

Junaid Ahmad Malik · Mohamed Jaffer Sadiq M. *Editors*

Modern Nanotechnology

Volume 1: Environmental Sustainability and Remediation

This two-volume set provides a comprehensive overview of modern nanoscience, and encompasses advanced techniques of nanocomposite materials that make their way from the laboratory to the field for the revival of energy and environmental systems in a sustainable manner. It includes the design and the sophisticated fabrication of nanomaterials along with their potential energy and environmental applications, while looking at how nanoscience and nanotechnology can be used to promote environmentally friendly processes and strategies. The books' purpose is to promote eco-friendly methods and techniques by covering many elements of both the synthesis and uses of nanoparticles and nanofluids for energy and environmental engineering. They provide an up-to-date synthesis of nanocomposite materials for modern nanotechnology applications in the fields of environment protection, heterogeneous catalysis, wastewater treatment, fuel cells, electrochemical energy conversion, and storage applications. The set is designed for environmental scientists, nanotechnologists, chemists, engineers, and individuals seeking current research on nanotechnology and its applications in environmental engineering. Graduate students working in these fields will also find it a valuable resource.

Volume 1 focuses on the fundamentals of nanotechnology, environmental protection, sustainable agriculture, bioremediation, bio-nanocomposites, and wastewater treatment.

ISBN 978-3-031-31110-9



9 783031 311109
▶ springer.com

Malik · Sadiq M. *Eds.*



Modern Nanotechnology

Junaid Ahmad Malik
Mohamed Jaffer Sadiq M. *Editors*

Modern Nanotechnology

Volume 1: Environmental Sustainability
and Remediation

 Springer

Junaid Ahmad Malik
Mohamed Jaffer Sadiq M.

Editors

Modern Nanotechnology:

Environmental Sustainability and Remediation

About the Editors

Dr. Junaid Ahmad Malik



Dr. Malik received B.Sc. (2008) Science from the University of Kashmir, Srinagar, J&K; M.Sc. (2010) in Zoology from Barkatullah University, Bhopal, Madhya Pradesh; and PhD (2015) in Zoology from the same university. He completed his B.Ed program in 2017 from the University of Kashmir, Srinagar, J&K. He started his career as Lecturer in School Education Department, Govt. of J&K for 2 years. Dr. Malik is now working as a Lecturer in Department of Zoology, Govt. Degree College, Bijbehara, Kashmir (J&K) and actively involved in teaching and research activities. He has more than 8 years of research experience. His areas of interest are ecology, soil macrofauna, wildlife biology, conservation biology etc.

Dr. Malik has published more than 20 research papers in various national and international peer-reviewed journals. He has published 19 books, 31 book chapters and more than 10 popular editorial articles with various publishers like Springer Nature, Elsevier Inc., Taylor and Francis Group and IGI Global. Dr. Malik is acting as the Editor-in-Chief of *Inventum Biologicum* (An International Journal of Biological Research) published by World Biologica, India. He is also serving as editor and reviewer of several journals with a reasonable repute. He has participated in several State, National, and International conferences, seminars, workshops, and symposia and more than 20 conference papers are to his credit. He is the life member of SBBS (Society for Bioinformatics and Biological Sciences) with membership id LMJ-243.

Readers may contact him at editor@worldbiologica.com, or malik.junaidahmad@gmail.com

Dr. Mohamed Jaffer Sadiq Mohamed



Dr. Mohamed Jaffer Sadiq Mohamed, PhD, is working as a Postdoctoral Researcher in the King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia.

Dr. Sadiq received BSc (2006) in Chemistry from Bharathiyar University, Coimbatore, Tamil Nadu; MSc (2008) in Applied Chemistry from National Institute of Technology (NIT), Tiruchirappalli, Tamil Nadu; MTech (2014) in Nanotechnology from Karunya University, Coimbatore, Tamil Nadu; and PhD (2017) in Chemistry from National Institute of Technology Karnataka (NITK), Surathkal, Mangalore, Karnataka. He started his career as Chemist in Hindustan Zinc Limited, Rajasthan, for four years. He worked as a Postdoctoral Researcher in the Yunnan University, Kunming, China for two years. Dr. Sadiq is now working as a Postdoctoral Researcher in the King Fahd University of Petroleum and Minerals, Dhahran, Saudi Arabia, and is actively involved in teaching and research activities. He has more than 10 years of industrial and research experience. His areas of interest are Nanomaterials/Nanocomposites/Nanocrystals/Perovskites based photocatalysis, water splitting, fenton's like catalysts, electrocatalysis (HER, OER, ORR), heterogeneous catalysis, supercapacitors, fuel cell catalysis, and solar cells. He has authored 2 book chapters, edited 2 books, published 30 research articles and technical papers in international peer-reviewed journals like Springer, Elsevier, RSC, ACS, etc. He is also serving as editor and reviewer of several journals with a reasonable reputation. He has participated in several State, National, and International Conferences, seminars, workshops, and symposia, and more than 20 conference papers are to his credit.

