Photocatalysis in Environment, Energy, and Sustainability - Editorial


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**Published in:**
International Journal of Photoenergy

**Publication Status:**
Published (in print/issue): 01/01/2016

**DOI:**
10.1155/2016/5436847

**Document Version**
Publisher's PDF, also known as Version of record

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Download date: 14/10/2023
Photocatalysis has attracted enormous attention in solar energy conversion to provide renewable and sustainable energy source, thus solving the serious environmental and energy-related problems. Those applications include hydrogen evolution by water splitting, CO$_2$ conversion to hydrocarbon fuels, photocatalytic pollutants degradation, and water disinfection. In the past few decades, TiO$_2$ has been the most commonly used photocatalyst because of its low-cost, nontoxicity, and high efficiency with UV-irradiation. Meanwhile, in recent years, researchers have turned their focus to novel materials and advanced technology that may bring photocatalysis into practical use. In this regard, to move this field forward, we invited investigators to contribute original research articles on recent development of photocatalysis in environment, energy, and sustainability. This special issue consists of 9 papers, mainly related to environmental purification by using various advanced photocatalysts. A brief summary of all accepted papers is provided below.

In “Adsorption and Photocatalytic Kinetics of Visible-Light Response N-Doped TiO$_2$ Nanocatalyst for Indoor Acetaldehyde Removal under Dark and Light Conditions,” the paper investigated the removal of indoor acetaldehyde using N-doped TiO$_2$ photocatalyst under visible light irradiation. It was found that the mesoporous N-TiO$_2$ had a high ability to absorb acetaldehyde, which was subsequently photooxidized under visible-light irradiation. The increase in temperature would result in the decrease in the adsorption rate of indoor acetaldehyde.

The paper “Evaluation of the Antimicrobial Activity of Nanostructured Materials of Titanium Dioxide Doped with Silver and/or Copper and Their Effects in Arabidopsis thaliana” reported the sol-gel synthesis of Cu$^{2+}$-TiO$_2$ and Ag@TiO$_2$ as nanostructured photocatalysts for microbial disinfection. The Ag@TiO$_2$ was more active than Cu$^{2+}$-TiO$_2$, while E. coli was more sensitive to Ag@TiO$_2$ than S. cerevisiae. The impact of the as-prepared photocatalysts in plants was evaluated by exposing Arabidopsis thaliana Col-0 strain to these materials at different conditions and concentrations. Deleterious effects on A. thaliana due to exposition of silver base materials were observed at longer times of exposures and higher concentrations of photocatalysts.

The paper “Synthesis of CdS Sensitized TiO$_2$ Photocatalysts: Methylene Blue Adsorption and Enhanced Photocatalytic Activities” reported the microwave-assisted hydrothermal synthesis of a series of CdS/TiO$_2$ nanocomposite with different Cd to Ti molar ratio by using P25-TiO$_2$ nanopowder as the raw materials. Results showed that CdS/TiO$_2$ photocatalysts with low Cd to Ti molar ratios exhibited much higher activities than P25-TiO$_2$, and the CdS/TiO$_2$ sample with 20% CdS/(TCd2) showed the highest activity among all these samples, which is attributed to the low rate of electron-hole recombination.

The paper “TiO$_2$/Halloysite Composites Codoped with Carbon and Nitrogen from Melamine and Their Enhanced Solar-Light-Driven Photocatalytic Performance” reported the fabrication of C and N codoped anatase TiO$_2$/amorphous
halloysite nanotubes (C,N-TiO$_2$/HNTs) using melamine as C and N source. The as-prepared C,N-TiO$_2$/HNTs showed higher photocatalytic activity for the degradation of methylene blue than that of TiO$_2$/HNTs.

In the paper “Synthesis of CuO/Co$_3$O$_4$ Coaxial Heterostructures for Efficient and Recycling Photodegradation,” a highly efficient CuO/Co$_3$O$_4$ composite was synthesized on Cu wire mesh by a simple hydrothermal method. These CuO/Co$_3$O$_4$ coaxial heterostructures were easy to recycle and exhibited enhanced photocatalytic activity for the degradation of methylene blue than that of single CuO nanorod arrays.

The paper “Evaluation of La-Doped Mesoporous Bioactive Glass as Adsorbent and Photocatalyst for Removal of Methylene Blue from Aqueous Solution” reported a series of La-doped mesoporous bioactive glasses (BG-La) with excellent biosafety and hypotoxicity. The BG-La showed higher photocatalytic activity than undoped mesoporous bioactive glasses (BG). The MB loaded on BG-La could be easily desorbed with acid solution due to its electronegativity and mesoporous structure.

In the paper “New TiO$_2$/DSAT Immobilization System for Photodegradation of Anionic and Cationic Dyes,” a new technique to immobilize TiO$_2$ was developed by coating TiO$_2$ solution onto double-sided adhesive tape (DSAT) as a thin layer binder without adding any organic additives. The immobilized TiO$_2$/DSAT showed lower and higher photocatalytic activity for the degradation of reactive red 4 and methylene blue than that of TiO$_2$ powders in suspension mode, respectively. The DSAT provided a very strong interaction between glass and TiO$_2$ layers, and therefore the reusability of immobilized TiO$_2$/DSAT could be up to 30 cycles.

In the paper “Hydrophobic ZnO-TiO$_2$ Nanocomposite with Photocatalytic Promoting Self-Cleaning Surface,” ZnO nanorod array film on quartz crystal microbalance is modified by $\beta$-CD in hydrothermal process and then decorated by P25-TiO$_2$ after impregnating in its suspension. The as-prepared films exhibited excellent hydrophobicity as well as self-cleaning property for organics under UV-irradiation.

The paper “Enhanced Photocatalytic Property of Cu Doped Sodium Niobate” reported the synthesis of Cu doped NaNbO$_3$ by modified polymer complex method. Compared with pristine NaNbO$_3$, the as-prepared Cu-NaNbO$_3$ showed enhanced photocatalytic activity for H$_2$ evolution from methanol aqueous solution as well as degradation of rhodamine B (RhB) under visible light irradiation. The Cu doping was found to improve the adsorption property of NaNbO$_3$ and accelerate the mineralization process.

Acknowledgments

We would like to express our sincere thanks to all the authors for submitting their articles to this special issue.

Wanjun Wang
Po Keung Wong
Suresh C. Pillai
Tian Ming
Patrick S. M. Dunlop
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