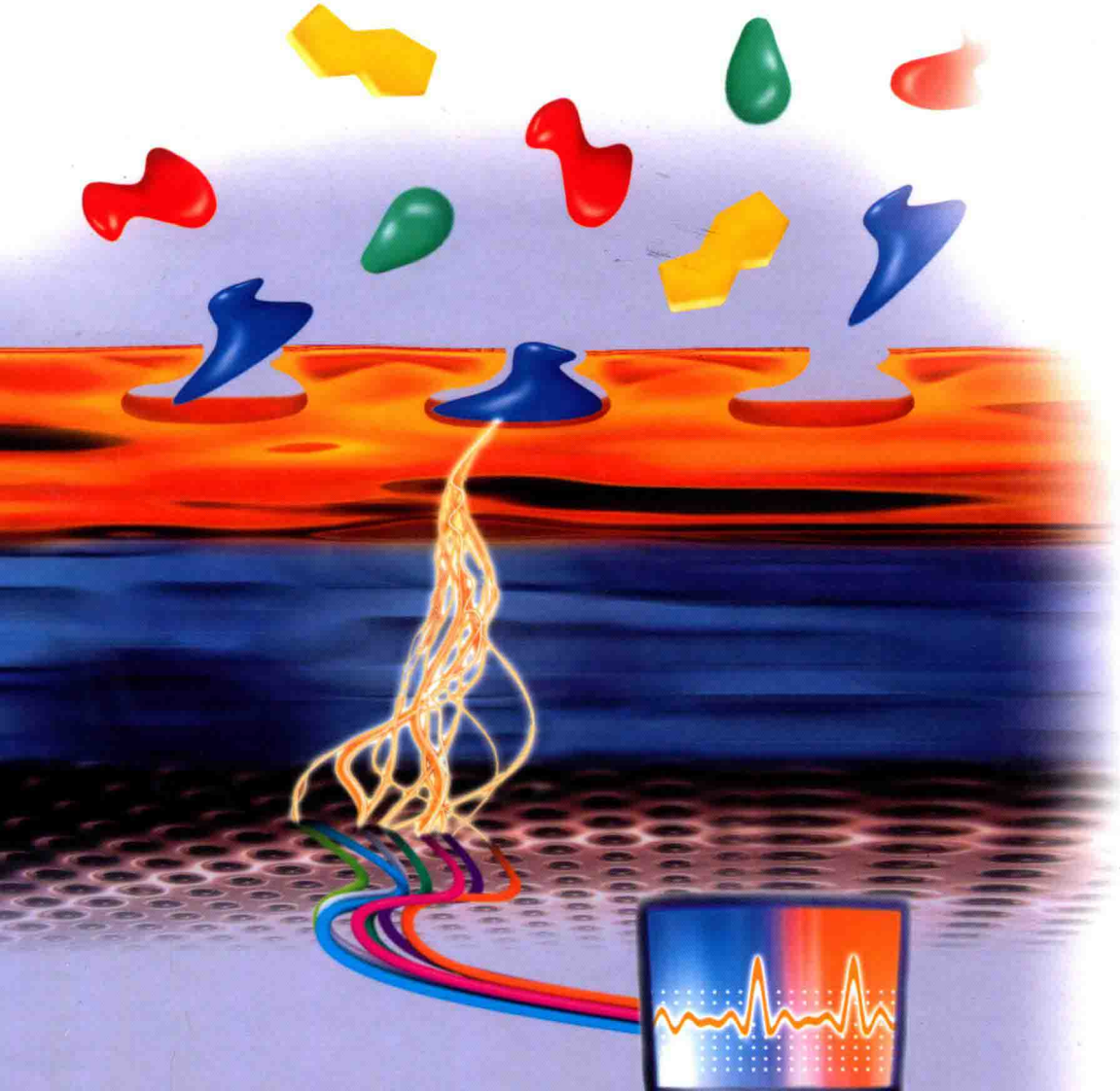
Edited by Songjun Li, Jagdish Singh,
He Li, and Ipsita A. Banerjee

WILEY-VCH

Biosensor Nanomaterials



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WILEY-VCH Verlag GmbH & Co. KGaA

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Library of Congress Card No.: applied for

British Library Cataloguing-in-Publication Data
A catalogue record for this book is available from the British Library.

