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Book Review

# Nanomaterials for Biosensors. Nanotechnologies for the Life Sciences, Volume 8 Edited by Challa S. S. R. Kumar (Louisiana State University, Baton Rouge). Wiley-VCH Verlag GmbH & Co. KGaA: Weinheim. 2007. xxii + 408 pp. $175.00 ISBN 978-3-527-31388-4.

Paul Pantano

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**Nanomaterials for Biosensors. Nanotechnologies for the Life Sciences, Volume 8**. Edited by Challa S. S. R. Kumar (Louisiana State University, Baton Rouge). Wiley-VCH Verlag GmbH & Co. KGaA: Weinheim. 2007. xxii + 408 pp. $175.00 ISBN 978-3-527-31388-4.

*Nanomaterials for Biosensors* is the eighth volume of the 10-volume book series, *Nanotechnologies for the Life Sciences*, a comprehensive source covering the convergence of materials and life sciences on the nanoscale. Kumar, a Nanofabrication Group Leader at the LSU Center for Advanced Microstructures and Devices, is both the series editor and editor of this volume; he has performed an admirable job of uniting authoritative authors from the physical, biological, and engineering sciences.

The book has 13 chapters that cover the chemistry and materials science of nanomaterials and biomolecules, along with their detection strategies, sensor physics, and device engineering. It comprises sections dedicated to certain classes of nanoparticles, such as carbon nanotubes, metal and semiconductor colloidal nanocrystals, dendrimers, fullerenes, and nanowires, as well as nanocantilever-, silicon-, silicate-, and magnetic-based nanoparticles. There are also sections dedicated to specific approaches to sensing, such as reagentless detection, coordinated biosensors, protein-based biosensors, and biomimetics, each of which contains subsections describing devices fabricated with the various classes of nanoparticles listed above. The book finally covers a wide range of (bio)chemical instrumentation, such as scanning probe-, microscopic-, spectroscopic-, and electrochemical-based systems, as well as integrated micro/nanosystems for the analysis of single cells and biological samples. Individual chapters start with a relevant overview and background, are filled with well-illustrated diagrams and information-rich figures, include demonstrative examples of specific applications, and conclude with future prospects. While each chapter can stand alone, the book as a whole is a nice blend of sensing principles, materials chemistry, and detection strategies. The index is very thorough, and there is no excessive overlap between chapters. Almost all chapters are exceptionally supplemented with pertinent references from the past 4 years by leaders in the field. This book can be recommended to interdisciplinary members of teams in the nanobiosciences, ranging from graduate students to decision makers, and is appropriate for acquisition by libraries.

**Paul Pantano,** *The University of Texas at Dallas*

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**Free Energy Calculations: Theory and Applications in Chemistry and Biology Springer Series in Chemical Physics, 86**. Edited by Christophe Chipot (Université Henri Poincaré Vandoeuvre-lès-Nancy, France) and Andrew Pohorille (University of California, San Francisco, USA). Springer: Berlin, Heidelberg, New York. 2007. xviii + 518 pp. $199.00. ISBN 978-3-540-38447-2.

The concept of free energy is absolutely central to chemistry and biology. For the theoretician, therefore, accurate and efficient calculation of free energies is critical; however, such calculations constitute a considerable challenge. Although methods such as thermodynamic integration, which dates back to Kirkwood, and free-energy perturbation, which dates back to Zwanzig (and even further back to Landau, as the editors note in the Introduction), are still widely used, many new, innovative ideas and strategies for obtaining free energies have emerged in the past decade. Thus, it is timely for the appearance of a book in which the basic problem of computing different types of free energies is described and a selection of such newer techniques for performing the calculations is presented.

Assembling a compendium such as the present book is a tall order both in the choice of topics to be included and in the selection of experts to write about them. The challenge is even greater when, as is stated in the Foreword, the book is aimed at a “broad readership that includes advanced undergraduate and graduate students of chemistry, physics and engineering, post-doctoral associates and specialists from both academic and industry...”. Given the enormity of the task, I feel that the editors and the contributing authors have done a *very* reasonable job of emphasizing important techniques and related issues and of adhering to a pedagogical style. Had I edited this book, I might have chosen a slightly different set of topics (although the overlap would still have been considerable), and another editor would probably have made yet a different selection. Still, I believe that the editors have chosen their topics well. What is more important—and what I believe will contribute substantially to the book’s overall impact—is the organization of the individual chapters into implicit “sections” that constitute a useful framework for the presentation of the material.

