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Fabrication of Phosphorus Nanostructures/TiO₂ Composite Photocatalyst with enhancing Photodegradation and Hydrogen Production from Water under Visible Light

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Abstract

As the world faces serious environmental pollution and energy shortage, developing Vis-light-driven photocatalysts for water splitting is highly attractive in clean energy utilization. Fabricating heterostructures has been proposed to be an efficient system to enhance the photocatalytic activity. However, synthesizing heterostructures with good contact and understanding charge transfer dynamics are still unresolved issues. In this work, a facile calcination approach was used to synthesize red phosphorus (RP) nanostructures/TiO₂ heterostructured composites. The RP nanostructures were directly grown on the TiO₂ nanoparticles with an intimate surface contact. By adjusting the molar ratio of amorphous RP to TiO₂ and the synthesizing temperature, thin nanorod-like RP nanostructures with a large exposed surface and a good surface contacting with TiO₂ were obtained. The synergetic effect of heterostructured RP/TiO₂ composites leads to an enhanced charge separation and transfer, and a better utilization of visible-light. As expected, the RP/TiO₂-700°C composites exhibit good photocatalytic activity of degrading RhB and the optimal H₂ evolution rate. This work not only provides a method to prepare earth abundant elemental phosphorus well-contacted heterostructures, expand the well-known UV-active TiO₂ photocatalyst to visible active, but also deepens understanding of charge transfer dynamics in heterostructured photocatalyst.

Keywords: Phosphorus nanostructures, Heterostructure, Photodegradation, H₂ evolution

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