“This intriguing book presents an extensive and critical discussion on the modern methods of pollution treatment and control using nanocomposites, ranging from carbon-based ones and other inorganics to polymers, membranes, and bionanocomposites. It focuses on greener, environment-friendly, and sustainable techniques. The book is a valuable resource for environmental nanotechnologists, engineers, toxicologists, and researchers in companies and universities, as well as an excellent supporting material for students.”

Dr. Boris I. Kharisov
Universidad Autónoma de Nuevo León, México

Nanocomposites have outstanding mechanical properties and compatibility owing to their composite matrix and unique physical and chemical composition provided by large surface-area-to-volume ratios and high interfacial reactivity. The freedom to functionalize nanocomposites with various chemical groups increases their affinity toward target pollutants, which is highly desirable for the selective extraction of target analytes in complex environmental matrices.

This book presents the recent progress in the field of nanocomposites and their properties, fabrication methods, and applications for pollution control and sensing. It discusses the advances in pollution control techniques made possible because of nanocomposites and focuses on environment-friendly and efficient approaches. The text also covers relevant economic, toxicological, and regulatory issues and research trends.

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Nanocomposites for Pollution Control
Nanocomposites for Pollution Control

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Chaudhery Mustansar Hussain
Ajay Kumar Mishra
Contents

Preface xvii

PART 1: NANOCOMPOSITES: A NEW DIMENSION TOWARDS POLLUTION CONTROL

1. Nanocomposites: An Approach towards Pollution Control 3
   Rekha Sharma and Dinesh Kumar
   1.1 Introduction 3
   1.2 Adsorption 6
   1.3 Preparation and Characterization of Nanocomposites 6
   1.4 Water Treatment 7
   1.5 Removal of Inorganic Pollutants 7
   1.6 Removal of Organic Pollutants 18
   1.7 Removal of Biological Pollutants 20
   1.8 Future Perspectives of Nanocomposites 29
   1.9 Conclusion 30

2. Nanocomposites for Pollution Control 47
   Ephraim Vunain, Ajay Kumar Mishra, and B. B. Mamba
   2.1 Introduction 47
   2.2 Classification of Nanocomposites 50
   2.3 Synthesis of Organic–Inorganic Nanocomposites 51
   2.4 Application of Nanocomposites in Environmental Remediation 51
      2.4.1 Use of Nanocomposites for Adsorption of Pollutants 52
      2.4.2 Use of Nanocomposites for Catalytic and Redox Degradation of Dyes and Organic Pollutants 59
2.4.3 Use of Nanocomposites for Sensing and Detection of Pollutants 63
2.5 Conclusions and Perspectives 66

3. Nanocomposites for Abatement of Water Pollution 81
   Mona Abdel Rehim and Abdelrahman Badawy
   3.1 Introduction 81
   3.2 Hyperbranched Polymers for Wastewater Purification 83
   3.3 Hybrid Materials Based on Hyperbranched Polymers for Wastewater Treatment 84
   3.4 Metal Oxide Photocatalysts 87
   3.5 Influence of Light on TiO₂ Properties 88
   3.6 Reactions of Water on Irradiated TiO₂ 89
   3.7 TiO₂ and ZnO as Photocatalysts 89
   3.8 Photocatalytic Activity of Hyperbranched/Metal Oxide Hybrids 92

4. Dimensions of Nanocomposites in Pollution Control 107
   Pradeep Pratap Singh and Ambika
   4.1 Introduction 108
   4.2 Classification of Nanocomposites 109
      4.2.1 Classification Based on the Nanomaterial’s Dimensional Morphology 109
      4.2.2 Classification Based on Microstructure 109
      4.2.3 Classification Based on Matrices 109
         4.2.3.1 Metal oxides nanocomposites 109
         4.2.3.2 Carbon nanotube matrix–based nanocomposites 111
         4.2.3.3 Ceramic-based nanocomposites 111
         4.2.3.4 Polymeric nanocomposites 112
   4.3 General Approaches to Nanocomposite Fabrication 113
   4.4 Applications of Nanocomposites in Pollution Control 114
5. **Zinc Oxide-Based Nanocomposites for Photocatalytic Conversion of Organic Pollutants in Water**  
*Sze-Mun Lam and Jin-Chung Sin*

