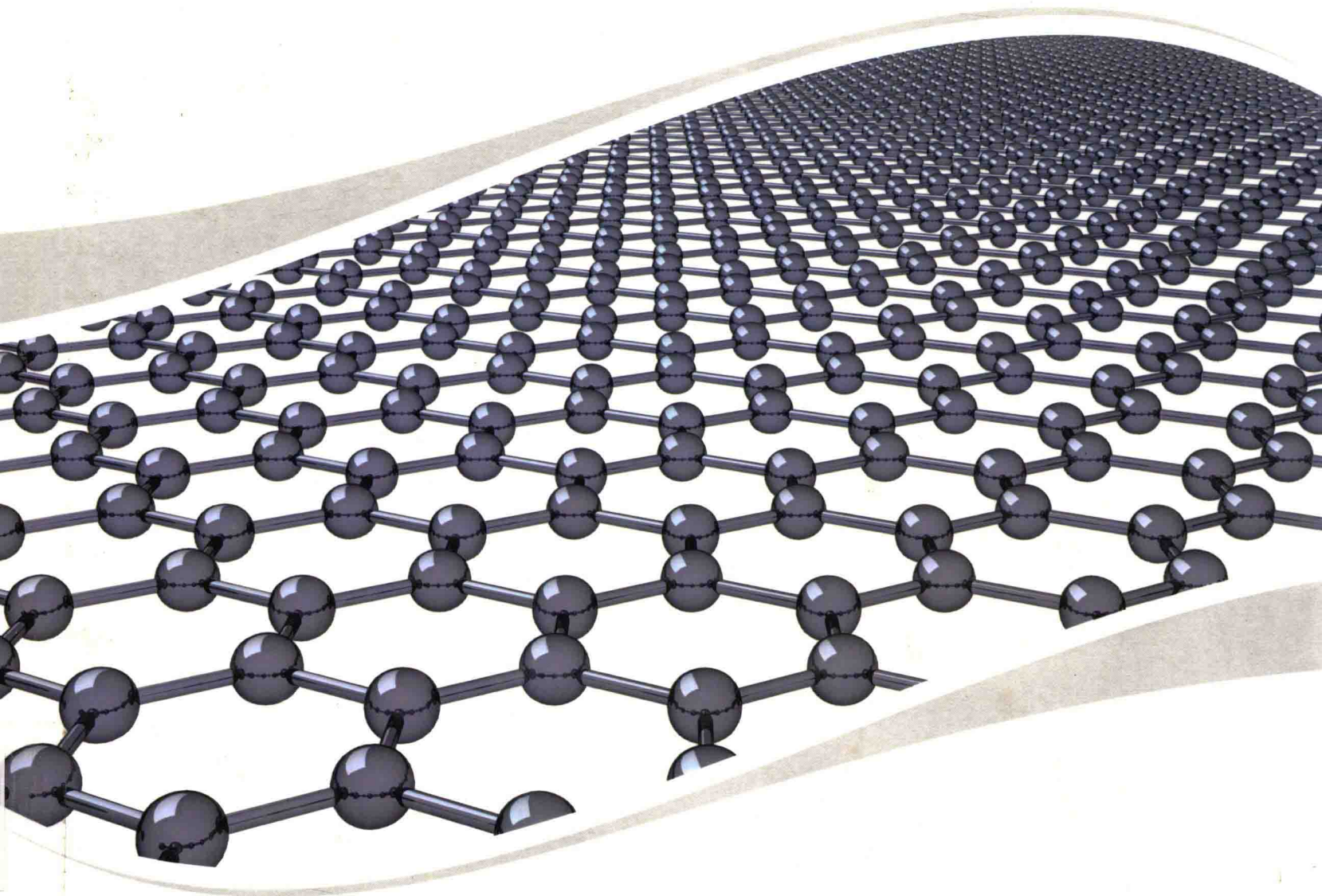


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# Nanotechnology

Concepts, Methodologies, Tools, and Applications



Information Resources Management Association



Volume III

# Nanotechnology:

## Concepts, Methodologies, Tools, and Applications

Information Resources Management Association  
*USA*

Volume III

**Information Science**  
**REFERENCE**

An Imprint of IGI Global

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|------------------------------------------|------------------|
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Published in the United States of America by  
Information Science Reference (an imprint of IGI Global)  
701 E. Chocolate Avenue  
Hershey PA 17033  
Tel: 717-533-8845  
Fax: 717-533-8661  
E-mail: [cust@igi-global.com](mailto:cust@igi-global.com)  
Web site: <http://www.igi-global.com>

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#### Library of Congress Cataloging-in-Publication Data

Nanotechnology : concepts, methodologies, tools, and applications / Information Resources Management Association, editor.

volumes cm

Includes bibliographical references and index.

ISBN 978-1-4666-5125-8 (hardcover) -- ISBN 978-1-4666-5126-5 (ebook) -- ISBN 978-1-4666-5128-9 (print & perpetual access) 1. Nanotechnology. I. Information Resources Management Association.

T174.7.N34553 2014

620'.5--dc23

2013046358

#### British Cataloguing in Publication Data

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

The views expressed in this book are those of the authors, but not necessarily of the publisher.

For electronic access to this publication, please contact: [eresources@igi-global.com](mailto:eresources@igi-global.com).

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## Preface

