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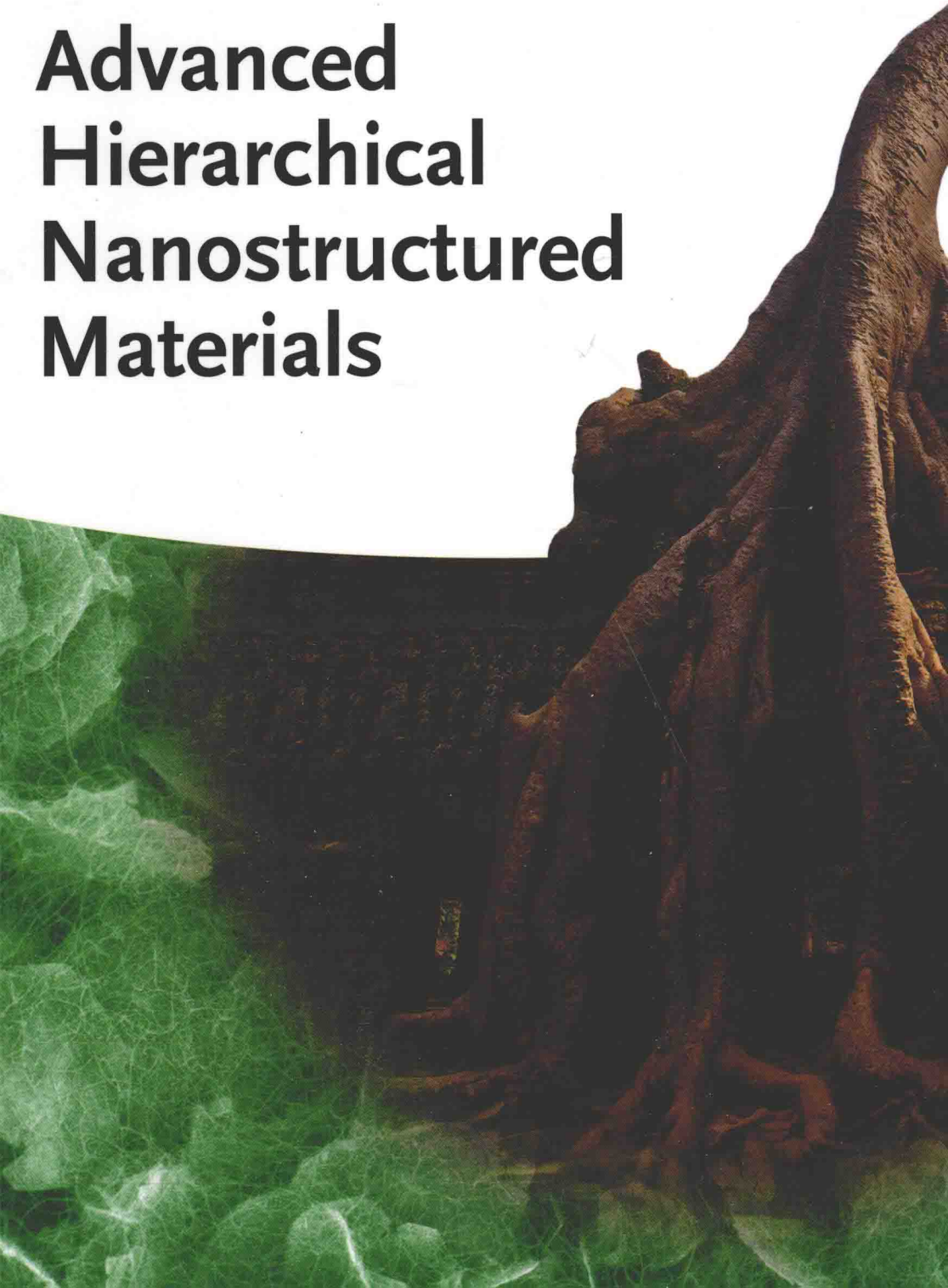
Qiang Zhang and Fei Wei