- 5.1 Introduction
  - 5.1.1 What Is Zinc Oxide?
  - 5.1.2 What Is Photocatalytic Conversion of Organic Pollutants?
- 5.2 Synthesis and Characterization of Zinc Oxide-Based Nanocomposite Photocatalysts
  - 5.2.1 Solution Mixing
  - 5.2.2 Sol-Gel Method
  - 5.2.3 Hydro(Solvo) Thermal Approach
  - 5.2.4 Microwave-Assisted Method
- 5.3 Applications of Zinc Oxide-Based Nanocomposites for Photocatalytic Conversion of Organic Pollutants
- 5.4 Degradation Mechanism of the Improved Photocatalytic Performance for Organic Pollutants Conversion
- 5.5 Summary and Perspectives

6. **Polymer Nanocomposites as Nanoadsorbents for Environment Remediation**  
*Priyanka Ghanghas, Kavita Poonia, and Dinesh Kumar*

- 6.1 Introduction
- 6.2 Preparation of Polymer-Based Nanoadsorbents
- 6.3 Applications of Polymer-Based Nanoadsorbents
  - 6.3.1 Removal of Organic Compound
  - 6.3.2 Removal of Heavy Metals
6.4 Magnetic Polymer-Based Nanocomposites 181
6.5 Magnetic Nanocomposites 182
  6.5.1 Core–Shell Inorganic Nanocomposites 182
  6.5.2 Self-Assembled Colloidal Nanocomposites 183
  6.5.3 Organic–Inorganic Nanocomposites 183
6.6 Synthesis of Magnetic Nanoparticles 183
  6.6.1 Synthesis of Magnetic Polymer Nanocomposites 184
  6.6.2 Application of Magnetic Polymer-Based Nanocomposites 185
    6.6.2.1 Removal of heavy metals 185
    6.6.2.2 Removal of oil 188
  6.6.3 Multifunctional Nanocomposites 189
  6.6.4 Applications of Multifunctional Nanocomposites 190
    6.6.4.1 Removal of heavy metals 190
  6.6.5 Solid Waste Treatment 191
  6.6.6 Removal of Dye 193
6.7 Summary 194

7. Role of New-Generation Technology in Remediating Environmental Pollution 207
   Sapna and Dinesh Kumar

  7.1 Introduction 208
  7.2 CNTs for Remediation 208
  7.3 Role in Controlling Air Pollution 211
    7.3.1 Photocatalysis 211
  7.4 Methods for the Synthesis of TiO₂ Nanoparticles 212
    7.3.2 Fullerenes 214
    7.3.3 Dendrimers 216
    7.3.4 Zeolite 217
  7.5 Iron Nanoparticles 219
PART 2: CARBON NANOMATERIAL-BASED NANOCOMPOSITES FOR POLLUTION CONTROL

8. Carbon Nanostructures: Applications and Perspectives for a Green Future

Ankita Dhillon, Ritu Painuli, and Dinesh Kumar

8.1 Introduction
8.2 Carbon-Based Nanomaterials
8.3 Unique Properties of Carbon Nanomaterials
8.4 Carbon Nanomaterials as Sorbents
8.5 Carbonaceous Nanomaterials as Antimicrobial Agents
8.6 Carbon Tubes in Air Pollution
8.7 Carbon Tubes in Biotechnology
8.8 Carbon Tubes in Energy Conversion
8.9 Carbon Tubes in Environmental Monitoring and Wastewater Treatment
8.10 Pollution Prevention via Molecular Manipulation
8.11 Carbon Nanotubes in Green Nanocomposites Design
8.12 Significant Applications of Carbon Nanotubes
8.13 Conclusions

9. Role of Computational Tools in Designing Enzymatic Biosensors for the Detection of Pesticides in Environment

Mohd. Shahbaaz, Suvardhan Kanchi, Myalowenkosi Sabela, and Krishna Bisetty

9.1 Introduction
9.2 Materials and Methods
9.2.1 Molecular Modelling
9.2.2 Molecular Docking
9.2.3 Molecular Dynamic Simulations
9.3 Results and Discussion

9.3.1 Calibre of Acetylcholinesterase as a Future Biosensor: Interaction Studies of ACH with Fenobucarb, DDT and Parathion 292

9.3.2 Calibre of Cytochrome P450 as a Future Biosensor: Interaction Studies of CYP with Fenobucarb, DDT and Parathion 295

9.3.3 Calibre of Glutathione S-Transferase as a Future Biosensor: Interaction Studies of GST with Fenobucarb, DDT and Parathion 299

9.3.4 Calibre of Protein Kinase C as a Future Biosensor: Interaction Studies of PKC with Fenobucarb, DDT and Parathion 302