The constantly changing landscape of Nanotechnology challenges experts and practitioners to stay apprized of the field's most up-to-date research. That is why Information Science Reference is pleased to offer this three-volume reference collection that will empower students, researchers, and academicians with a strong understanding of critical issues within Nanotechnology by providing both broad and detailed perspectives on cutting-edge theories and developments in the field. This collection is designed to act as a single reference source on conceptual, technical, and methodological issues, as well as provide insight into emerging trends and future opportunities within the discipline.

*Nanotechnology: Concepts, Methodologies, Tools, and Applications* is organized into six distinct sections that provide comprehensive coverage of important topics. The sections are (1) Fundamental Concepts and Theories, (2) Tools and Technologies, (3) Development and Design Methodologies, (4) Utilization and Application, (5) Critical Issues, and (6) Emerging Trends. The following paragraphs provide a summary of what readers may expect from this invaluable reference tool.

Section 1, "Fundamental Concepts and Theories," begins with several introductory chapters on Nanotechnology and its associated areas of research. *Nanosciences and Nanotechnologies* by Ugo Finardi begins this volume with a discussion of the science behind technologies developed on the nanoscale. Further chapters utilize this introduction to investigate more specific facets of the field, including *Bionanotechnology* by David E. Reisner, Samuel Brauer, Wenwei Zheng, Chris Vulpe, Raj Bawa, Jose Alvelo, and Mariekie Gericke, as well as *Parallel Quantum Chemistry at the Crossroads* by Hubertus J. J. van Dam and *Synthesis and Characterization of Hexagonal Shaped Nanocrystalline Zinc Oxide Powders* by M. Ahmad, E. Ahmed, N. R. Khalid, M. J. Jackson, and W. Ahmed. Another notable contribution to this field is the use of *Nanotechnology for Photovoltaic Energy*, as described in the chapter by Salahuddin Qazi and Farhan A. Qazi. This topic provides an effective transition into Section Two through its exploration of one of the many ways that Nanotechnologies can serve effectively in real-world settings.