Advanced Hierarchical Nanostructured Materials



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Advanced Hierarchical Nanostructured Materials

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Preface

Hierarchical materials are present everywhere around us. Hierarchical nanostructures are widely observed in nature, for example, in plant cell walls, bone, animal shells, and skeletons, showing that a high mechanical performance can be attained by structuring matter across a range of length scales. The combination of low dimensional nanomaterials with distinct physical and chemical properties with hierarchical nanostructures can usually inherit the full advantages of the component materials, or even lead to the formation of multifunctional materials with unexpected properties for unique applications.

Nanoscience and nanotechnology brings not only new concepts to understand Nature but also new materials for building our society. Proper arrangement and construction of different low dimensional nanomaterials (e.g., zero-dimensional nanoparticles, one-dimensional nanotubes, nanowires, nanorods, and two-dimensional flakes) as building blocks with two or more levels from the nanometer to the macroscopic scale leads to the formation of three-dimensional hierarchical nanostructures. The as-obtained hierarchical nanostructures are usually with unexpected properties for unique applications in energy conversion and storage, catalysis, material science, environment protection, biology, and so on. A tremendous amount of work has been carried out on the synthesis, properties, and applications of hierarchical nanostructured materials. Hierarchical nanostructures have become a hot topic and will be vigorously pursued in the years to come. A family of cutting-edge materials, such as graphene, carbon nanotubes, magnetic nanoparticles, boron nitride, layered double hydroxides, polymer vesicles, as well as zeolites, is still being considered to build hierarchical nanostructures. The strategies to fabricate the related hierarchical nanostructures and their novel properties and applications for energy storage, environmental protection, catalysis, electronics, and healthcare are being widely investigated. Therefore, this rapidly growing field is of critical significance and is attracting great attention from both academia and industry. It is the time to review the progress achieved by outstanding researchers to shed light on the science and technology of hierarchical nanostructures.

In 2012, the first book *Hierarchical Structured Porous Materials* edited by Bao-Lian Su, Clement Sanchez, and Xiao-Yu Yang was published by Wiley-VCH. This has been a great contribution to porous materials with bimodal, trimodal, and multimodal pore size, with emphasis on the rational design, synthesis, and applications. For the facile transfer of the latest knowledge on hierarchical nanostructures, a new title *Advanced Hierarchical Nanostructured Material* was proposed. This book is devoted to the hot field of the science and technology of hierarchical nanostructures with low dimensional nanomaterial building blocks, with particular emphasis on the emerging nanocarbon (graphene, carbon nanotube), nanocrystals, mesoporous silicates, polymers, layered double hydroxides, and their related composites. Their complex, three-dimensional nanostructures and ever-increasing applications for energy storage, environmental protection, green catalysis, and biointerface for healthcare are also included.

This book contains 13 chapters written by leading experts worldwide. The book starts with the structural diversity in mesoporous materials (Chapter 1). Then a family of hierarchical nanostructured materials, including biological materials (Chapter 2), magnetic nanoparticles (Chapter 3), metallic micro/nanostructures (Chapter 4), polymer vesicles (Chapter 5), helices (Chapter 6), layered double hydroxides (Chapter 7), boron nitride (Chapter 8), graphene (Chapter 9), hydrothermal nanocarbons (Chapter 10), carbon nanocomposites (Chapter 11), porous carbon (Chapter 12), and functional polymer coatings (Chapter 13), is dealt with. The synthesis, structure, and applications of these above-mentioned materials are also provided in each chapter, with some of them toward certain applications in energy or healthcare.

This book can be used as a basic reference work for the rational design, facile synthesis, and emerging applications of hierarchical nanostructures. This is a critical reference source for scientists and engineers in academia and industry, as well as graduate and undergraduates in a wide range of disciplines including materials science, chemistry, physics, chemical engineering, and environmental and biology sciences.

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