and understandable view of key engineering materials for graduate students and scientists in related fields. This book will satisfy readers with both direct and lateral interests in the discipline.

This volume is structured into different parts devoted to key engineering materials and their applications. Every section of this book has been expanded, where relevant, to take account of significant new discoveries and realizations of the importance of key concepts. Furthermore, emphases are placed on the underlying fundamentals and on acquisition of a broad and comprehensive grasp of the field as a whole.

This book contains innovative chapters on the growth of educational, scientific, and industrial research activities among chemists, biologists, and polymer and chemical engineers and provides a medium for mutual communication between international academia and the industry. This book presents significant research and reviews reporting new methodologies and important applications in the fields of industrial chemistry, industrial polymers, and biotechnology as well as includes the latest coverage of chemical databases and the development of new computational methods and efficient algorithms for chemical software and polymer engineering.

This book's aim is to provide comprehensive coverage on the latest developments of research in the ever-expanding area of polymers and advanced materials and their applications to broad scientific fields spanning physics, chemistry, biology, materials, and so on.

This new book:

- provides physical principles in explaining and rationalizing polymeric phenomena
- features classical topics that are conventionally considered part of chemical technology
- covers the chemical principles from a modern point of view
- analyzes theories to formulate and prove the polymer principles
- presents future outlook on application of bioscience in chemical concepts
- focuses on topics with more advanced methods

— François Kajzar, PhD, Eli M. Pearce, PhD,
Nikolai A. Turovskij, PhD, and Omari Vasilii Mukbaniani, DSc