The first six chapters of the book follow a steady progression that builds on itself. The pedagogical style followed in these chapters should make them approachable by a less experienced audience seeking an overview that follows a seamless path from the basics of free-energy calculations and the underlying statistical mechanics to modern methodoligies. As an endpoint of this path, Chapter 6 on error analysis and reduction is an especially important and interesting contribution to the book. The style and level of pedagogy become noticeably less uniform after this chapter. Chapters 7−12 cover a broad and very useful range of topics, but different authors assume different levels of expertise of their readership. These chapters are less self-contained, and less experienced readers will occasionally need to refer to the source material for important missing details. In addition, I would have liked to have seen an additional chapter or two devoted to enhanced sampling methods, both because of their importance to free-energy calculations and because there have been some significant innovations in this area that are not adequately covered here, such as configuration-bias Monte Carlo, variable transformations, replica-exchange with solute tempering, adiabatic free-energy dynamics, to name a few. Finally, the reader should be aware that some topics are rapidly evolving and that the “snapshots” of these captured in the book are of limited utility. The discussion in Chapter 11 on the structure of water based on *ab initio* calculations, for example, is already obsolete, and the applications discussed in Chapter 13 will, of course, soon be supplanted by newer ones.

Despite these few shortcomings, however, I thoroughly enjoyed reading this book, and I believe many other readers will as well. I found the figures and their explanations a useful supplement to the high-quality text, and the references are, for the most part, up-to-date. The editors and the authors are to be commended for creating a work capable of serving as a source of learning material for newcomers to the field and as a reference book for a wide variety of important free-energy techniques. I expect I will refer to this book many times over the next few years.

**Mark E. Tuckerman,** *New York University*

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**Boronic Acids in Saccharide Recognition**. By Tony D. James (University of Bath, U.K.), Marcus D. Phillips (University of Bath, U.K.), and Seiji Shinkai (Kyushu University, Fukuoka, Japan). Royal Society of Chemistry: Cambridge. 2006. x + 174 pp. $189.00. ISBN 0-85404-537-6.

Research involving the use of boronic acids for molecular recognition and sensing applications has burgeoned over the past two decades. This makes publication of this monograph, an impressive compilation of the numerous and varied approaches for using boronic acids for sensing of saccharides, particularly timely. In addition, the authors not only cover the sensing and fundamental physical organic rationale behind why and how boronic acids bind as they do but also venture to explore the biochemical aspects and potential applications for these sensory materials. This book brings into focus the history and evolution of boronic acids as sugar sensors, from the groundbreaking work of Lorand and Edwards in the 1950s relating to diol complexation to research being done today, placing each progressive step in perspective.

The authors are frequent contributors to this field and have used much of their own work to typify and clarify principles and concepts while still managing to highlight work from most of the other major contributors to the field. They have assembled a balanced and comprehensive collection of where the field began, how it has grown, and where it currently stands. In the first chapter, they provide compelling reasons for studying this often overlooked class of compounds. From there, fundamental concepts and paradigms are presented and explained. The examples cited in the work focus primarily on fluorescent-based sensors and the details of the transduction mechanisms utilized to signal binding to sugars. They also touch upon other transduction mechanisms, including colorimetric, electrochemical, and indicator displacement assays. The volume concludes with a chapter on “other” diverse and unique platforms that have incorporated boronic acids, such as saccharide transporters and molecularly imprinted polymer-based sensors.

The authors even briefly touch on some of their pioneering efforts in materials development based on boronic acid and saccharide-containing building blocks.

Overall, the authors give many examples, explain mechanistic subtleties, and outline several detection motifs in this book, while including many relevant and timely references. Without a doubt, this monograph is a great introduction for anyone interested in using boronic acids for sugar sensing.

**John J. Lavigne,** *University of South Carolina*

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