Visible-Light-Driven Magnetic Nano-photocatalysts for the Degradation of Persistent Organic Pollutants

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Persistent organic pollutants (POPs), such as pharmaceuticals, personal care products, pesticides and metabolites are frequently detected and are becoming widespread in wastewater and aquatic environments, mainly because these compounds are barely biodegradable and thus conventional wastewater treatment plants fail to completely remove them. As is well known, TiO_2 is the most widely used photocatalyst due to its high stability and oxidative power, which can efficiently degrade a variety of organic and inorganic pollutants. However, TiO_2 with a wide band gap of 3.2 eV can only be excited by UV light, which leads to low utilization efficiency of the solar spectrum, because UV light accounts for only a small fraction (5%) of the sun's energy compared to visible light (45%). To meet the demands of future photocatalytic technologies activated by solar light, a novel magnetic visible-light-driven photocatalyst was prepared for photocatalytic removal of POPs in this study. The structural characterization of the photocatalyst indicates that the monodisperse Fe_3O_4 nanoparticles of diameter 10 nm are highly assembled on the Bi_2O_4 nanorods of diameter 120 nm. Under visible light irradiation, using an optimum molar ratio of Bi_2O_4/Fe_3O_4 (1:2.5) resulted in a complete photocatalytic degradation of ibuprofen (IBU), which is selected as the target POPs, within 2 h and a complete mineralization of IBU with a prolonged irradiation time of 4 h. The photocatalytic mechanisms of Bi_2O_4/Fe_3O_4 (1:2.5) were revealed, indicating that the enhanced photocatalytic performance was mainly attributed to the accelerated separation of electron-hole pairs after surface modification of Fe_3O_4, and that the photogenerated h^+ was the primary reactive species for the photocatalytic removal of IBU. Furthermore, the Bi_2O_4/Fe_3O_4 (1:2.5) can be magnetically recycled and shows good reusability without significant loss of photocatalytic activity or structural change even after reuse over five cycles, showing a promising application for the photocatalytic degradation of POPs from water.