9.4 Conclusions 305

10. Core–Shell Quantum Dots: Sensing Applications 313

Suvardhan Kanchi, Myalowenkosi Sabela, Krishna Bisetty, and Venkatasubba Naidu Nuthalapati

10.1 Introduction 313

10.2 Core–Shell QDs and Their Types 315

10.3 QD Surface Modification 315

10.3.1 Surface Modification with Inorganic Materials 316

10.3.2 Surface Modification with Organic Materials 317

10.4 Applications 318

10.5 Conclusion 324

11. Use of Carbon Nanotubes as Sorbents for Heavy Metal Remediation from Wastewater 331

Akil Ahmad, David Lokhat, Siti Hamidah Mohd Setapar, Asma Khatoon, Mohammad Shahadat, and Mohd Rafatullah

11.1 Introduction 332

11.2 Carbon Nanotubes as Adsorbents 341

11.2.1 Single-Walled Carbon Nanotubes 341

11.2.2 Multi-Walled Carbon Nanotubes 344
11.3 Binding Mechanism of Metal Ions onto Modified CNTs 346
11.4 Conclusion and Future Prospects 348

PART 3: NANOCOMPOSITE MEMBRANES FOR POLLUTION CONTROL

12. Nanocomposite Membranes for Heavy Metal Removal from Wastewater 361
   Zulhairun Abdul Karim, Goh Pei Sean, and Ahmad Fauzi Ismail

12.1 Introduction 362
12.2 Conventional Heavy Metal Removal Treatment 365
12.3 Membrane Technology 367
12.4 Nanocomposite Mixed Matrix Membranes 370
   12.4.1 Carbon Nanotubes Nanocomposite Membrane 371
   12.4.2 Graphene Nanocomposite Membrane 372
   12.4.3 Metal Oxide Nanocomposite Membrane 374
   12.4.4 Clay Nanocomposite Membrane 377
   12.4.5 Zeolite Nanocomposite Membrane 380
12.5 Electrospun Nanocomposite Membranes 381
12.6 Thin Film Nanocomposite Membranes 384
12.7 Future Direction and Concluding Remarks 386

13. Nanocomposite Membrane-Based Photocatalytic Reactor for Degradation of Endocrine-Disrupting Compound in Water 403
   Hazlini Dzinun, Mohd Hafiz Dzarfan Othman, A. F. Ismail, Mohd Hafiz Puteh, Mukhlis A. Rahman, and Juhana Jaafar

13.1 Introduction 403
13.2 Dual-Layer Hollow Fiber as Photocatalytic Membranes 406
13.3 Co-Extrusion Approach in the Preparation of Dual-Layer Hollow Fiber Membranes 408
   13.3.1 Polymer Dope Preparation 410
13.3.2 Post Treatment  411
13.4 Delamination  411
13.5 Morphology and Physical Properties of Dual-Layer Hollow Fiber Membranes  414
13.6 Filtration Performance  427
13.7 Photocatalytic Performance in Hybrid Photocatalytic Membrane Reactor  428
13.8 Determination of Degradation Intermediates  431
13.9 Conclusion  434


