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Editorial

Editorial: Special Issue Entitled "Development of g-C_3N_4-Based Photocatalysts: Environmental Purification and Energy Conversion"

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Solar photocatalysis has evolved rapidly over the past few decades and has received significant attention for its green, safe and renewable energy benefits, particularly in the current era of global crisis, being considered as a potential solution to the major problems we face today, such as the shortage of fossil fuels and the impact of human activities on the environment [1,2]. The photocatalytic process is based on the unique ability of semiconductor catalysts to generate electrons and holes when exposed to light, and these photo-generated carriers are then used to interact with substances in the system, leading to the degradation of contaminants, water splitting into H_2 production, the reduction of CO_2 and the synthesis of high-additional-value chemicals [3]. Among the numerous catalysts for realizing photocatalysis, graphitic carbon nitride (g-C_3N_4) has attracted extensive attention due to its low cost, suitable band structure, and easy structural adjustment [4].

g-C_3N_4 is a carbon-based material that can be produced via the thermal polymerization reaction using precursors such as melamine, dicyandiamide, cyanamide, urea, thiourea, ammonium thiocyanate and other similar substances [5]. Although g-C_3N_4 possesses various advantages, its fast photo-generated carriers' recombination and narrow visible-light absorption region [6,7] limit its further practical application. There is therefore an urgent need, but still a significant challenge, to rationally design and develop g-C_3N_4-based photocatalysts though various modification strategies. Adjusting the morphology and structure of carbon nitride is one of the methods of modification. A review of reaction parameters, structure design and exfoliation methods focuses on the effect of various parameters of the synthesis process of g-C_3N_4 on the photocatalytic activity and on the methods of construction of microstructures [8]. Moreover, the synthesis of g-C_3N_4 was been described by Biswas et al. [9]. In addition, Shi et al. added phloxine B to the process of preparing g-C_3N_4 to produce black g-C_3N_4 nanosheets containing cyanine defects, which not only reduces the distance of charge transfer, but also enhances the photocatalytic activity through overlying the photothermal effect, providing beneficial ideas for the design of photocatalysts to degrade antibiotic pollutants [10].

Next, the construction of heterojunctions is also one of the means to enhance the photocatalytic activity of g-C_3N_4 [11,12]. When two semiconductors are in contact, the internal electric field (IEF) can be formed because of the difference between their Fermi levels, and the separation of electrons and holes is promoted under the action of IEF, effectively solving the problem of the fast recombination of photon-generated carriers [13]. Khan's team fabricated a dual Z-scheme heterojunction photocatalyst by anchoring P and S co-doped g-C_3N_4 on Ag/AgI/WO_3, which effectively reduced the recombination of photo-generated electrons and holes due to the enhancement of IEF, and effectively improved the photodegradation efficiency [14]. Li et al. prepared an isotype heterojunction of phosphorus-doped g-C_3N_4/phosphorus–sulfur co-doped g-C_3N_4 (P-g-C_3N_4/PS-g-C_3N_4)

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Citation: Guo, F.; Lin, X.; Hong, Y.; Shi, W. Editorial: Special Issue Entitled "Development of g-C_3N_4-Based Photocatalysts: Environmental Purification and Energy Conversion". *Catalysts* **2024**, *14*, 46. https://doi.org/10.3390/catal14010046

Received: 3 January 2024
Accepted: 9 January 2024
Published: 10 January 2024

using a two-step calcination method, which not only suppressed electron–hole complexation through IEF to prolong the electron lifetime, but also lowered the interfacial resistance and accelerated the electron mobility [15].

In addition, loading co-catalysts on the surface of g-C_3N_4 is also a means of improvement. For example, Al-Hartomy's group using Pt as the co-catalyst to coat on the g-C_3N_4 framework for the efficient photocatalytic reduction of CO_2 to CO and CH_4 [16]. Peng et al. loaded g-C_3N_4 onto carbon dots modified with SBA-15 mesoporous silica by means fo precursor impregnation, where the carbon dots act as co-catalysts with the ability to transfer photo-generated electrons, while the mesoporous silica has a larger specific surface area and porosity [17]. Furthermore, Kim et al.'s team loaded anthraquinone (AQ) onto g-C_3N_4, endowing the conduction band with the ability to trap electrons and was able to reduce the photocatalytic decomposition of produced H_2O_2, improving the selectivity of H_2O_2 production [18]. Not only that, Sun et al. also promoted the visible-light photocatalytic reduction of carbon dioxide by loading sodium hydroxide on the g-C_3N_4 surface. In the thin layer of alkaline electrolyte formed on the carbon nitride surface, it not only acts as a hole acceptor but also maintains the cycle of carbonic acid production and decomposition [19]. Li's group synthesized a g-C_3N_4/MoS_2 composite with a hydrogen production rate 13.44 times higher than that of the pure phase under visible light due to the fact that MoS_2 acted as a co-catalyst to significantly enhance the transfer of photo-generated electrons to H^+ [20]. In conclusion, the modification of g-C_3N_4 materials is based on the following three principles: (i) structural adjustment of the g-C_3N_4 material itself to increase the specific surface area as well as the active sites; (ii) construction of g-C_3N_4-based heterojunctions to separate the photogenerated carriers by IEF; and (iii) combining with co-catalysts to make up for the problems of g-C_3N_4 itself.

To conclude, this Special Issue entitled "Development of g-C_3N_4-Based Photocatalysts: Environmental Purification and Energy Conversion" provides a comprehensive overview of recent advances in the synthesis, modification, and energy-environmental applications of g-C_3N_4, an excellent photocatalyst. We hope that this collection of important research papers will inspire further research in this field.

We would like to express our sincere gratitude to all authors for their valuable contributions, as well as to the editorial team of *Catalysts*, especially Mr. Yang Liu, for their kind support. All authors have read and agreed to the published version of the manuscript.

Conflicts of Interest: The authors declare no conflicts of interest.

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