Biomedical Engineering

**Biomaterials Fabrication and Processing HANDBOOK**

Focusing on a lucrative and increasingly important area of biomedicine, the *Biomaterials Fabrication and Processing Handbook* brings together various biomaterials production and processing aspects, including tissue engineering scaffold materials, drug delivery systems, nanobiomaterials, and biosensors.

The different facets of biomaterials technology are split into four sections in the book. The first describes the development of new materials and devices capable of interacting specifically with biological tissues and the preparation of scaffolds using materials with appropriate composition and structure. The next section discusses the necessary materials to create a drug delivery system capable of controlled release and the incorporation of drug reservoirs into implantable devices for sustained controlled release. The book then explores the significant role nanotechnology plays in the biomedical and biotechnology fields. The last part examines more biomaterials, including synthetic and natural degradable polymeric biomaterials, electroactive polymers as smart materials, and biomaterials for gastrointestinal and cartilage repair and reconstruction.

**FEATURES**

- Focuses on a variety of fabrication and processing aspects of the latest biomaterials
- Discusses how scaffolds are used in tissue engineering
- Examines the important role nanotechnology plays in the preparation of drugs, protein delivery, tissue engineering, cardiovascular biomaterials, hard tissue replacements, biosensors, and bio-MEMS
- Describes common implant materials, such as hard tissue, blood contacting, and soft tissue
- Explains how to improve the blood compatibility of biomaterials using a novel antithrombin–heparin covalent complex and how to modify the surface of biomaterials using plasma immersion ion implantation and deposition

With contributions from renowned international experts and extensive reference lists in each chapter, this volume provides detailed, practical information to produce and use biomaterials.
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Preface

Biomaterials are used in the biomedical industry to replace or repair injured and nonfunctional tissues. The worldwide biomaterials market was worth over $300 billion in 2005. This market is projected to grow at a rate of 20% per year, and a growing number of scientists and engineers are engaged in fabrication and research of biomaterials. Recognizing the ever increasing importance of biomaterials, a number of books on biomaterials were published in the past 20 years. The Biomaterials Fabrication and Processing Handbook is different from these published books in that it brings together the various aspects of fabrication and processing of the latest biomaterials, including tissue engineering scaffold materials, drug delivery systems, and nanobiomaterials and biosensors. Some common implant materials including hard tissue materials, blood-contacting materials, and soft tissue materials are also described in this book.

Tissue engineering involves the development of new materials or devices capable of interacting specifically with biological tissues. The key to tissue engineering is the preparation of scaffolds, using materials with the appropriate composition and structure. In the drug industry, advances in drug delivery systems are very important. Controlled release can be obtained by selecting the appropriate materials to produce the drug delivery system. Attempts have been made to incorporate drug reservoirs into implantable devices for sustained and preferably controlled release. Nanotechnology also plays an important role in the biomedical and biotechnology industries and has been used in the preparation of drugs for protein delivery, tissue engineering, bones, cardiovascular biomaterials, hard tissue replacements, biosensors, and biological microelectromechanical systems (Bio-MEMS). This book covers the latest information pertaining to tissue engineering scaffold materials, drug delivery systems, and nanobiomaterials and biosensors.

The book has 21 chapters describing different types of biomaterials, and is divided into four sections, namely tissue engineering scaffold materials, drug delivery systems, nanobiomaterials and biosensors, and other biomaterials. The section on tissue engineering describes inorganic and composite bioactive scaffolds for bone tissue engineering, design, fabrication, and characterization of scaffolds via solid free-form fabrication techniques, control and monitoring of scaffold architecture for tissue engineering, rapid prototyping methods for tissue engineering applications, as well as design and fabrication principles of electrospinning of scaffolds. The section on drug delivery systems discusses nanoparticles in cancer drug delivery systems, polymeric nano/microparticles for oral delivery of proteins and peptides, nanostructured porous biomaterials for controlled drug release systems, and inorganic nanostructures for drug delivery. The section on nanobiomaterials and biosensors includes self-assembly of nanostructures at biomaterials, electrohydrodynamic processing of micro- and nanometer biological materials, fabrication and functions of biohybrid nanomaterials prepared via supramolecular approaches, polypyrrole nano- and microsensors and actuators for biomedical applications, as well as processing of biosensing materials and biosensors. The last section, which deals with other biomaterials, includes synthetic and natural degradable polymeric biomaterials, electroactive polymers as smart materials with intrinsic actuation properties such as new functionalities for biomaterials, blood-contacting surfaces, improvement of blood compatibility of biomaterials using a novel antithrombin-heparin covalent complex, surface modification of biomaterials using plasma immersion ion implantation and deposition, biomaterials for gastrointestinal medicine, repair, and reconstruction, and biomaterials for cartilage reconstruction and repair.

