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Editorial

Photocatalytic Materials

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With the rapid development of global industry, steadily worsening environmental pollution and energy shortages have raised awareness of a potential global crisis. So it is urgent to develop a simple and effective method to address these current issues. In recent years, semiconductor photocatalysis has emerged as one of the most promising technologies because it represents an easy way to utilize the energy of either natural sunlight or artificial indoor illumination and is thus abundantly available everywhere in the world. The potential applications of photocatalysis are found mainly in the following fields: (i) photolysis of water to yield hydrogen fuel; (ii) photodecomposition or photooxidization of hazardous substances; (iii) artificial photosynthesis; (iv) photoinduced superhydrophilicity; (v) photoelectrochemical conversion, and so forth [1].

Among various common photocatalysts, bits photocatalytic activity under UVTiO_2 has been extensively used in a wide range of applications (such as gas sensor, solar cell, batteries, etc.), since the discovery of its application in photocatalysis [2]. Since then, intense research has been carried out on TiO_2 photocatalysis, which has been focused on understanding the fundamental principles, enhancing the photocatalytic efficiency, and expanding the scope of applications. Many potential uses of TiO_2 photocatalysis have been identified, such as the hydrogen fuel production, detoxification of effluents, disinfection, superhydrophilic self-cleaning, the elimination of inorganic/organic gaseous pollutants, and the synthesis of organic fuels.

To further improve the photocatalytic performance, there has been great interest in preparation of the supported nanocatalysts, for instance, carbon nanotubes composites, magnetic composites, graphene composites, and so forth, because of their enhanced photocatalytic activity or magnetic separation [3]. Nanomaterials have emerged as pioneering photocatalysts and account for most of the current research in this area. Nanomaterials can provide large surface areas, diverse morphologies, abundant surface states, and easy device modeling, all of which are properties beneficial to photocatalysis. Significant progress has been made in the development of novel nanomaterials in recent years. Nevertheless, the efficiency of nanomaterials, especially in solar photocatalysis, must be improved in order to meet engineering requirements. For example, TiO_2 exhibits photocatalytic activity under UV light ($\lambda < 387\,nm$), whose energy exceeds its band gap, resulting in its limited practical applications [4–6]. Therefore, the exploitation of visible-light-driven photocatalysts is indispensable for the practical application of the photocatalytic system. Furthermore, the stability and cost of these materials should also be carefully considered. It is thus a challenge of great importance to identify and design new semiconductor materials that are efficient, stable, and abundant.

Another key issue influencing the photocatalytic capability of a semiconductor is the nature of its surface/interface chemistry. The surface energy and chemisorption properties play crucial roles in the transfer of electrons and energy between substances at the interface, in governing the selectivity, rate, and overpotential of redox reactions on the photocatalyst surface, and in determining the susceptibility of the photocatalyst toward photocorrosion [1]. In general, a higher surface energy yields higher catalytic activity. Recently, much interest has been focused on research into semiconductor crystals with morphologies, such as nanorods, nanoparticles, nanotubes, and micro/nanospheres, which have been fabricated successfully and that provide large percentages of highly reactive facets [7–10]. Appropriate modification of the surface is frequently necessary to facilitate photocatalysis.

Despite important insight being gained, the mechanisms involved in photocatalysis are not yet known in detail. Fulfilling this goal requires the help of theoretical investigations such as electronic structure calculations and molecular dynamic simulations. Indeed, the theoretical study of photocatalysis has progressed rapidly alongside the experimental work. The above computational methods require a degree of understanding of photocatalysis. The calculation results obtained then raise the level of this understanding and provide guidance toward the practical improvement of photocatalytic materials and their applications.

The papers in this special issue concern the development of new photocatalytic nanomaterials for degradation of organic pollutes. They concentrate on preparation of photocatalytic materials, with assistant of magnetic nanoparticles, metal or nonmetal doping, annealing treatment. Novel photocatalytic materials or special preparation process are provided to solve limited photocatalytic activity that hindered by the lack of visible absorption. The works assembled in the present volume contribute to such development. Hopefully, they will inspire further research along the same lines.

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