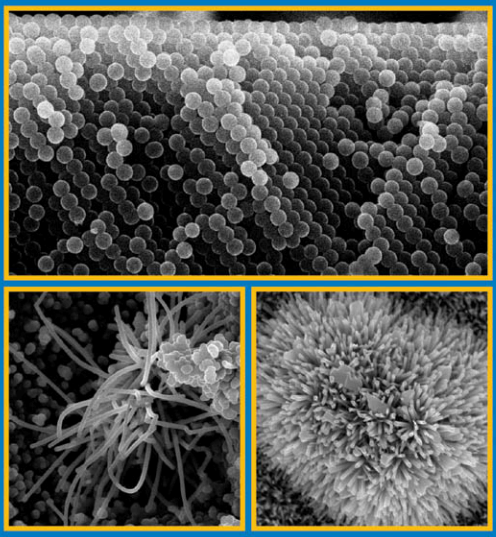
Nanotechnologies for Water Environment Applications



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NANOTECHNOLOGIES FOR WATER ENVIRONMENT APPLICATIONS

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Nanotechnology Task Committee of the Environmental Council

Environmental and Water Resources Institute (EWRI)
of the American Society of Civil Engineers

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Preface

Nanomaterials have structures with exotic properties due to the interactions and physics between atoms. Built on the ability to control or manipulate at the atomic scale, nanotechnology involves research and technology development at the 0.1–100 nm range. Nanotechnology enables a powerful new direction for our industries and human activities. Nanotechnology has the potential to enhance environmental quality and sustainability by improving detection/sensing techniques for environmental pollutants, controlling/removing environmental contaminations and development/utilization of new green engineering processes to reduce energy/resource consumption and generation of waste products. However, just like any new technology, nanotechnology may be abused and, thereafter, can harm the environment and sustainability.

The ASCE's Technical Committee on Hazardous, Toxic and Radioactive Waste has identified nanotechnology as an important area for water environmental applications. This book brings together nanotechnology research and applications that contribute to enhanced protection of aquatic environments. It also addresses the problems and processes that might occur should nanotechnology be abused, including toxicology, interactions and risk management of nanomaterials in aquatic environments.

The book presents a discussion of fundamentals of nanomaterials and nanosystems, various applications of nanotechnologies, behavior, and possible impacts of nanomaterials on human health and the environment. Chapter 1 is the introductory chapter which introduces historical development of nanotechnology, general applications and implications of nanotechnologies. Chapter 2 focuses on synthesis of nanomaterials concerning environmental applications. The major part of this book includes several chapters addressing applications of nanoparticles, including catalysts TiO_2 nanoparticles for water purification (chapter 3), nanoparticles for treatment of chlorinated organic contaminants (chapter 4), removal of inorganic compounds such as arsenic (chapter 5) and heavy metal ions from aqueous environments (chapter 6). More applications and related research are introduced, including bimetallic nanoparticles (e.g., bimetallic Pd/Fe nanoparticles) for environmental remediation (chapter 7), challenges in groundwater remediation with iron nanoparticles–enhancement colloidal stability (chapter 8), iron-based magnetic nanoparticles for removal of heavy metals from industrial wastewater (chapter 9), nanoscale carbon materials for contaminant separation (chapter 10), nanoscale porous materials for water treatment–advances and challenges (chapter 11), nanomembranes for water purification (chapter 12), fabrication and general applications of nano- or micro-sensors in environmental areas (chapter 13), and nanomaterials for environmental burden reduction, waste treatment and non-point source pollution

control (chapter 14). The last part of the book consists of three chapters (15–17). Chapter 15 addresses the fate and transport of nanomaterials in aquatic environments; chapter 16 discusses issues related to engineered nanomaterials as emerging contaminants in water; and chapter 17 presents environmental risks of nanomaterials and related management issues. This organization will help the readers readily find the information they are looking for.

We hope that this book will be of interest to scientists, engineers, government officers, decision-makers, process managers, and practicing professionals. It will provide them an in-depth understanding of the fundamentals and environmental applications of nanotechnologies. The book also will serve as a reference for undergraduate and graduate students, as well as for practicing professionals.

The editors gratefully acknowledge the hard work and patience of all the authors who have contributed to this book. The views or opinions expressed in each chapter of this book are those of the authors and should not be construed as opinions of the organizations they work for. Special thanks go to the faculty and staff members at the University of Nebraska-Lincoln: Dr. Yongfeng Lu for providing the cover pictures of nanomaterials developed in his laboratories; Ms. Arlys Blakey for her thoughtful comments and invaluable support during the development of this book; and Mr. Rui Ma for designing the cover of the book.

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