These chapters have been written by renowned experts in their respective fields, and this book is valuable to the biomaterials and biomedical engineering community. It is intended for a broad and diverse readership including bioengineers, materials scientists, physicians, surgeons, research students, practitioners, and researchers in materials science, bioengineering, and medicine.
Readers will be able to familiarize themselves with the latest techniques in biomaterials and processing. In addition, each chapter is accompanied by an extensive list of references for readers interested in pursuing further research.

The outstanding cooperation from contributing authors who devoted their valuable time and effort to write excellent chapters for this handbook is highly appreciated. We are also indebted to all our colleagues who have made this book a reality.

Paul K. Chu
Xuanyong Liu
Editors

Paul K. Chu is a professor (chair) of materials engineering at the City University of Hong Kong. He received a BS in mathematics from The Ohio State University in 1977 and an MS and a PhD in chemistry from Cornell University in 1979 and 1982, respectively. Professor Chu’s research activities are quite diverse, encompassing plasma surface engineering and various types of materials and nanotechnology. He has published over 550 journal papers and has been granted eight U.S. and three Chinese patents. He is a fellow of the IEEE, AVS, and HKIE, senior editor of IEEE Transactions on Plasma Science, associate editor of International Journal of Plasma Science and Engineering, and a member of the editorial board of Materials Science & Engineering: Reports, Surface and Interface Engineering, and Biomolecular Engineering. He is a member of the Plasma-Based Ion Implantation and Deposition International Committee, Ion Implantation Technology International Committee, and IEEE Plasma Science and Application Executive Committee.

Xuanyong Liu is an associate professor of materials engineering at the Shanghai Institute of Ceramics, Chinese Academy of Sciences (SICCAS), and a professor at Hunan University. He received a BS and an MS in materials science and engineering from Hunan University in 1996 and 1999, respectively, and a PhD in materials science and engineering from SICCAS in 2002. His doctoral dissertation was awarded the National Excellent Doctoral Dissertation of People’s Republic of China in 2004. Professor Liu’s primary research focus is on surface modification of biomaterials. He has founded the Surface Engineering of Biomaterials Group in SICCAS and has published over 70 journal papers, including 14 papers on biomaterials.
Contributors

Arti Ahluwalia
Interdepartmental Research Center
"E. Piaggio" and Department
of Chemical Engineering
University of Pisa
Pisa, Italy

Hua Ai
National Engineering Research Center
for Biomaterials
Sichuan University
Chengdu, China

Katsuhiko Ariga
WPI Center for Materials Nanoarchitectonics
National Institute for Materials Science
Tsukuba, Japan

Halil Murat Aydin
Institute for Science and Technology
in Medicine
Keele University
Staffordshire, U.K.

Pierre Olivier Bagnaninchi
Institute for Science and Technology
in Medicine
Keele University
Staffordshire, U.K.

Yevgeny Berdichevsky
Electrical and Computer Engineering
Department
University of California
San Diego, California, U.S.A.

Leslie Roy Berry
Henderson Research Centre
Hamilton, Ontario, Canada

Aldo R. Boccaccini
Department of Materials
Imperial College
London, U.K.

Oana Breceanu
Department of Materials
Imperial College
London, U.K.

Federico Carpi
Interdepartmental Research Centre
"E. Piaggio"
University of Pisa
Pisa, Italy

Anthony Kam Chuen Chan
Henderson Research Centre
Hamilton, Ontario, Canada

Qi-Zhi Chen
Department of Materials
Imperial College
London, U.K.

Paul K. Chu
Department of Physics and Materials
Science
City University of Hong Kong
Hong Kong, China

Robert Lewis Clark
Center for Biologically Inspired Materials
and Material Systems
Pratt School of Engineering
Duke University
Durham, North Carolina, U.S.A.

