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Book Review
Advanced Materials for Wastewater Treatment and Desalination: Fundamentals to Applications

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ABSTRACT

The book provided a comprehensive overview of the current progress in the development of advanced materials used in wastewater treatment and desalination. It consists of 13 chapters, covering both the fundamentals and applications of advanced materials for the abovementioned application. Six chapters in this book discussed the direct application of advanced materials in wastewater treatment which is working based on adsorption or photocatalytic degradation. Meanwhile, seven chapters in this book revealed the roles of advanced materials in developing membranes for wastewater treatment, desalination and pervaporation. The advanced materials could be incorporated into a polymeric matrix to form mixed matrix membranes or nanohybrid membranes. Meanwhile, the development of inorganic membranes using silica and its derivatives for treating wetland saline water is discussed. Worth mentioning the recently advanced 2D-quasi nanomembranes made from various carbonaceous nanomaterials were highlighted in this book. Overall, this book is divided into two major sections. The first section covers the fundamental of synthesis, modification and characterization of advanced materials, specifically, metal oxide, carbon-based materials, perovskite-based materials, polymer-based composite materials, and advanced nanocomposites. The working principles of these advanced materials in wastewater treatment are elucidated. In the latter section, potential applications of the developed advanced materials in the removal of organic contaminants, discolouration of dye wastewater and agricultural wastewater reclamation are highlighted.

Chapter 1 provided an overview of the development of g-C_3N_4 as a visible light-sensitive photocatalyst. It covers the synthesis approaches, working mechanism and application of this carbon-based materials in photocatalytic degradation to remove various types of pollutants. Chapter 2 discussed the synthesis and modification of metal-organic frameworks (MOF) in various forms of structure. It provided an overview of the functionalization of MOF with amine (-NH_2) and hydroxyl (-OH) to improve the selectivity of adsorption towards dyes, heavy metals, and porous coordination polymers (PPCPs). Chapter 3 addressed the utilization of metal oxides such as titanium oxide (TiO), copper oxide (CuO), zinc oxide (ZnO) and iron oxide as

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photocatalytic and adsorptive materials. The mechanism of adsorptive removal and photocatalytic degradation is illustrated. Chapter 4 highlighted the recent advances and future outlooks of 2D-quasi nanomembrane. Several materials are deployed for the fabrication of membranes, for instance, graphene-based materials, transition metallic dichalcogenide (TMDCs) and MXenes. The emergence of 2D-quasi nanomembranes could be a solution to the conventional RO membranes that have high energy consumption and low permeability. Chapter 5 demonstrated the development of a polyamide thin film composite membrane through interfacial polymerization of mixed piperazine and 1,3-phenylenediamine (MPD) with trimesoyl chloride (TMC) on nylon 66 substrate for isopropanol dehydration. An extensive characterization of the physicochemical properties of the membrane was conducted to explain the findings obtained during the pervaporation process. Chapter 6 gave an overview of the carbonaceous nanomaterials such as fullerenes, carbon nanotubes and graphene in wastewater treatment. Several mechanisms of solute removal in wastewater were elucidated, including adsorption, disinfections, advanced oxidation process and filtration. Chapter 7 provided insights into the development of magnetic materials for water treatment. The types of magnetic materials, synthesis routes and useful characterization techniques to study their magnetic properties have been provided.

The second section of the book compiled the application of advanced materials in wastewater treatment. Chapter 8 summarized various types of direct membrane filtration for wastewater treatment. In this chapter, the driving forces, modules, and configuration of the membrane are described, followed by the challenges associated with membrane filtration and how the operating variables influence separation efficiency. In the following chapter, 3D printing technology in the development of a greener membrane was highlighted. The authors addressed the challenges of 3D printing in membrane engineering, including the poor material thermal stability and difficulty in fabricating membranes of pore below micrometer scale. Chapter 10 addressed the development of nanohybrid membranes for natural rubber wastewater treatment. This chapter summarizes the types of nanofillers used to develop nanohybrid membranes, characterization techniques and the evaluation of the filtration performance in treating the effluent discharged from natural rubber processing. The authors proposed integrated membrane process and photocatalytic membrane filtration as approaches to improve the productivity, product quality, energy consumption, environmental aspect, safety, and operational cost of membrane filtration. Chapter 11 addressed the application of mixed matrix membranes (MMMs) in the agriculture industry. This chapter categorized the types of fillers that can be incorporated into a membrane matrix. The developed MMMs have huge potential to be applied in the purification of virgin coconut oil and the treatment of palm oil wastewater. Chapter 12 probed the applicability of organo-silica membranes for wetland saline water desalination. The authors highlighted the membrane fouling and mitigate it through hybridization with adsorption and coagulation as a pretreatment. The development of a photocatalytic integrated membrane was recommended to address the fouling issue. Chapter 13 highlighted doped metal oxides for photocatalytic degradation of dyes. Several types of metal oxides were discussed in this chapter, for instance, zinc oxide, titanium dioxide, tin (IV) oxide and copper oxide.

This book gathered valuable opinions from experts around the world in the relevant research field. Insightful information is provided based on the current advancement, challenges and future outlooks of advanced materials in wastewater treatment. The review was done based on the recently reported studies where the research was mostly conducted in the laboratory. These preliminary studies proved that advanced materials

offer advantages over typical materials used in wastewater treatment with their high flexibility, application potential, smart characteristics and tailorable properties. It also serves as an important guideline for upscaling these technologies to an industrial level in the nearest future. The opinion can inspire the researchers involved in additive manufacturing, which is important in the era of Industrial Revolution 4.0. It also fills in the knowledge gaps and set up a clear direction for future research in advanced materials.