Sukanchan Palit and Chaudhery Mustansar Hussain

14.1 Introduction  441
14.2 The Vision of the Chapter  443
14.3 The Need and the Rationale of the Study  443
14.4 The Scope of the Study  444
14.5 What Are Composites?  444
   14.5.1 Fibre-Reinforced Composites  445
   14.5.2 Engineering Applications  445
   14.5.3 Medical Applications  445
   14.5.4 Limitations of Composites  446
14.6 What Do You Mean by Nanocomposites?  446
14.7 Nanocomposites-Scientific Doctrine and Deep Scientific Vision  447
14.8 A Survey of the Applications of Nanocomposites  448
14.9 Scientific and Technological Objectives in the Application Domain of Nanocomposites  450
14.10 Nanocomposites and Environmental Protection  450
14.11 Recent Scientific Research Pursuit in the Field of Composites  451
   14.11.1 Recent Scientific Endeavour in the Field of Nanocomposites  452
14.11.2 Recent Scientific Research Pursuit in the Field of Membrane Science and the Vision to Move Forward 457
14.12 Advancements in Nanotechnology, the Forays into Research in Nanocomposites and the Vision for the Future 459
14.13 The Scientific Doctrine of Membrane Science 460
14.14 Definition of Membrane Separation Processes 461
14.15 Scientific Forays in the Domain of Membrane Science and Recent Scientific Research Pursuit 461
14.16 Global Water Issues and Membrane Science 462
14.17 Nanotechnology for Water Pollution Control 463
14.18 Membrane Science and Technology for Wastewater Reclamation 464
14.19 Recent Advances in Membrane Science and Technology in Seawater Desalination and Its Application in Drinking Water Treatment 465
14.20 Groundwater Remediation, the Success of Science and Technology and the Visionary Road towards Future 466
14.21 Nanocomposites: The Visionary Domain of Future 467
14.22 Applications of Nanocomposites 467
14.23 Environmental Sustainability and the Wide Vision for the Future 468
14.24 The Challenge of Scientific Endeavour in the Field of Nanocomposites 468
14.25 The Scientific Challenges, the Scientific Sagacity and the Visionary World of Membrane Science 469
14.26 Nanotechnology, the Immense Scientific Barriers and the Road towards Future 470
14.27 The Scientific Vision, the World of Chemical Process Engineering and Materials Science and Groundwater Remediation Technologies 470
14.28 Future of Nanoscience and Nanotechnology 471
14.29 Futuristic Trends in the Application Areas of Nanocomposites in Membrane Science 471
14.30 Future of Membrane Science Applications in Environmental Pollution Control 472
14.31 Vision of Science, the Road Forward and Success of Nanotechnology Applications in Industrial Pollution Control 473
14.32 Conclusion 473

15. Polymer Nanocomposite Membranes Prepared by Electrospinning for Water Remediation 477

Pengchao Liu, Xiangyang Shi, and Chen Peng

15.1 Introduction 477
15.2 Electrospinning 478
15.3 Polymer Nanocomposite Electrospun Membranes 480
  15.3.1 Methods of Fabricating PNEMs 481
    15.3.1.1 Direct compounding electrospinning 481
    15.3.1.2 In situ synthesis 481
    15.3.1.3 Post-treatment of electrospun fibers 481
  15.3.2 Functions of Nanoparticles 483
    15.3.2.1 Nanoparticles as adsorbents 483
    15.3.2.2 Nanoparticles as photocatalysts 485
    15.3.2.3 Nanoparticles as antibacterial agents 486
    15.3.2.4 Nanoparticles as reductants 486
15.4 Polymer Nanocomposite Membrane for Water Remediation 487
  15.4.1 Water Filtration 487
  15.4.2 Oil/Water Separation 488
  15.4.3 Adsorption of Heavy Metal Ions 488
  15.4.4 Removal of Organic Compounds 490
  15.4.5 Removal of Microorganisms 490
15.5 Conclusions and Perspectives 491
PART 4: BIO-NANOCOMPOSITES FOR POLLUTION CONTROL

16. Biosynthesized and Bio-Inspired Functional Nanocomposites for Pollution Control 501

Akeem Adeyemi Oladipo

16.1 Introduction 502
16.2 Treatment Techniques for Pollution Control 503
  16.2.1 Adsorption Process 504
  16.2.2 Advanced Oxidation 506
16.3 Bio-Inspired Fabrication
  16.3.1 Benefits of Using Biomolecules for Fabrication of Bio-Inspired Nanocomposites 508
  16.3.2 Bio-Inspired Synthesis of Nanocomposites 509
16.4 Adsorption Process Involving Biosynthesized and Bio-Inspired Nanocomposites 512
  16.4.1 Effect of Initial Concentration of Pollutant and Adsorbent Dose 514
  16.4.2 Effect of Solution pH 515
  16.4.3 Effect of Temperature and Interaction Time 517
16.5 Pollution Control via Advanced Oxidation Process Using Bio-Inspired Nanocomposites 519
16.6 Summary and Future Perspectives 521

PART 5: GREEN AND SUSTAINABLE FUTURE: NANOCOMPOSITES

17. Nanoscience and Its Role in the Solar Collectors’ Future 529

Ahmed Kadhim Hussein, H. A. Mohammed, Kolsi Lioua, Dong Li, Rasoul Nikbakhti, and B. Mallikarjuna

17.1 Introduction 548
17.2 What Is the Nanofluid? 548
17.3 Solar Collector 552
  17.3.1 Solar Collector Types 553
17.4 Benefits of Using Nanofluid in Solar Collectors 562
17.5 Applications of Nanofluid in the Flat-Plate Solar Collector 564
17.6 Applications of Nanofluid in the Direct Absorption Solar Collector 578
17.7 Applications of Nanofluid in the Parabolic Trough Solar Collector 586
17.8 Applications of Nanofluid in the Wavy Solar Collector 589
17.9 Applications of Nanofluid in the Heat Pipe Solar Collector 590
17.10 Applications of Nanofluid in the Other Solar Collectors 593
17.11 Review Papers Related to Application of Nanotechnology in a Solar Collector 597
17.12 Challenges and Difficulties 600
17.13 Summary Remarks and Outlook 600

