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Supermagnetic recyclable Bi/Fe-based nanomaterial with multiple functionalities and its potential practical application in environmental decontamination

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Advanced oxidation processes (AOPs) and physical adsorption are efficient and green approaches in environmental decontamination. As everyone knows, TiO_2 can drive strong photocatalysis in slurry type and Fe^{2+} ion can induce Fenton oxidation at pH~3 while there are many investigations on adsorbents (e.g., urchin-like α-FeOOH can adsorb 80 mg g^{-1} of Pb(II), which is much higher than others). However, those used nanomaterials are difficult to separate from the treated water and the post-treatment will be high cost. Herein, we propose a Bi/Fe-based nanomaterial with hierarchical morphology, which can effectively drive AOPs in heterogeneous type at pH~7, has outstanding physical adsorption and supermagnetic property. It can be used to remove organic pollutants and heavy metals, and can be recovered quickly via an environmental-friendly magnetic separation technology. The magnetic property for pristine bismuth ferrites is too weak to be used in practical application effectively. Here Bi/Fe-based materials with coral-like hierarchical morphology were fabricated using solvothermal treatment in methanol system. Its saturation magnetization (M_s) marvelously increase from 0.375 to 30.7 emu g^{-1}, while the adsorption of methyl orange (a dye pollutant) ranges from 0.5 to 46.6%. Besides, it also can effectively induce visible light photo-Fenton oxidation which can be used to degrade different types of organic pollutants (e.g., dyes, pharmaceuticals, pesticides). Even at a low catalyst loading of 0.12 g L^{-1}, the removal rate of organic pollutants can be ~99% in 100 min by degradation and/or adsorption. Its adsorption ability also can be used to remove different kinds of heavy metal ions (e.g., Pb(II), Cd(II), As(V), Cr(VI), Cu(II), Mn(II), Ba(II) and Co(II)), especially for Pb(II), for which its maximal adsorption capacity can reach a new height of 214.5 mg g^{-1}. The outstanding performances are possibly ascribed to its coral-like hierarchical morphology which was investigated by several characterization techniques. It was proved that it is self-assembled by 1D nanowires (~6 nm in diameter) and 2D ultrathin nanoflakes (~4.5 nm in thickness). This product has remarkable optical properties with absorption of UV, visible light and even IR as well.

Biography

Zhong-Ting Hu is a PhD student from Nanyang Technological University (Singapore). He holds BSc in Applied Chemistry and MSc in Environmental Engineering. He was a R&D researcher of NanoMaterials Technology Pte Ltd. in Singapore (2007-2012). He has experiences in nanoparticle synthesis, surface modification, wet coating and nanomaterial production in pilot plant. He was a Team Leader of a research project for undergraduate students (chemical plating & H_2 energy) and their paper won the 1st Prize of the 1st ZJNU Natural Science's Academic Paper Competition. His current research interests are material and environment including advanced nanomaterials fabrication/optimization (morphology, self-assembly, nanocomposite, doping, synthesis), environmental photochemistry, heterogeneous catalysis, water treatment, solar energy, magnetic separation.

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