Readers may contact him at: sadiqmsc@gmail.com

Preface

While there is ongoing discussion about the regulation of nanomaterials, research on nanotechnology applications in food production remains outside the mainstream despite the early 2000 appearance of nano-foods, which later became a topic of interest in discussions about the sustainability of nanotechnology. An abundance of items on the market that offer specific benefits for environmental and climate preservation is caused by rising costs for raw materials and energy combined with customers' growing environmental consciousness. Nanomaterials are intriguing for new, ecologically friendly goods because of their unique physical and chemical characteristics. By conserving raw resources, energy, and water, as well as by lowering greenhouse emissions and dangerous wastes, nanotechnological goods, processes, and applications are anticipated to make a substantial contribution to environmental and climatic protection. Therefore, using nanomaterials promises to have positive impacts on sustainability and the environment. Even though nanoparticles have the adaptable qualities to change a variety of pollutants, the remediation of contaminants in environmental media, technological viability, cost-effectiveness, and possible risks to the environment and humans also need to be addressed.

Massive oil spills provide a challenge that conventional cleanup methods cannot handle. Nanotechnology has recently come to light as a possible source of creative answers to many of the world's unresolved issues. Although it is still in its infancy, using nanotechnology to clean up oil spills has a lot of potential for the future. The three categories of treatment and remediation, sensing and detection, and pollution prevention constitute the potential key areas for nanotechnology in water applications. One of these categories is the enhancement of desalination technologies. Desalination might change owing to nanotechnology-based water filtration systems that, for example, make use of the ion concentration polarization phenomena. Artificial photosynthesis, which splits water using solar energy to produce hydrogen and oxygen, may provide a portable, clean source of energy that is just as enduring as sunshine. Industrial and urban trash releases a wide range of harmful organic and inorganic contaminants into the water, land, and atmosphere. These contaminants cannot be eliminated with just current technology. As a result, using contemporary technologies like nanotechnology might be crucial in resolving this issue. Nanofilters, nanosensors, nanophotocatalysts, and nanoparticles are a few of the nanomaterials that are often utilized in waste management. By proving the effectiveness of such nanoparticles in biomedicine and environmental remediation, the bio-based nanomaterials might provide fresh perspectives into the quickly developing disciplines of biomedical and environmental sciences. These nanoscale particles are very beneficial and have a great deal of potential to develop into the next generation of nanoscale factories.

As a result, research is ongoing, and the data generated in the biological and environmental disciplines may lead to a sustainable future.

Given that bioremediation, a green and sustainable technology, is gaining momentum swiftly, the chapters in this book would be well-suited for future research that might be beneficial to all interested stakeholders. With contributions from renowned specialists in the aforementioned domains, the chapters in this companion book offer a particular selection spanning the most current findings. We anticipate that this book, which covers and highlights major research and progress in the area, will be a huge benefit to researchers and will also provide the sustainable use of bio-based nanomaterials a fresh perspective.

