

# Preface

This Special Topic Volume is a result from the contribution of fifty six experts from the international scientific community in the respective field of research. It thoroughly covers various photocatalytic materials and surfaces along with their applications for environmental cleanup and hydrogen production. It gives a comprehensive picture of the process related to photocatalysis that has posed several scientific and technological challenges in this area. This volume will provide the latest and in-depth coverage to the nanomaterials, nano-composite, chemistry, physics, and engineering of photocatalytic materials applications for environmental and energy applications.

There has been remarkable progress in the fields of semiconductor photocatalysis and solar energy conversion over the past five decades which mainly cover environmental abatement and hydrogen production. The research, development, demonstration and commercialization in both the photocatalysis and solar energy conversion field have been received great attention globally from academia, government research laboratories and industry. In recent years, engineering firms have been paying considerable attention to these developments. Photocatalytic materials and surfaces have shown their potential to solve the environmental and energy problem. However, still the efforts are under progress to use these materials more effectively and bring out the cost effective, economic, and reliable process for the same. Presently, many researchers are working on development of new photocatalytic materials to utilize the solar light for environmental cleanup and hydrogen production. Here in this volume development of visible light active photocatalytic materials and surface for various applications have been covered some extent.

This volume is indeed the result of remarkable cooperation of many distinguished experts, who came together to contribute their research work and comprehensive, in-depth and up to date review chapters. I am very thankful to all contributing authors who, in spite of their busy life in research and teaching, willingly accepted the call to contribute and sent their manuscript in time. I would also like to express my gratitude to all the publishers and authors and others for granting us the copyright permissions to use their illustrations. Although sincere efforts were made to obtain the copyright permissions from the respective owners to include the citation with the reproduced materials, I would like to offer my honest apologies to any copyright holder if unknowingly, their right is being infringed.

This volume contains nineteen state-of-the-art research articles and reviews: Chapter-1, a review article, focuses on photo catalytic reduction of carbon dioxide with water to produce fuels/chemicals, which is an emerging area of research towards utilizing the abundant sunlight. This Chapter provides a comprehensive picture of the process that has posed several scientific and technological challenges, all the major aspects/developments in this process and covers the design and development of efficient catalyst systems and achieving higher yield of desired products (higher selectivity) and extending the catalyst life are the key issues being pursued by the researchers.

Chapter 2, is also a review article provides an overview of current research activities that centres on the preparation, characterization and application of highly efficient photocatalysts for water disinfection under both UV and visible light irradiation. This overview

discusses the development of TiO<sub>2</sub>-based photocatalysts including surface noble metal modified; ion doped, dye-sensitized, composite TiO<sub>2</sub>, and the latest highly attracted pioneering fields such as graphene-based photocatalysts, plasmonic-metal nanostructures and naturally occurring photocatalysts.

Chapter 3, 4, & 5 contains, Preparation and characterization of Li-doped ZnO nano-sized powders, TiO<sub>2</sub> nanoparticles and single crystalline ceria nanoparticles for photocatalytic applications such as degradation of dyes like methylene blue, tannic acid, and water splitting.

Chapter 6, is a review article provides current perspective of semiconductor and its composites with unusual surfaces for the use of photocatalysis. This chapter covers different methods followed for synthesis of semiconductors, metal supported/loaded semiconductors, heterostructures, graphene based semiconductors and other newer materials. In addition, the surface morphologies of these materials and composites for its photocatalytic processes is explained and the photophysical properties of semiconductor and composite materials with unusual texture is summarized.

Chapter 7, is also a review article elaborately discusses on the development of titania based mixed oxide catalyst with or without different doping for visible-light application. In addition, this review deals with critical analysis of these materials towards photocatalytic oxidation of organics and reduction of pollutants like toxic metal ions and nitrates.

Chapter 8 & 9, contains development of photocatalytic thin films for 1,4-dichlorobenzene, methyl orange and phenol red under ultraviolet and visible-light irradiation. Chapter 10, talks about the Sonochemical decolourisation of Reactive Blue 21 and Acid Red 114 in the presence of TiO<sub>2</sub> and Rare Earths.

Chapter 11 is a review article deal with photocatalytic degradation of different kinds of organic pollutants; mainly, surfactants, pesticides, dyes, phenols, chloro compounds, and nitrogen containing compounds along with their degradation mechanisms. Chapter 12, is also a review article discusses about application of photocatalysis in environment like biological contamination, air purification, water disinfection, hazardous waste remediation, water purification, self clean buildings, deodorizing, anti-bacterial action, and anti-fogging resolving cleaning action etc.

Chapter 13 & 14, are research articles based on the use of manganese loaded on Titania Surface by Impregnation method and Fe-TiO<sub>2</sub>-immobilized on granular activated carbon for photocatalytic degradation of alachlor and Reactive Red-3 dye respectively. Chapter 15, talks about photocatalytic degradation of Acid Red 27 in Sunlight using TiO<sub>2</sub>. Chapter 16, focuses on the Photocatalytic degradation of dyes by Al<sub>2</sub>O<sub>3</sub>-TiO<sub>2</sub> and ZrO<sub>2</sub>-TiO<sub>2</sub> nanocomposites.

Chapter 17, provide a comparative study on the photocatalytic and photoelectrochemical study of ferrites for water splitting applications. Chapter 18 & 19, are reviews based on application of nano-photocatalysts in the treatment of colored wastewater and the metal doped titanium dioxide which discusses the synthesis and effect of metal ions on physico-chemical and photocatalytic properties of the catalysts.

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