BOOK REVIEW

Nanostructures in Electronics and Photonics

F. Rahman (editor), 302 pages, ISBN 978-981-4241-10-6, Pan Stanford, Singapore (2008), $179.00, hardcover.

Reviewed by Zhiyong Gu, University of Massachusetts Lowell, Department of Chemical Engineering and CHN/NCOE Nanomanufacturing Center, Lowell, MA 01854, USA, Zhiyong_Gu@uml.edu.

Nanostructures and nanomaterials have experienced explosive development in the past two decades and attracted great attention from both scientific and industrial communities. Besides the scientific aspect of these new materials/structures and their novel properties, nanotechnology, in a broader sense, not only has improved existing fields such as microelectronics, MEMS, sensors, information storage, and microfluidics, but also is enabling new fields including nanoelectronics, nanoelectromechanical systems (NEMS), nanophotonics, nanofluidics, and nanomedicine. With intensive effort toward research and significant funding into the commercialization process, the environmental, health, and safety aspects of nanomaterials have been gaining increasing attention. Among many new books that have been published in the various disciplines of nanoscience and nanotechnology, this book focuses on nanostructures and nanomaterials in the areas of electronics and photonics, two of the most promising and important fields.

The first of the 16 chapters in this book are written by the editor himself, who provides a nice description of microstructures and microfabrication, especially lithography, from a historical point of view, and the transition into nanostructures and their future applications. The remaining 15 chapters are split into two sections, one containing nine chapters on electronic applications and the other containing six on photonic applications.

In the first section, some of the most promising nanostructures and their electronic applications are discussed. The following topics are discussed in this section of the book: ferromagnetic single-electron transistors, single-walled carbon-nanotube transistors, nanowire electronic devices fabricated by using anodized-aluminum-oxide (AAO) templates, dielectrophoretic assembly of gallium-nitrite nanowires, indium doping of ZnO nanowires and nanobelts, and field emission characteristics of SiC nanowires. Besides some popular bottom-up assembling techniques such as atomic force microscopy (AFM) and dielectrophoresis (DEP), some specialized techniques are also discussed. These include ultraviolet nano-imprint lithography (UV-NIL) and combined interference lithography with deep reactive ion etching (DRIE). An interesting but somehow lonely chapter in this section is focused on cooling with integrated carbon-nanotube films.

The following topics are covered in the section on photonic applications: gold nanopyramids and arrays, nanoantennas formed by gold nanowires, polymeric photonic crystals, 2D ZnO photonic nanostructures, and silica nanoparticles grown with plasma-enhanced chemical vapor deposition (PECVD). The chapters cover both the fundamental optical characterization techniques and results as well as techniques that can be used to integrate photonic devices, such as 3D holographic lithography and continuous roll nanoimprinting.

Received 21 Aug 2009; accepted 25 Aug 2009; published 25 Aug 2009 [CCC: 19342608/2009/$25.00]

This book covers a variety of exemplar nanostructures, including nanoparticles, shaped nanoparticles (nanopyramids, nanobelts), nanowires, nanotubes, thin films, and ordered 2D and 3D structures. The structures discussed are composed of metals (especially gold), metal oxides (e.g., ZnO), polymers, and carbon nanotubes. Even though it has a diverse selection of materials and structures, there are three chapters dealing with ZnO, which is a bit repetitive, though the applications are not the same. There are some other important and widely studied nanocomponents that are not to be found in this book. For example,

(1) metallic nanowires are researched intensively not only as stand-alone nano-building blocks, but also as nanoconductors/nanocables and interconnect-formation elements, and

(2) organic or polymeric nano-building blocks (nanospheres, colloids, nanoshells, nanofibers, etc.) are soft nanomaterials of importance for molecular electronics or hybrid electronic devices.

In addition, some mathematical/modeling work would have enhanced the contents, since this book covers predominately experimental work. Furthermore, at this stage of nanotechnology development, it would have been beneficial if the nanomanufacturing aspects of nanoelectronics and nanophotonics had been addressed or discussed, for example, nanoelectronics assembly and packaging, process scale-up, process control/optimization, and defect tolerance and reliability issues.

Overall, this is a book that focuses on nanoelectronics and nanophotonics, which is good for novice researchers who can quickly grasp the related information in various research fields. It is also a good reference book for students to use in graduate-level courses on nanoelectronics or nanophotonics, or survey courses on nanotechnology.