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Editorial

Editorial: Special Issue on "Photocatalysts for Pollutants Disposals, CO_2 Reduction, Hydrogen Evolution Reaction"

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The global energy and environmental crisis are some of the most pressing challenges facing mankind. Photocatalytic technology has broad application prospects in alleviating energy problems and has been widely studied. The study of controllable preparation and the fine structure of semiconductor composites is of great significance for an in-depth understanding of solar energy conversion technology. However, due to the high recombination of photogenerated charges in conventional semiconductors, electrons, and holes cannot be effectively separated and transferred, which greatly inhibits photocatalytic activity. Colleagues have modified conventional semiconductors by doping metal elements and constructing heterojunctions to promote the efficient separation of photogenerated charges.

Wu et al. [1] prepared Fe-doped and Fe-BiOCl nanosheets with surface oxygen vacancies (Vo) as electron capture centers. Fe doping, Fe doping, and Vo introduction have narrowed the band gap of pure BiOCl nanosheets. In addition, the electron enrichment effect of vacancies and Fe can effectively transfer and separate the charge. Compared with BiOCl nanosheets with vacancies and pure BiOCl nanosheets, the photocatalytic-Fenton performance of Fe-BiOCl-Vo nanosheets was improved by two and four times, respectively.

Liang et al. [2] synthesized the Z-type heterojunction Ag_2CrO_4 @ MIL-125 (Ti) $–NH_2$ by microemulsion method. Highly dispersed nano-Ag_2CrO_4 could be uniformly anchored on the surface of porous MIL-125 (Ti) $–NH_2$. Compared with pure M125 and Ag_2CrO_4, the prepared AgCr@M125 composites showed significant photocatalytic efficiency for inactivated S.aureus, and the inactivation rate of bacteria reached more than 97% after 15 min of visible light irradiation. It is worth noting that the photocatalytic activity of the obtained 20% AgCr@M125 was about 1.75 times higher than that of AgCr-M125 prepared by the traditional precipitation method.

Zhuang et al. [3] designed ternary PDI/BiOCl-$BiPO_4$ composites with different PDI contents to degrade tetracycline hydrochloride and rhodamine B pollutants. The structure and composition of BiOCl-BiPO4 and PDI/BiOCl-$BiPO_4$ samples were characterized in detail. The optimized PDI (5%)/BiOCl-$BiPO_4$ sample showed the best photocatalytic activity for the degradation of tetracycline hydrochloride and rhodamine B.

Huang et al. [4] synthesized a series of 0D/2D TiO_2/Bi_2O_3 nanosheet heterojunctions, which could improve the visible light absorption of TiO_2. When the loading of Bi_2O_3/TiO_2 was 15 wt %, the photocatalytic degradation of tetracycline hydrochloride was the best. The degradation rate constant of TC was about 8 times and 39 times that of P25 and Bi_2O_3, respectively. The improved catalytic performance was attributed to the improved visible light absorption and Z-type charge transfer path of the heterojunction.

Shi et al. [5] used phthalimide (PDI) as a co-catalyst to fabricate MIL-53 (Fe)@PDI organic heterojunction structures through an ultrasonic assembly. The PDI organic supramolecular material was uniformly distributed on the surface of MIL-53 (Fe). The most effective

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M53@PDI-20 organic heterojunction obtained a 72.7% photodegradation of 10 ppm Rhodamine B within 50 min and a 99.9% reduction of 10 ppm Cr (VI) within 150 min. Additionally, under visible light irradiation, M53@PDI-20 catalyzed the conversion of benzyl alcohol to a rate of 91.5% in 5 h with selectivity above 90%.

Meng et al. [6] prepared 0D/2D-3D Pt/In_2S_3 Schottky junctions to directly utilize the photoexcited holes and electrons in one reaction system to selectively convert benzyl alcohol into value-added aldehydes and produce the clean energy of H_2 simultaneously. Compared with pure In_2S_3, both reaction thermodynamics and hydrogen evolution kinetics were significantly enhanced on Pt/In_2S_3. 0.3% Pt/In_2S_3, exhibiting the highest photocatalytic hydrogen production rate of 22.1 mmol g^{-1} h^{-1} and almost 100% benzaldehyde selectivity.

The D-A structure semiconductor material has great prospects in the decomposition of water to produce hydrogen. Li et al. [7] summarized the latest research progress. The principle of constructing a D-A heterojunction photocatalytic system was summarized, and its application in the photolysis of water to produce hydrogen on different types of organic semiconductors was discussed in detail. The development prospects and future challenges of D-A structural materials were also prospected. It has important reference value for the development of organic semiconductor materials with a special structure in the future research of photolysis water.

He et al. [8] discussed how rare earth ion doping could influence the transformation of $Bi_2O_2CO_3$ to β-Bi_2O_3 so as to obtain the mixed crystal phase photocatalyst of rare earth-modified $Bi_2O_2CO_3$/β-Bi_2O_3. This heterostructure exhibited a lower band gap and efficient charge transfer. It could enhance the photocatalytic degradation of dimethyl phthalate under a 300 W tungsten lamp. After 150 min of illumination, the degradation rate of DMP by Er-doped samples was 78%.

Chen et al. [9] summarized four common synthesis strategies of cobalt sulfide-based catalytic materials and discussed the multifunctional role of cobalt sulfide-based cocatalysts in photocatalysis. They also introduced the latest progress of cobalt sulfide in the application fields of photocatalytic hydrogen production, nitrogen fixation, carbon dioxide reduction, and the photocatalytic degradation of pollutants. Finally, the prospects and challenges of cobalt sulfide-based photocatalysts were prospected.

The formation of bismuth halide perovskites with high stability to oxygen, water, and light could promote the formation of solar fuels with good CO2RR efficiency. Leticia M. Torres-Martinez et al. [10] summarized and analyzed the research status in this field, discussed the stability strategies from internal and external perspectives, and the challenges and opportunities faced by designing stable bismuth halide perovskites.

In conclusion, our Special Issue of "Photocatalysts for Pollutants Disposals, CO_2 Reduction and Hydrogen Evolution Reaction" can provide a reference regarding recent advances in the design and synthesis of popular photocatalytic materials. We thank all the photocatalytic colleagues of this Special Issue for their contributions and also thank the editorial team of *Catalysts* for their support provided for this Special Issue.

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