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Donglu Shi

纳米生物医学

NanoScience in Biomedicine

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Editor-in-Chinef
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内 容 简 介

本书主要介绍了纳米生物医学研究领域的新进展。本书分为三部分，第一部分叙述了纳米尺度的生物材料的设计、合成、特性以及应用，包括干细胞和相关技术、聚合体纳米纤维及其生物医学应用、自组织生物材料及其生物医学应用、生物探测材料的合成和自组织、磷酸盐陶瓷的生物领域的应用、生物材料的表面和界面特性、碳纳米管在生物传感方面的应用等；第二部分详细介绍纳米尺度的生物医学的新技术，包括药物输运技术、生物医学领域的微纳技术、DNA 技术、纳米尺度的生物活性表面和移植、碳纳米管智能材料在生物和医学方面的应用等。第三部分的重点是纳米材料合成和结构的最新进展，包括纳米材料中的声子行为、纳米粒子和纳米流体的合成和特性的最新进展等。

本书由工作在世界纳米生物医学领域的杰出科学家撰写。本书的读者对象为相关专业高年级大学生、研究生、科技人员、工程技术人员。

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Preface

The research on nanomaterials and nano biomedicine has been advancing rapidly in recent years, particularly in the development of unique nanostructures for specific biomedical applications. The research addresses the critical issues in medical applications including in vivo imaging, cell targeting, local drug delivery and treatment, bioactivity, compatibility, and toxicity. In the biomedical applications, traditional materials science and engineering have to deal with new challenges in the areas of synthesis, structure development, and biological, chemical, and physical behaviors, since medical needs place new demands in these respects.

The novel nanotechnologies included in this book are of great importance for biomedical applications. Based on these new developments, it is possible to alter the intrinsic properties of nanomaterials that cannot be achieved by conventional methods and materials. A key aspect of being able to manipulate the properties of the nanomaterials is the nanoscale architecture and engineering by various processing techniques. Some of the novel approaches introduced in this book can provide multi-functionality for a variety of substrates, be it biological, physical, or chemical, which can then be engineered for particular biomedical applications. For instance, novel surface functionalization methods have been developed for bio assays and cell targeting. In these approaches, a thin coating of polymer can be applied to the nano species and to provide various functional groups for passive or covalent coupling to biological molecules, such as antigens, antibodies, and DNA/RNA hybridization. However, the conventional synthesis of materials has only resulted in a single functionality which is generally not suitable for the complex procedures required for medical applications. The novel concept introduced in this book can be used to develop multiple functionalities, particularly suitable for medical diagnosis and treatment. The enhancement of properties is based on the study of the new nano structures and interfacial mechanisms.

This book summarizes the most recent research and development in nano biomedicine and addresses the critical issues in nanomaterials synthesis, structure, and properties. In particular, the major topics in nano biomedicine are covered in

this book. The book devotes three parts of 25 chapters to various aspects of nanomaterials and their medical applications. Detailed experimental procedures are presented at a level suitable for readers with no previous training in these areas.

The first part of the book concentrates on the research works of design, synthesis, properties, and applications of nano scale biomaterials. Chapter 1 is on the topics of stem cells and related nanotechnology. In Chapter 2, an overview is documented on the recent progress of polymer nanofibers, mostly electrospun in biomedical applications, along with a brief description of history, principle, and operating parameters of electrospinning process. Chapter 3 introduces new concepts in assembly of biomaterials. In view of the emerging importance of bio-inspired materials in medical applications, this chapter is focused on describing the fundamentals of intermolecular interactions and their applications in biomaterials science. The particular focus will be on processes and structures that mimic the natural ECM. Chapter 4 is on the fabrication and assembly of nanomaterials for biological detections. In Chapter 5, the authors first introduce the peptide design strategies for the construction of nanostructured materials. It then gives a brief tutorial of amino acid structure and function. It further describes higher-order assemblies of peptides and peptidomimetics. Chapter 6 introduces an important category of nanomaterials: quantum dots. Chapter 7 focuses on the phosphate ceramics for applications in bio-related fields. In this chapter, the authors briefly review the progress made in the last decade on the microwave-assisted synthesis and processing of biomaterials both in nanometer- and micrometer-size range. Chapter 8 introduces the characterization of biointerfaces and biosurfaces in biomaterials design. In Chapter 9, the authors bring the focus of the discussion to one of the important nanomaterials: carbon nanotubes and their applications in biosensing. Chpater 10 discusses the issues on heparin-conjugated nanointerfaces for biomedical applications.

The second part of the book is on the new nanotechnologies in biomedicine. In Chapter 11, the authors introduce some of the novel technologies in drug delivery. Chapter 12 reports unique experimental results on nano metal particles for biomedical applications. Chapter 13 is on the micro- and nanoscale technologies in high-throughput biomedical experimentation. Chapter 14 introduces delivery system of bioactive molecules for regenerative medicine. Chapter 15 gives an overview on modification of nano-sized materials for drug delivery. Chapter 16 is another chapter on drug delivery, however via a different approach. Chapter 17 is about most recent developments in DNA nanotechnology. A major objective in this chapter deals with the creation of ordered nanostructures for executing complex operations. Chapter 18 provides an overview on the nanoscale bioactive surfaces and endosseous implantology. Chapter 19 gives an overview of potential applications of carbon nanotube smart materials in biology and medicine.

The last part of the book concentrates on some of the most recent experimental results on the nanomaterials synthesis and structure developments. These include

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the synthesis, properties, and application of intrinsically electroconducting nanoparticles of polypyrrole and pyrrole/sulfonic diphenylamine (20/80) Copolymers. Some studies focuse on the fracture processes in advanced nanocrystalline and nanocomposite materials. Unique nano properties such as field emission of carbon nanotubes are also introduced. Finally, the book concludes by introducing some theoretical aspects of the nanomaterials. In this chapter, the authors develop microscopic modeling of phonon modes in semiconductor nanocrystals.

Chapter 20 is on the physical origins of phonon behaviors in nanocrystals. Chapter 21 gives an overview on computer simulations and theoretical modeling of fracture processes in nanocrystalline metals and ceramic nanocomposites. Chapter 22 describes a detailed experimental study on the fabrication, structures, unique properties, and wide application potential of novel conducting polypyrrole (PPY) nanoparticles and nanocomposites. Chapter 23 introduces some of the most recent developments in the fascinating carbon nanotubes. Chapter 24 reviews the progress in the flexible dye-sensitized nanostructured thin film solar cells (DSSCs). Chapter 25 presents recent results on the synthesis of magnetic nanoparticles (MNP) and various types of magnetic nanofluids (MNF) or ferrofluids, their structural properties and behaviors in an external magnetic field.

We hope that these chapters will provide timely and useful information for the progress of nanomaterials and their applications in biomedicine.

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