Bibliographic information published by the Deutsche Nationalbibliothek
The Deutsche Nationalbibliothek lists this publication in the Deutsche Nationalbibliografie; detailed bibliographic data are available on the Internet at <http://dnb.d-nb.de>.

Composition Toppan Best-set Premedia Ltd., Hong Kong
Printing and Binding betz-druck GmbH, Darmstadt
Cover Design Adam Design, Weinheim

Printed in the Federal Republic of Germany
Printed on acid-free paper

ISBN: 978-3-527-32841-3

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Preface

There is a tremendous interest in reliable sensors and detection systems. Growing concerns about public exposure to harmful agents have fueled the essential requirement of developing and designing new sensing and detection systems. An immense knowledge base on biosensor materials is already assessable, but most of the available biosensor materials are limited to detecting both biological and chemical reagents under a relatively simple and undisturbed background. These available sensors have only limited ability for rapid sensing and discrimination of small amounts of harmful agents embedded in large amounts of a chemically inert but complex background. Scientists in this field are working under pressure to meet these challenges. Nanomaterials, because of the excellent electronic, magnetic, acoustic, and light properties, as well as their unique nanosize effects, have provided a key solution to these impending challenges.

Impressive progress has been made over the past few years because of the timely use of nanomaterials in the field of biosensors. Nanomaterials with the most promising outlook enable us to alter the texture in sensing and controlled modes by their unique electronic, magnetic, acoustic, and light properties or through external stress, electric and magnetic fields, temperature, moisture and pH, and so on. Nanotechnology, coupled with the recent advances in molecular device materials, biomimetic polymers, hybridized composites, supramolecular systems, information- and energy-transfer materials, environmentally friendly materials, and so on, has led to a profound revolution in the field of biosensors. This book summarizes the main applications of nanotechnology in the field of biosensors. The emphasis is to highlight the latest and most significant progress made in this field. Other aspects such as the biosensing principle, mechanism, design, and methods are also described. When providing a relatively comprehensive description on the current knowledge and technologies, we hope to provide an insight into some new directions in this field. As such, this book can be used not only as a textbook for advanced undergraduate and graduate students, but also as a reference book for researchers in biotechnology, nanotechnology, biomaterials, medicine, bioengineering, and other related disciplines.

Several books, each composed of many chapters, are probably not enough to cover all details in the field of biosensor nanomaterials. Thus, it is difficult to live up to the ideal of an absolute and comprehensive summary. Fortunately, because

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ISBN: 978-3-527-32841-3

of their expert backgrounds, all of the contributors have done their best when describing their chapters. Owing to the multidisciplinary nature of this subject, a large number of experts with different backgrounds have been invited to contribute their research. Without doubt, if it was not for the participation of such a diverse group of experts, we would not have been able to accomplish our goal of developing a systematic book in the field of biosensor nanomaterials.

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About the Editors

Dr. Songjun Li, the leading editor of *Biosensors Nanomaterials*, is a Professor of Chemistry. He received his PhD degree in 2005 from the Chinese Academy of Sciences. Subsequently, he was appointed by Central China Normal University (CCNU) as an Associate Professor with a research interest in molecular recognition. He doubles also as an Invited Professor at the University of Jinan (China) and an Adjunct Professor at Jiangsu University (China). From 2005 to 2008, he worked as Deputy Director of the Chemical Experimental Center of CCNU. He was a postdoctoral fellow in the University of Wisconsin-Milwaukee (USA) during the period from August 2008 to August 2009. Currently, he is working in Cranfield Health (one of the most successful biosensor R & D centers around the world) of Cranfield University (UK) as the Marie Curie Fellow of Europe. During the past 10 years, Dr. Li, as the principal investigator and first author (excluding non-principal investigator and coauthor), has published about 40 papers in international peer-reviewed journals. He was also the leading editor for three other books: *Smart Polymer Materials for Biomedical Application* (Nova Science, USA, 2010), *Smart Nanomaterials for Sensor Applications* (Bentham Science, USA, 2010), and *Current Focus on Colloids and Surfaces* (Transworld Research Network, India, 2009). In March 2010, he cofounded the international principal journal *Advanced Materials Letters* and has been the Editor-in-Chief since then. He also serves as an editorial member or on the editorial boards of *American Journal of Environmental Sciences, Journal of Public Health and Epidemiology, Open Electrochemistry Journal,* and *Journal of Computational Biology and Bioinformatics Research.* He has been invited over 100 times to be a reviewer for various grants and international journals. His recent interest is focused on designing and developing novel, highly substrate-selective molecular recognition systems with molecular imprinting.

