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Editorial

Progression in Photocatalytic Materials for Efficient Performance

Faryal Idrees [1,2,*], Faheem K. Butt [3] and Samia Ben Hammouda [1]

[1] Institut für Technische Chemie, Gottfried Wilhelm Leibniz Universität Hannover, Callinstrasse 3, D-30167 Hannover, Germany; benhammouda@iftc.uni-hannover.de
[2] Department of Physics, University of the Punjab, Lahore 54000, Pakistan
[3] Division of Science and Technology, University of Education Lahore, Lahore 54000, Pakistan; faheemk.butt@ue.edu.pk
* Correspondence: mermaidinaqua@hotmail.com

Photocatalysis is a highly promising technique to address the challenges of environmental and energy aspects. TiO_2 is currently in commercial use, but due to its wide bandgap, it is limited to UV region which is 5% of total solar energy spectrum. Moreover, the fast recombination rates of photo-generated charge carriers have also limited its photocatalytic efficiency. Substantial efforts have been made over the past few years to engineer various semiconductor photocatalysts. Numerous strategies have been employed to improve photocatalytic efficiency by tuning the bandgap such as developing type-II and Z-scheme, lowering the recombination rate, increase the surface kinetics, etc. The main objectives of this special issue are to cover challenges and recent progresses in engineering/designing, synthesis, characterization and establishing efficient/advanced photocatalytic systems which are addressed in this special issue of Catalysts through several examples. The two review articles and six research articles were published addressing the photocatalytic activity of Metal halide perovskites, Aeroxide P25 ($ATiO_2$), black TiO_2, Sachtleben Hombikat UV100 ($HTiO_2$), CoO@meso–CN@MoS_2, and Pt nanowire-anchored dodecahedral Ag_3PO_4, etc.

The first review article, by Bianca-Maria Bresolin et al. [1], presented a detailed review on metal halide perovskite-based materials and focused on their recent advancements and progresses as potential photocatalyst. Metal halide perovskites (MHPs), due to their facile synthesis and excellent optoelectronic properties, have gained a lot of attention. They have summarized recent progresses of all-inorganic MHPs and hybrid organic-inorganic MHPs [1]. The second review article, by Yuan Yao et al. [2], provided a detailed review of the most important commercial process, i.e. photocatalytic reforming of organic compounds into hydrogen. This process is sustainable and converts the stored solar energy into chemical energy. Therefore, in relevant areas this review presents the summary of the reported works that are categorized by reforming precursors of organic compound such as biomass, ethanol, and methanol, etc. [2].

Al-Madanat et al. [3], presents a work on photocatalytic production of H_2 from Naphthalene by using two photocatalysts of commercial TiO_2: Sachtleben Hombikat UV100 ($HTiO_2$) and Aeroxide P25 ($ATiO_2$). They studied the Pt loading impacts to check efficiency in production of H_2 from an aqueous solution of naphthalene for different ratios and formation of intermediates. The nanosized-Pt^o particles were characterized by physicochemical characterization that further confirmed a well dispersion of particles on photocatalysts surface under study and hence the higher photocatalytic activity was reported for Pt-$HTiO_2$.

Sun, Ke, et al. [4], designed reactive structures of novel push–pull chromophores that were capable of efficient free radical polymerization of acrylates initiated with LEDs emitting at 405 nm. To design multi-component photoinitiating systems, their applications in the fabrication of photocomposites and vat photo-polymerization (or 3D-printed structures) as efficient photoinitiators were also studied to choose eleven new push–pull dyes.

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Dai, Yujie, et al. [5], articulated necessary asymmetric photocatalytic reactions to observe the mechanism of the asymmetric electromagnetic interaction between molecules and light. For this they investigated the electromagnetic interactions between the chiral reaction of PM567 dye and the light-induced charge transfer reaction. For different wave-length ranges, the chiral responses of molecules were found due to presence of binaphthalene and pyrromethene. The first-principles investigation was found complete and self-consistent.

Chen, Linjer, et al. [6], developed effective and simple synthetic approach to synthesize uniform CoO@meso–CN@MoS_2 heterostructures to study the photodegradation under a visible light for organic pollutants. Heterostructure established between CoO@meso–CN and MoS_2 were confirmed by numerous morphological and physicochemical characterizations techniques. The photocatalytic response of hybrid heterostructure was found to be higher than pure MoS_2.

Zhang, Xu, et al. [7] articulated a photocatalytic degradation of chlorophyll-a by using a black TiO_2 in algae cells with modified carbon (b-N-TiO_2/C) and doped nitrogen synthesized by sol-gel technique. The highly efficient degradation was observed due to surficial defects introduced by nitrogen doping and a fast-synergistic effect due to modified carbon. Moreover, photocatalysis degradation was also promoted by the addition of H_2O_2. In this O_2- and OH were identified as the major reactive species on the bases of electron spin resonance (ESR) and the trapping experiments.

Zhu, Hanxu, et al. [8], constructed a Pt nanowire-anchored dodecahedral Ag_3PO_4{110} to study anti-photocorrosion and organics photodegradation. Morphological and structural analysis of the Pt nanowires confirmed that they were attached on dodecahedral Ag_3PO_4 and completely bounded by {110} facets. Schottky barrier is developed by this construction and transfer rate of photogenerated electrons becomes faster. This construction also extended the lifetime of the charge carriers with the help of long-distance transport for organics degradation. More importantly, the reduction potentials of the photogenerated electrons were improved by the Pt nanowires for O_2 reduction to O_2-, which improved anti-photocorrosion properties and the photocatalytic activity of Ag_3PO_4. Electron paramagnetic resonance (EPR) analysis and radical trapping experiments demonstrated that for organics photodegradation the main active species were holes.

This collection shows how great in number and convoluted the research topics related to the photocatalysis are. In addition, in future visible light-induced heterostructure-based photocatalyst can be designed for a highly efficient photocatalytic response.

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