

book reviews

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Nanodevices for the Life Sciences. Edited by Challa S. S. R. Kumar. Nanotechnologies for Life Sciences. Volume 4. Weinheim: Wiley-VCH Verl. GmbH Co. KGaA, 1st Edition 2006. Pp. 469. Price 139 EUR/220 SFR. ISBN-10: 3-527-31384-2. ISBN-13: 978-3-527-31384-6.

The potential impact of nanotechnology on the life sciences is one of the main motivations for the worldwide increase of government and private investment in this rapidly growing field of research and development. The early stages of such an activity involve the task of finding a realistic balance between expectations and possible results. If the new technology emerges by combining contributions from various sciences such as physics, chemistry, engineering, biology and medicine, an evaluation of the scientific potential as well as the time horizon of expected applications are bound to be uncertain. Therefore, even in the early stages it is helpful to discuss the various aspects of the new technology under a joint conceptual approach, as has been done in this volume by Challa Kumar, the editor of the famous series *Nanotechnologies for Life Sciences*.

This volume presents a survey over the physical and chemical basics of nanodevices, their engineering and biological applications. It also provides a glimpse of nanoscale devices utilized by nature itself. The editor has brought together a group of experts to present the various aspects in 13 chapters.

To provide a deeper understanding of the challenges connected with the development of nanodevices that can compete in their performance with natural structures, the first two chapters *The Physics and Modeling of Biofunctionalized Nanoelectromechanical Systems* (BioNEMS) and *Mathematical and Computational Modeling: Towards the Development and Application of Nanodevices for Drug Delivery* are very helpful. They are dedicated to theoretical modeling and computational simulations. Both sides of the development have been discussed – the fluid dynamics and mechanics at small scale as well as the interaction of nanodevices with biomolecules and living tissue. Thus, the chapters give a very informative introduction to the theory of BioNEMS.

The main part of the book is devoted to the advances in developing tools for building nanodevices, and in the applications of such devices in various fields, such as biosensors, bioelectronics, drug delivery and photodynamic therapy. Under *Nanolithography: Towards fabrication of Nanodevices for Life Sciences* the advantages and limitations of various approaches such as bias-induced lithography, AFM-based force induced nanolithography, 'dip-pen' nanolithography, and latex particle lithography are summarized. Owing to its

importance there is a special chapter on *Microcantilever-based Nanodevices in the Life Sciences*. Here the various ways of manufacturing microcantilevers and their applications for biopatterning and biosensing are described. The chapter ends with an outlook to the possible integration of microcantilevers into micro- or nanofluidic systems.

Nanobioelectronics opens the way to a possible paradigm change in microelectronics. DNA and proteins as bio-building blocks for nanoelectronics are presented. Interconnections of biomolecules and the exploitation of their self-assembly properties for the implementation of nanobiodevices such as rectifiers, amplifiers and information storage devices are explained. The structural richness of DNA can also be used for the fabrication of DNA-based molecular motors and automata as shown in the chapter *DNA Nanodevices: Prototypes and Applications*. Here a wide spectrum of possibilities has been discussed: simple devices based on conformation changes induced by small molecules and ions, hybridization driven devices, and functional devices which can sense environmental information, perform a simple computation and decide which action to take.

Two chapters demonstrate the application of protein-based nanodevices: *Towards the Realisation of Nanobiosensors Based on G-protein-coupled Receptors* and *Protein-based Nanotechnology: Kinesin-Microtubule-Driven Systems for Bioanalytical Applications*. These chapters can give scientists who are searching for new analytical tools in the life sciences a lot of valuable ideas.

Complementary to the bio-based design there are nanodevice designs based on non-biological building blocks. In the chapter *Self-assembly and Bio-directed Approaches of Carbon Nanotubes: Towards Device Fabrication*, the advantage of a hybrid technology combining the CNT with biomolecules in the so-called DNA-directed approach has been emphasized. A similar possibility has been addressed in the chapter *Fullerene-based Devices for Biological Applications*. Here a manifold of interesting applications of fullerene derivatives has been outlined. Ideas such as DNA-photocleavage, photodynamic therapy, neuroprotective activity, enzyme inhibition and antiviral as well as antibacterial activity are discussed.

The effective manufacturing of nanodevices and its reliable connection with the macroworld are the guiding motive in the chapter *Nanodevices for Biosensing: Design, Fabrication and Applications*. Two classes seem to be the favourites for future development: nanodevices based on nanophotonics/optoelectronics and nanodevices based on nanomechanics. Both can be manufactured with microelectronics technologies and constitute platforms with a high probability of being used in real applications in the near future.

The book ends with two more general chapters. In *Nanotechnology for Biomedical Devices* a review of various forms of applications related to biomedical devices and technology has been given. It ends with thoughts on the future use of such devices in point-of-care analysis or as home-doctor kits. In order to emphasize that all the artificial nanodevices known so far are rather simple compared with nature, the last chapter *Nanodevices in Nature* presents some examples for the wealth of wonderful functional nanostructures created in the biological evolution. This is meant as an encouragement to study biological systems thoroughly in order to look for novel options in the engineering of new functional nanodevices.

Altogether, the book offers a wide survey over new developments in an exciting field which supposedly will strongly influence our life within the next decades. The larger part of the book could serve as a suitable textbook for teaching nanotechnology in masters programs. Some chapters would be useful for senior researchers, too.

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