18. Green and Sustainable Future Nanocomposites 615
   Vaneet Kumar, Saruchi and Ajay Kumar Mishra

   18.1 Introduction 615
   18.2 Nanocomposites Based on Cellulose 619
   18.3 Nanocomposites Based on Plant Oil 621
   18.4 Nanocomposites Based on Thermoplastic Starch 622
   18.5 Nanocomposites Based on Poly Lactic Acid 625
   18.6 Nanocomposites Based on Biopolymers 627
   18.7 Green Fillers in Nanocomposites 629
   18.8 Challenges and Prospects in the Field of Green Nanocomposites 630
   18.9 Challenges and Prospects 630
   18.10 Concluding Remarks and Future Perspectives 631

19. Concluding Notes 639
   Chaudhery Mustansar Hussain and Ajay Kumar Mishra

Index 645
Preface

The use of nanotechnology in composite technology has become increasingly important in addressing vital global needs in the 21st century for reliable, sustainable, and efficient access to clean energy, water, and environment. Environmental pollution has become a major problem nowadays for society and seriously threatens the existence of terrestrial life, as the natural environment cannot destroy pollutants on its own. Pollution must be taken seriously, as it has a negative effect on the natural elements that are crucial to the existence of life on the earth. Technology at the nanoscale has inspired the progress and use of novel and cost-effective techniques for catalytic degradation, adsorptive removal, and detection of pollutants in the environment. Nanocomposites, which integrate the benefits of both nanomaterials (NMs) and composite matrices, are the new avenues of modern scientific innovation and deep scientific reflection. They have been successfully utilized in pollution control devices and techniques at both research and industrial scales, show great promise toward the next generation of advanced materials, and have received increasing attention of researchers, scientists, and the industry. As a result, the pollution control arena in today’s world is invariably linked with research and development initiatives in nanocomposites.

Nanocomposites possess outstanding mechanical properties and compatibility owing to their composite matrix, unique physical and chemical properties caused by unusually large surface-area-to-volume ratios, and high interfacial reactivity. In general, a nanocomposite is fabricated by combining composite materials with nanomaterials, where the incorporation of nanomaterials can provide a resultant material with several unique properties of nanomaterials and also possibly induce new characteristics and functions based on their synergetic effects. Nanocomposites of various compositions and morphologies can provide powerful tools for their pollution control applications. Moreover, freedom to functionalize NMs with various chemical groups can also increase their affinity toward target pollutants, which is very
much desirable for selectively extracting target analytes in complex environmental matrices. However, the advanced comprehensive understanding and real-world applications of these nanocomposites in pollution control field are still away. This book summarizes the recent progress of nanocomposites and their properties, fabrication methods, and applications for pollution control, pollutant sensing, and detection at both experimental and theoretical model scales. Special attention has been paid to the approaches that tend to be green and eco-friendly. In the end, the research trends and future prospects are briefly discussed.

The book is divided into several parts. The first part discusses nanocomposites as a new dimension in the field of pollution control devices and techniques. The second part is focuses on carbon nanomaterial–based nanocomposites for pollution control. The third part is about recent developments in membrane separation techniques based on nanocomposites. The fourth part describes new trends such as the use of bionanocomposites in pollution control techniques. The last part discusses the future prospects of nanocomposites for the anticipated green and sustainable environment. The organization of these parts is based on the most recent research, teaching, and practical experience of the editors and the philosophy that pollution control techniques and devices are moving toward their next generation. Highly ranked researchers and scientists in academia and industry from across the world have contributed to the book. The diversity of authors and their disciplinary backgrounds reveals the interdisciplinary emphasis of the book.

This book is of significant interest to environmentalists, scientists, researchers, consultants, regulators, and engineers working on the issues surrounding real-time nanocomposite applications for pollution control, as well as those working in the industry on the commercial-scale exploration of nanocomposites. It is an up-to-date source of knowledge and guidelines for advanced undergraduate and graduate students. Overall, this book is aimed to be a reference for researchers and scientists who are searching for new and advanced materials, techniques, and devices for pollution control applications. We are grateful to all contributors for enriching the book with their distinctive and hard work.