Dr. Jagdish Singh is Professor and Chair of the Department of Pharmaceutical Sciences at North Dakota State University (NDSU) College of Pharmacy, North Dakota, and a Fellow of the American Association of Pharmaceutical Scientists and a Fellow of Pharmacy and Biotechnology. Dr. Singh's research efforts focus

on mechanistic studies for developing and testing novel delivery technologies to deliver biotechnologically derived molecules (e.g., peptides, proteins, and genes). His research has been funded by the US Department of Defense, National Institutes of Health, PhRMA Foundation, and American Foundation for Pharmaceutical Education. Recently, he has been successful in establishing an Economic Development Center of Excellence in Vaccinology, called the Center of Biopharmaceutical Research and Production. He has published over 138 peer-reviewed papers and 250 abstracts. Dr. Singh has twice received the NDSU College of Pharmacy Researcher of the Year award, and was recognized with the Fred Waldron Research Award in 2002 in recognition of his outstanding contribution in research and creative activities at NDSU. Dr. Singh has supervised 30 graduate students and postdoctoral fellows, and over two dozen undergraduate and professional (PharmD) research students. He is a member and actively participates in several national and international professional and scientific societies (e.g., American Association of Advancement of Science, American Association of Pharmaceutical Scientists, American Association of Colleges of Pharmacy, and Controlled Release Society, Inc.). He is also a member of the US Pharmacopeia (1995–current), and serves as reviewer of grants and manuscripts for numerous pharmaceutical and biomedical journals.

Dr. He Li is a Professor of Chemistry. He is currently the Associate Editor for the international principal journal *Advanced Materials Letters*. He received his PhD degree in 2004 from the Chinese Academy of Sciences. Subsequently, he joined the University of Jinan (China), and became an Associate Professor with research interests in nanomaterials and their biomedical applications. He doubled also as Chair of the Pharmaceutical Engineering Department during the period from 2007 to 2009. At present, he is working in the University of Wisconsin (USA) as a Senior Visiting Scientist. In his personal database, he has published over 30 papers in international peer-reviewed journals. He has also been an invited reviewer for various grants and journals (over 40 times). His recent works are focused on designing and developing advanced functional materials for nanomedicine and biosensor applications. Specifically, he is designing and synthesizing multifunctional nanocarriers for cancer therapy and diagnosis, and fabricating biosensors (especially electrochemical biosensors) made of nanomaterials to detect various biomolecules in the field of clinical diagnosis, bioaffinity assays, and environmental monitoring.

Dr. Ipsita Banerjee received her PhD Degree in Chemistry from the University of Connecticut (USA) in 2001, following which she worked as a Postdoctoral Research Associate at the University of Notre Dame, Indiana (2001–2002), at the Chemical and Biomolecular Engineering Department and at Hunter College, New York (2002–2004), Department of Chemistry and Biochemistry in the field of Bionanotechnology. She then joined the Chemistry Department at Fordham University, New York in fall 2004 as a Faculty Member. Her current research focuses on the area of molecular self-assembly and supramolecular nanostructures in order to understand the important fundamental aspects of the surface chemistry associated with the growth and development of functional nanobiomaterials. She also

works on the development of nanomaterials with tailored properties wherein the shape, size, and porosity can be controlled via new bioengineering routes. Specifically, her research interests are geared toward the design and synthesis of nanomaterials for potential biomedical applications and molecular therapeutics for tissue regeneration, drug delivery, examining the mechanisms of peptide folding (both natural and artificial), catalysis and green synthetic methods for the preparation of nanoparticles for preparation of new improved materials for catalysis and applications as antibacterials, and device fabrication for optoelectronics and biosensors. Over the past 9 years, Dr. Banerjee has authored/coauthored over 45 articles in journals and various proceedings, and has presented at many conferences leading to over 70 presentations. She serves as a reviewer for multiple international journals and is also an Editorial Board Member of the journal *Advanced Materials Letters*.

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ISBN: 978-3-527-32841-3

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ISBN: 978-3-527-32841-3