



Review

Recent Developments in ZnS-Based Nanostructures Photocatalysts for Wastewater Treatment

Luminita Isac ^{1,2,*} and Alexandra Enesca ¹

¹ Product Design, Mechatronics, and Environmental Department, Transilvania University of Braşov, 500036 Braşov, Romania

² Renewable Energy Systems and Recycling Research Center, Transilvania University of Braşov, 500036 Braşov, Romania

* Correspondence: isac.luminita@uniibv.ro

Abstract: The continuous growth of the world population has led to the constant increase of environmental pollution, with serious consequences for human health. Toxic, non-biodegradable, and recalcitrant organic pollutants (e.g., dyes, pharmaceuticals, pesticides) are discharged into water resources from various industries, such as textiles, leather, pharmaceuticals, plastics, etc. Consequently, the treatment of industrial wastewater, via a sustainable technology, represents a great challenge for worldwide research. Photocatalytic technology, an innovative technique based on advanced oxidation process (AOP), is considered a green technology with promising prospects in the remediation of global environmental issues. In photocatalysis, a very important role is attributed to the photocatalyst, usually a semiconductor material with high solar light absorption capacity and conductivity for photogenerated-charge carriers. Zinc sulfide (ZnS), as n-type semiconductor with different morphologies and band gap energies ($E_g = 3.2\text{--}3.71\text{ eV}$), is recognized as a promising photocatalyst for the removal of organic pollutants from wastewater, especially under UV light irradiation. This review deals with the recent developments (the last five years) in ZnS nanostructures (0D, 1D, 3D) and ZnS-based heterojunctions (n-n, n-p, Z-scheme) used as photocatalysts for organic pollutants' degradation under simulated (UV, Vis) and sunlight irradiation in wastewater treatment. The effects of different synthesis parameters (precursors' type and concentration, capping agents' dosages, reaction time and temperature, metal doping, ZnS concentration in heterostructures, etc.) and properties (particle size, morphology, band gap energy, and surface properties) on the photocatalytic performance of ZnS-based photocatalysts for various organic pollutants' degradation are extensively discussed.

Keywords: ZnS nanostructures; heterojunctions; photocatalysis; organic pollutants; wastewater treatment



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1. Introduction

Wastewater loaded with toxic, non-biodegradable organic pollutants represents a real problem, both for aquatic environments and for human life and development. Industrial wastewater originates mainly from the textile industry, but also from the plastics, paper, food, and cosmetic industries, due to the large amount of water used in the various technological stages, especially during the dyeing process [1]. It has been estimated that the wastewater from textile production contributes approximately 20% of the total industrial polluted water [2].

The presence of a very small concentration of organic dyes in water (less than 1 ppm for some dyes) may have serious consequences for the environment, but more for the population health, such as skin and eyes irritations, respiratory and gastric tracts affections, quadriplegia, tachycardia, tissue necrosis, and cancer [3–4].

The dyes most used industrially are azo dyes (usually with an aromatic structure) which, under natural conditions, require a long time to degrade due to their high photosta-

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Recent Research Developments In Nanostructures Vol 11999:

Recent Advances in Analytical Techniques Volume 1 Atta -ur- Rahman,2017-09-06 Recent Advances in Analytical Techniques is a collection of updates in techniques used in chemical analysis This volume presents information about a selection of analytical techniques Readers will find information about New methods of sample preparation in biological and environmental analysis Developments in electrochemical sensors In vivo cytometry for detection of tumor cells Flow discharge spectroscopy for depth profile analysis Advances in photodynamic therapy New methods to analyze volatility in alcoholic beverages Quantum Dots, Nanoparticles and Nanowires: Volume 789 P. Guyot-Sionnest,2004-05-04 Nanostructures of semiconductors and metals show novel optical and transport properties and offer the perspective of designing materials properties with unprecedented flexibility and control This has motivated research in the synthesis and characterization of new materials This 2004 book brings together scientists with various levels of expertise in the growth characterization and applications of inorganic nanostructures such as quantum dots nanowires and nanorods to discuss and share developments in the field Reports focus on techniques to prepare and characterize novel materials investigations of novel optical and electronic properties and novel applications such as those that are biologically inspired Topics include synthesis and characterization of semiconductor quantum dots nanoparticles and nanowires using wet chemistry and molecular beam approaches synthesis characterization and novel properties of metallic nanostructures optical properties of neutral and charged excitons and exciton complexes in self assembled quantum dots nanoscale devices and sensors based on nanostructures and their properties and design and characterization of quantum dot bioconjugates and their use in assay developments Advanced Energy Materials Ashutosh Tiwari,Sergiy Valyukh,2014-02-12 An essential resource for scientists designing new energy materials for the vast landscape of solar energy conversion as well as materials processing and characterization Based on the new and fundamental research on novel energy materials with tailor made photonic properties the role of materials engineering has been to provide much needed support in the development of photovoltaic devices Advanced Energy Materials offers a unique state of the art look at the new world of novel energy materials science shedding light on the subject s vast multi disciplinary approach The book focuses particularly on photovoltaics efficient light sources fuel cells energy saving technologies energy storage technologies nanostructured materials as well as innovating materials and techniques for future nanoscale electronics Pathways to future development are also discussed Critical cutting edge subjects are addressed including Non imaging focusing heliostat state of the art of nanostructures Metal oxide semiconductors and their nanocomposites Superionic solids polymer nanocomposites solid electrolytes advanced electronics Electronic and optical properties of lead sulfide High electron mobility transistors and light emitting diodes Anti ferroelectric liquid crystals PEEK membrane for fuel cells Advanced phosphors for energy efficient lighting Molecular computation photovoltaics and photocatalysts Photovoltaic device technology and non conventional energy applications Readership The