Cassilda Cunha-Reis
Institute for Science and Technology
in Medicine
Keele University
Staffordshire, U.K.

Richard M. Day
Department of Medicine
University College
London, U.K.
Danilo De Rossi  
Interdepartmental Research Centre “E. Piaggio”  
University of Pisa  
Pisa, Italy

Sanjukta Deb  
Department of Biomaterials  
Dental Institute, King’s College  
London, U.K.

Andrew K. Ekaputra  
Graduate Program in Bioengineering  
National University of Singapore  
Singapore

Miroslawa El Fray  
Division of Biomaterials and Microbiological Technologies  
Szczecin University of Technology Polymer Institute  
Szczecin, Poland

Yuijiang Fan  
National Engineering Research Center for Biomaterials  
Sichuan University  
Chengdu, China

Ricky K.Y. Fu  
Department of Physics and Materials Science  
City University of Hong Kong  
Hong Kong, China

Zhongwei Gu  
National Engineering Research Center for Biomaterials  
Sichuan University  
Chengdu, China

Dietmar W. Hutmacher  
Division of Regenerative Medicine  
Institute of Health and Biomedical Innovation  
Queensland University of Technology  
Brisbane, Australia

So Yeon Kim  
Division of Engineering Education  
College of Engineering  
Changnam National University  
Daejeon, South Korea

Menno L.W. Knetsch  
Centre for Biomaterials Research  
University of Maastricht  
Maastricht, The Netherlands

Krzysztof J. Kurzydlowski  
Division of Materials Design  
Faculty of Materials Science and Engineering  
Warsaw University of Technology  
Warsaw, Poland

Young Moo Lee  
School of Chemical Engineering  
Hanyang University  
Seoul, South Korea

Jifan Li  
Hitachi Chemical Research Center  
Irvine, California, U.S.A.

Yang Yang Li  
Hitachi Chemical Research Center  
Irvine, California, U.S.A.  
and  
Department of Physics and Materials Science  
City University of Hong Kong  
Hong Kong, China

Xuanyong Liu  
Shanghai Institute of Ceramics  
Chinese Academy of Sciences  
Shanghai, China  
and  
Department of Physics and Materials Science  
City University of Hong Kong  
Hong Kong, China

Yanyan Liu  
Shanghai Institute of Ceramics  
Chinese Academy of Sciences  
Shanghai, China  
and  
Laboratory of Special Functional Materials  
Henan University  
Kaifeng, China

Yu-Hwa Lo  
Electrical and Computer Engineering Department  
University of California  
San Diego, California, U.S.A.
Bunichiro Nakajima
Hitachi Chemical Research Center
Irvine, California, U.S.A.

S. Sajeesh
Division of Biosurface Technology
Sree Chitra Tirunal Institute for Medical
Sciences and Technology
Thiruvananthapuram, India

Chandra P. Sharma
Division of Biosurface Technology
Sree Chitra Tirunal Institute for Medical
Sciences and Technology
Thiruvananthapuram, India

Wojciech Swieszkowski
Division of Materials Design
Faculty of Materials Science and Engineering
Warsaw University of Technology
Warsaw, Poland

Giovanini Vozzi
Interdepartmental Research Center “E. Piaggio”
and Department of Chemical Engineering
University of Pisa
Pisa, Italy

Maria Ann Woodruff
Division of Regenerative Medicine
Institute of Health and Biomedical Innovation
Queensland University of Technology
Brisbane, Australia

Yiquan Wu
Center for Biologically Inspired Materials
and Material Systems
Pratt School of Engineering
Duke University
Durham, North Carolina, U.S.A.

Ying Yang
Institute for Science and Technology in Medicine
School of Medicine
Keele University
Staffordshire, U.K.

Yu Yang
Shanghai Institute of Ceramics
Chinese Academy of Sciences
Shanghai, China

Yingchun Zhu
Shanghai Institute of Ceramics
Chinese Academy of Sciences
Shanghai, China

Ying-Jie Zhu
State Key Laboratory of High Performance Ceramics
and Superfine Microstructures
Shanghai Institute of Ceramics
Chinese Academy of Sciences
Shanghai, China