Section 2, "Tools and Technologies," discusses some of the many diverse uses of Nanotechnology in the modern world. This section begins with technologies for harnessing and effectively utilizing solar energy, notably *Quantum Well Solar Cells* (Magdalena Lidia Ciurea, Ana-Maria Lepadatu, and Ionel Stavarache), *Nanotechnology and Polymer Solar Cells* (Gavin Buxton), and *Quantum Dot Solar Cells* (Yoshitaka Okada, Katsuhisa Yoshida, and Yasushi Shoji). Other uses of Nanotechnology covered in this section include high-performance computing, materials science, information systems, and sensor technologies, among others. One notable chapter, *System-Level Design of NoC-Based Dependable Embedded Systems* by Mihkel Tagel, Peeter Ellervee, and Gert Jervan, investigates the miniaturization of computer chips into the subnanometer range. The final chapters in this section, *On the Forces Between Micro and Nano Objects and a Gripper* by Galin Valchev, Daniel Dantchev, and Kostadin Kostadinov and *Neurosurgical Operations Using Navigation Microscope Integration System* by Takashi Tamiya, Masahiko Kawanishi, Keisuke Miyake, Nobuyuki Kawai, and Shuxiang Guo, focus on the mechanical side of Nanotechnology, using microscopic robots for medical and engineering applications.

Section 3, “Development and Design Methodologies,” bridges the gap between the fundamentals of Nanotechnology and its application in a variety of environments and situations. The section opens with an extension of the previous discussion on nanoscale mechanics with chapters such as *Robust Integral of NN and Error Sign Control for Nanomanipulation Using AFM* by Qinmin Yang and Jiangang Lu. Following this, Section Three includes a range of chapters discussing the application of Nanotechnology and quantum physics principles, such as *Quantum Confinement Modeling and Simulation for Quantum Well Solar Cells* by Laurentiu Fara and Mihai Razvan Mitroi, and *The Biotic Logic of Quantum Processes and Quantum Computation* by Hector Sabelli and Louis H. Kauffman. Finally, this section concludes with several chapters on other uses for nanoscale technologies, including modeling and analysis of macroscopic systems, notably *Basic Research on Elemental and Size Analytical System for Nano-Sized Suspended Particulate Matter Using Contactless Optical Measurement Techniques* by S. Ikezawa and T. Ueda.

Section 4, “Utilization and Application,” continues with an in-depth look at some practical applications in the field of Nanotechnology. This section covers a wide range of topics because Nanotechnology is a critical component of many cutting-edge technologies and fields. Some notable examples present in this section include medical operations (*Advances in Robot Surgery* by Silvia Frumento, Roberto P. Razzoli, and Francesco E. Cepolina), biomedicine (*On the Modeling of Carbon Nanotubes as Drug Delivery Nanocapsules* by F. Alisafaei and R. Ansari), computing (*Nanocomputing in Cognitive Radio Networks to Improve the Performance* by Yenumula B. Reddy), and even art (*NanoArt* by Cris Orfescu). This wide variety demonstrates the ubiquity of technologies designed to be as small as possible, and the section ends with some of the most well-known applications of Nanotechnologies: materials science. *Effects of Different Parameters on Delamination Factor of Glass Fiber Reinforced Plastic (GFRP)* by Vikas Sharma, Vinod Kumar, and Harmesh Kumar discusses the properties of a new material made possible by Nanotechnology, while *Phononic Engineering for Hot Carrier Solar Cells* by Sana Laribi, Arthur Le Bris, Lun Mei Huang, Par Olsson, and Jean Francois Guillemoles describes and analyzes a novel, micro-engineered solar cell for more efficient solar energy capture, a topic that transitions effectively into the next section.