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aspects of tissues have shown success in the clinic better more intricate models are needed to understand drivers of tissue repair and regeneration fully Tissue engineering bears tremendous potential toward gaining a complete understanding of the underlying biological and physical mechanisms advancing the treatment of damaged organs The following Research Topic Bio mimetic materials for tissue regenerations discusses examples of progress toward this objective Bio mimicking scaffold materials for tissue regeneration Cell adhesion to scaffold materials Role of materials for the migration of cells Mechanisms of cell growth for organ development

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Self-Assembly of Nanostructures Stefano Bellucci, 2011-10-26 This is the third volume in a series of books on selected topics in Nanoscale Science and Technology based on lectures given at the well known Istituto Nazionale di Fisica Nucleare INFN schools of the same name The present set of notes stems in particular from the participation and dedication of prestigious lecturers such as Nunzio Motta Fulvia Patella Alexandr Toropov and Anna Sgarlata All lectures have been carefully edited and reworked taking into account extensive follow up discussions A tutorial lecture by Motta et al presents the analysis of the Poly 3 hexylthiophene self assembly on carbon nanotubes and discusses how the interaction between the two materials forms a new hybrid nanostructure with potential application to future solar cells technology In their contribution Patella et al review quantum dots of III V compounds which offer appealing perspectives for more sophisticated applications in new generation devices such as single photon emitters for nano photonics and quantum computing Focusing on self assembled quantum dots the chapter by Alexandr Toropov et al provides a comprehensive review of some important aspects in the formation of quantum dots and presents the results of the authors extensive investigation of the features of droplet epitaxy The fourth contribution by Sgarlata et al focuses on recent progress toward controlled growth of self assembled nanostructures dealing with the shaping ordering and localization in Ge Si heteroepitaxy and reviewing recent results on the self organization of Ge nanostructures at Si surfaces

Advances in Nanostructured Materials for Multifunctional Applications Luz Stella Gomez-Villalba, 2019 This volume presents the recent research progress in the synthesis characterization techniques properties and interactions of nanostructured materials for multifunctional applications The opportunity to apply singular or hybrid nanomaterials proves to be a constant challenge in order to optimize its use achieving simultaneous results for its application in different branches of research It is focused on the study of structures and their effect on the properties of solids using different experimental techniques and practical applications of nanostructured materials in the context of the latest achievements in the area of research of solid state phenomena Multifunctional Nanomaterials Synthesis Morpho Structural and Chemical Properties Experimental Characterization Techniques Optical Properties Electrical Properties Cultural Heritage Conservation Construction Materials Materials Science

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the latest research in this frontier field **Bioinspired and Green Synthesis of Nanostructures** Mousumi Sen, Monalisa Mukherjee, 2023-05-31 BIOINSPIRED AND GREEN SYNTHESIS OF NANOSTRUCTURES This unique book details various ways to synthesize advanced nanostructures using green methods explores the design and development of sustainable advanced nanostructures and discusses the antimicrobial and antiviral applications The future of the world depends on immediately investing our time and effort in advancing ideas on ways to restrict the use of hazardous chemicals thereby arresting further environmental degradation To achieve this goal nanotechnology has been an indispensable arena that has extended its wings into every aspect of modernization For example green synthetic protocols are being extensively researched to inhibit the harmful effects of chemical residues and reduce chemical wastes This involves the study of nanotechnology for artful engineering at the molecular level across multiple disciplines In recent years nanotechnology has ventured away from the confines of the laboratory and has been able to conquer new domains to help us live better lives Bioinspired and Green Synthesis of Nanostructures focuses on the recent developments and novel applications of bioinspired and biomimetic nanostructures as functionally advanced biomolecules with huge prospects for research development and engineering industries It provides detailed coverage of the chemistry of each major class of synthesis of bioinspired nanostructures and their multiple functionalities In addition it reviews the new research results currently being introduced and analyzes the various green synthetic approaches for developing nanostructures their distinctive characteristics and their applications The book provides readers with an understanding of the recent data as well as various strategies for designing and developing advanced nanostructures using a greener approach Audience The core audience of this book include materials scientists nanoscientists nanotechnologists chemical and biological engineers biochemists and biotechnologists Industry process engineers and scientists working in nanomaterial synthesis will find this book extremely valuable

Emerging Applications of Nanoparticles and Architectural Nanostructures Abdel Salam Hamdy Makhlouf, Ahmed Barhoum, 2018-03-13 Emerging Applications of Nanoparticles and Architecture Nanostructures Current Prospects and Future Trends discusses the most important current applications of nanoparticles and architecture nanostructures in a comprehensive detailed manner The book covers major applications of nanoparticles and architecture nanostructures taking into account their unusual shapes and high surface areas In particular coverage is given to applications in aerospace automotive batteries sensors smart textile design energy conversion color imaging printing computer chips medical implants pharmacy cosmetics and more In addition the book discusses the future of research in these areas This is a valuable reference for both materials scientists chemical and mechanical engineers working both in R D and academia who want to learn more on how nanoparticles and nanomaterials are commercially applied *Nanotechnology Research* Xiaohua J. Huang, 2008 Nanotechnology is a catch all description of activities at the level of atoms and molecules that have applications in the real world A nanometer is a billionth of a meter about 1 80 000 of the diameter of a human hair or 10 times the

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