--Editors

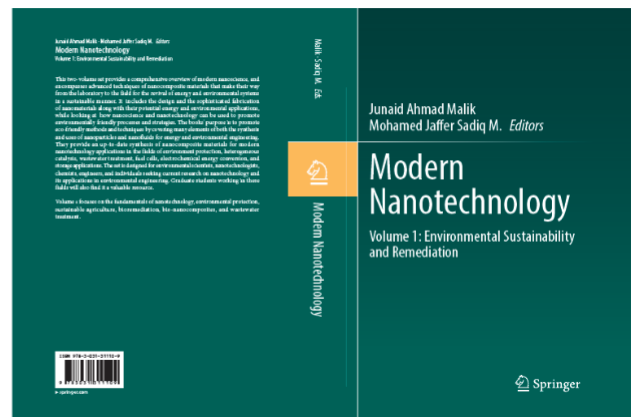
Table of Contents

Preface

About the Editor

List of Contributors

1. **Fundamentals of Nanotechnology for Environmental Engineering**
Kamal Kishore, Chou-Yi Hsu, Shankarappa Sridhara, Joseph Oduor Odongo, Muhammad Akram, Junaid Ahmad Malik, Yathrib Ajaj, Javid Manzoor
2. **Fundamental Aspects of Nanocomposite Materials for Environmental Protection and Remediation**
S. Sudha, M. Bavanilatha, L. Inbathamizh, B. Vishnu Priya, Sandra Samson
3. **Nanotechnology for Sustainable Agriculture: Current Trends and Future Prospects**
M. Hemalatha, Vinita H, G. Sravanalakshmi, Bhagyajyothi C Kotibagar, Megha M
4. **Nanomaterials in Soil Health Management and Crop Production**
Trisha Sinha, Bhaskar Pratap Singh, Kousik Nandi, Kshouni Das
5. **Nanomaterials for Water Purification and Reclamation**
Shivani Narwal, Rajesh Dhankhar
6. **Role of Nanomaterials in the Treatment of Wastewater**
Akansha Bassi, Nisha Rana
7. **Applications of Nanomaterials for Water Treatment: Current Trends and Future Scope**
M. Hemalatha, Gangadasari Sravana Lakshmi, Megha, Vinita, Bhagyajyothi C Kotibagar
8. **Engineered Nanomaterials for Water Treatment Applications**
G. Elanthendral, L. Inbathamizh, S. Sudha
9. **Research Trends in Photocatalytic Water Purification: Current Perspectives and Future Prospects – A Review**
Mohamed Jaffer Sadiq Mohamed, Anurag Roy, Mohammed Ashraf Gondal,
10. **Nanotechnology for Water Splitting: A Sustainable Way to Generate Hydrogen**
Md. Merajul Islam, Amina Nafees
11. **Carbon Nanomaterials for Wastewater Treatment**
Shikha Kumari, Manjeet Kaur, Geeta Dhania
12. **Nanosorbents – A Nanotechnological Approach for the Treatment of Heavy Metal Contamination in Wastewater**
Ankita Yadav, Geeta Dhania
13. **Nanofiltration Membrane Techniques for Heavy Metal Separation**
Moni Jakhar, Jitender Singh Laura, Meenakshi Nandal



14. Carbon Dots as Nanoprobes for Heavy Metal Detection

Alkiviadis A. Tzimas, Andromachi Gavriola, Ioannis S. Dasteridis, Constantine D. Stalikas, Theodoros G. Chatzimitakos,

15. Nanotechnology for Plastic Degradation

Telphy Kuriakose, Preetha Nair, Bannhi Das

16. Role of Nanomodification and Nanofertilizers in Crop Production and Soil Health

Narendra Kumar Bharati, Dipak Dnyaneshwar Kadam, Anwasha Samanta, Anshu Kumar, B. Teja Bhushan, Emani Rajeswari

17. Microbes Induced Biofabrication of Gold Nanoparticles and its Exploitation in Biosensing of Phytopathogens

Huma Nazneen, Emmadi Venu, Anshu Kumar, Razia Sulthana Begum

18. Removal of Radioactive Wastes Using Nanomaterial

Bannhi Das, Preetha Nair, Telphy Kuriakose

19. Nanotechnology-based Photocatalytic Degradation of Pharmaceuticals

Harshala S. Naik, Parvindar M. Sah, Rajesh W. Raut

20. Nanotechnological Interventions in the Degradation of Pharmaceutical Compounds

Jissa Theresa Kurian, Shilpa Susan Sacria, Juhi Puthukulangara Jaison, Jaya Gangwar, Preethy Chandran, Yogish Somayaji, Mridul Umesh, Joseph Kadanthottu Sebastian

21. Nanocomposites for Removal and Degradation of Organic Pollutants

Muhammad Akram, Seerat Ul Ain Bhutto, Sikandar Aftab, Lara Sindhu, Xing Xu, Zeeshan Haider

22. Nanotechnological Approaches against Fungal Pathogens of Economically Important Crop Plants

Mallika Mazumder, Somnath Roy, Sahina Parvin, Biswajit Das, Anup Kumar Sarkar

23. Advanced Approaches in Micro- and Nano-sensors for Harsh Environmental Applications: A Review

Randa Abdel-Karim

24. Cellulose Based Gels: Synthesis, Properties and Applications

Jyothy G Vijayan, T. Niranjana Prabhu

25. Artificial Photosynthesis Using Nanotechnology

Preetha Nair, Bannhi Das, Telphy Kuriakose

26. Artificial Photosynthesis with Gold Nanostructures Incorporation in Non-photosynthetic Bacteria

K.R. Padma, K.R. Don

Index