Section 5, “Critical Issues,” examines Nanotechnology applications to evaluate their effectiveness and explore methodologies and best practices for their implementation in real-world scenarios. The section begins with solar technologies and several designs for effective photovoltaic systems, including *Analytical Models of Bulk and Quantum Well Solar Cells and Relevance of the Radiative Limit* by James P. Connolly and *Materials Characterization Techniques for Solar Cell Devices* by Michael S. Hatzistergos. Following this, the section transitions into a discussion of particle science, particularly in the medical field, with chapters such as *Studies on Gymnemic Acids Nanoparticulate Formulations Against Diabetes Mellitus* by R. Ravichandran and *Nanostructured Metal Oxide Gas Sensor* by Jamal Mazloom and Farhad E. Ghodsi. Finally, the section continues with a focus on medicine with chapters such as *Strategy and Policy Issues Related to Nanotechnology Innovations in Medical Education* by Tamar Chachibaia, ending with a work that harkens back to previous chapters on nanorobotics: *Selective Pick-and-Place of Thin Film by Robotic Micromanipulation* by Bruno Sauvet, Mohamed Boukhicha, Adrian Balan, Gilgueng Hwang, Dario Taverna, Abhay Shukla, and Stéphane Régnier.

Section 6, “Emerging Trends,” concludes this multi-volume reference with some of the latest advances in the field of Nanotechnology. The chapters in this section seek to expand upon the present research, as outlined in the previous five sections, in order to reach new conclusions and develop new applications for these emerging technologies. In *Built-in Self Repair for Logic Structures*, Tobias Koal and Heinrich Theodor Vierhaus devise a new method of self repair for nanoscale integrated circuits. *Preparation of*

*a Uranium Conversion Plant's Nuclear Waste for Final Disposal by Means of Magnetically Assisted Chemical Separation* by Ahad Ghaemi, Mehdi Maghsudi, Fatemeh Hanifpour, and Mohammad Samadfam explores the nanoscience behind modern energy technologies, as does *CuInGaSe Based Thin Films for Photovoltaic Solar Cells* by Harry Efstathiadis and Adam Filios. Katsumi Yoshida discusses one area of materials science in *Application of Electrophoretic Deposition for Interfacial Control of High-Performance SiC Fiber-Reinforced SiC Matrix (SiCf/SiC) Composites*. Finally, this multi-volume reference work ends with, *An Advanced Architecture of a Massive Parallel Processing Nano Brain Operating 100 Billion Molecular Neurons Simultaneously* by Anirban Bandyopadhyay, Subrata Ghosh, Daisuke Fujita, Ranjit Pati, and Satyajit Sahu, their discussion centered on enhancing the computational power of the world's strongest supercomputers.

As a comprehensive collection of research on current findings related to the development of interdisciplinary technologies, *Nanotechnology: Concepts, Methodologies, Tools, and Applications* provides researchers, administrators, and all audiences with a complete understanding of the latest advances, applications, and concepts in Nanotechnology. Although the primary organization of the contents in this multi-volume work is based on its six sections, offering a progression of coverage on the important concepts, technologies, methodologies, applications, critical concerns, and emerging trends, the reader can also identify specific content by utilizing the extensive indexing system found at the end of each volume. Given the vast number of issues concerning usage, successes and failures, policies, strategies, and applications of Nanotechnology in countries around the world, *Nanotechnology: Concepts, Methodologies, Tools, and Applications* addresses the demand for a resource that encompasses the most pertinent research on the technologies being employed to globally bolster the knowledge and implementation of Nanotechnology.

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*This section begins with several introductory chapters on Nanotechnology and its associated areas of research. Nanotechnology is one of the fastest growing fields in engineering and materials science, making it an important area of study for a variety of disciplines. Primarily, this section will introduce topics ranging from biotechnology and chemistry to renewable energies and synthetic materials. In the opening 13 chapters of this extensive reference source, readers will obtain a clear understanding of the fundamental concepts and theories integral to the field of Nanotechnology.*

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## Section 2

### Tools and Technologies

*This section discusses some of the many diverse uses of Nanotechnology in the modern world. The most common applications of Nanotechnology are in the fields of materials science, robotics, and electronics, areas that make use of an array of specialized tools and techniques to accomplish complex tasks. In particular, Nanotechnology is used to enhance solar energy collectors, high-performance computers, medical sensors, and other critical devices. With 15 chapters, this section offers a broad treatment of some of the many tools and technologies within Nanotechnology.*

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