Photocatalytic nanocomposites for hydrogen production from water splitting and environmental purification

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Abstract

The paper overviews our recent studies on the photocatalytic nanocomposites for hydrogen production from water splitting and environmental purification.

In recent years, photocatalytic hydrogen evolution from water splitting and environmental purification with semiconductor photocatalyts has been extensively studied due to solar light can be utilized.

The photocatalytic production of H_2 in one step is potentially one of the most promising ways for the conversion and storage of solar energy. Our study attention was mainly focused on the promotion effects of nanosized modifications in the interlayer and surface of photocatalysts for hydrogen evolution with visible light. The photocatalytic activity depended significantly on modification techniques, such as loading, proton exchange, and intercalation. The formation of a “nest” on the particle surface promoted a uniform distribution and strong combination of the nanosized particles on the surface of catalysts. By the methods of intercalation and pillaring as well as by selecting both host and guest, a large variety of molecular designed host–guest systems were obtained. A series of solid solution metal oxides, such as K_4Ce_2 $Ta_{10-x}Nb_xO_{30}$, $BiYWO_6$, $Bi_{1-x}Dy_xVO_4$ and $Bi_xY_{1-x}VO_4$, were prepared and discovered to have the photocatalytic ability to split water under visible light. The present study indicated that forming solid solution was a feasible method to simultaneously adjust the CB and VB to obtain stable metal oxide photocatalysts for H_2 evolution from water using solar energy. This activity under visible light irradiation was enhanced by the incorporation of Pt, RuO_2, NiO and Pt-Cr_2O_3 as co-catalysts.

Most of the studies about the photocatalytis of TiO_2 are focused on powder TiO_2. But for most applications, there exist tough problem of post treatment separation in the mixture. We coated nanosized TiO_2 films on foam metal nickel and active carbon honeycomb by sol-gel methods. The photocatalytic activities of the samples were

evaluated by photocatalytic degradation efficiency of gaseous acetaldehyde, which is used as a representative of indoor volatile organic compounds (VOCs). Different modification processes were used to improve photocatalytic activity. When mesoporous SiO_2, Al_2O_3 and Al_2O_3/SiO_2 films were introduced as intermediate layers between the substrate and TiO_2, the photocatalyst increased markedly. It is thought that the increment of active sited of photocatalysis and the prevention of combination of photo-generated electrons and holes helped to enhance the photocatalytic ability. The results in the experiment gave ideal samples for commercial applications in the field of photocatalytic environmental cleaning. Moreover, the photocatalysis combined with ozonation promoted the VOCs degradation. Some composite catalysts as such TiO_2/H-ZSM-5 and TiO_2/M(Mn, Cu, Zn)-ZSM-5 were prepared and showed excellent catalytic activity for acetaldehyde removal. The improvement was attributed to the synergetic effect among adsorption, ozonation and catalytic reaction.

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