Rational Design of Next-generation Nanomaterials and Nanodevices for Water Applications

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Preface

Water pollution and water scarcity are among the most challenging problems facing mankind nowadays. With rapid population growth, steadily improving life standards, fast industrialization and modernization of developing countries, these challenges will persist, if not worsen, in the years to come. With conventional water treatment technologies being pushed towards their capacity limits, it is now a popular perception that the solutions to the existing and future water challenges will hinge upon further developments in nanotechnology.

Ever since 1959, when the term "nanotechnology" was first used by Richard Feynman in his famous lecture entitled "there's plenty of room at the bottom", the field of nanotechnology has been experiencing literally explosive growth, especially in the last two decades. Moreover, the application of nanotechnology to water treatment has steadily grown into a distinct field with the expected growth rate on an exponential rise.

In the early days when nanomaterials first attracted attention from researchers in water field, trial-and-error approach prevailed in which water scientists searched suitable applications for the nanomaterials developed by materials scientists and the disconnection between two sides was common. The rational design concept came into being when the researchers realized that the chemistry and ultimately the functions of nanomaterials could be deliberately pre-designed for a desired purpose before embarking on nanomaterial synthesis. Within the scheme of rational design, material design, synthesis and application are seamlessly integrated within one entity. The rational nano-design starts with a clear problem definition, necessitates interdisciplinary approaches, involves 'think-outside-the-box', and represents the future growth point of water field. However, it is still largely new to the educated public and even scientists and engineers in water fields. Therefore, it is the purpose of this book to promote the concept of rational nano-design and to demonstrate its creativity, innovation, and excitement in water treatment. The book presents a series of carefully selected rationally designed nano-materials/devices/surfaces

to embody the concept of nano-design and to illustrate its remarkable potential to change the face of the research in water industry in the future. The selected examples in the book chapters represent drastically different, ground-breaking, and eye-opening approaches to conventional problems and each of the book contributors is world-renowned expert in the burgeoning field of rational nano-design for applications.

As you will see, the topics of the book chapters are truly multidisciplinary. They span from an introduction to rational nano-design for water applications (Chapter 1, Renyuan Li and Professor Peng Wang from KAUST), design and application of magnetic-core composite nano/micro particles for environmental remediation (Chapter 2, Yuxiong Huang and Professor Arturo Keller from University of California, Santa Barbara), rational design of functional nanoporous materials to confine water pollutant in controlled nano-space (Chapter 3, Swasmi Purwajanti, Jie Yang, Xiaodan Huang, and Professor Chengzhong Yu from University of Queensland), hierarchical materials as a design concept for multifunctional membranes, (Chapter 4, Christopher Crock, Brian Starr, and Professor Volodymyr Tarabara from Michigan State University), smart membrane materials for controllable oil-water separation (Chapter 5, Lianbin Zhang and Professor Peng Wang from KAUST), design of the next-generation FO draw solution (Chapter 6, Dr. Aaron Wilson from Idaho National Laboratory, USA), to nanotechnology for microbial fuel cells (Chapter 7, Professor Muhammad Mustafa Hussain from KAUST).

Rational Design of Next-generation Nanomaterials and Nanodevices for Water Applications is intended for undergraduates, graduates, scientists and professionals in the fields of environmental science, material science, chemistry, and chemistry engineering. It provides coherent and good material for teaching, research, and professional reference. I hope that this book will provide an inspiration for readers who are interested in rational design of nanotechnology and who are passionate at further exploring nanomaterials to make contributions to the solutions to our grand environmental challenges.

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