Chemical Engineering Journal 219 (2013) 86–95

Contents lists available at SciVerse ScienceDirect

Chemical Engineering Journal

journal homepage: www.elsevier.com/locate/cej

Hydrothermal synthesis and characterization of novel $PbWO_4$ microspheres with hierarchical nanostructures and enhanced photocatalytic performance in dye degradation

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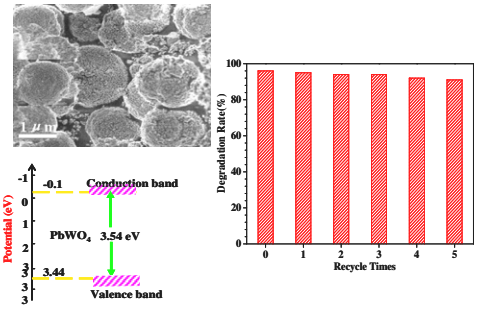
HIGHLIGHTS

- Novel $PbWO_4$ microspheres with hierarchical nanostructures were synthesized.
- The morphology and photocatalytic performance of $PbWO_4$ crystals were controlled by pH value in preparation.
- $PbWO_4$ microspheres exhibited remarkable photocatalytic activity and stability.
- Hierarchical structures and low recombination rate of the e^-/h^+ pairs enhanced photocatalytic performance.

GRAPHICAL ABSTRACT



ARTICLE INFO

Article history:
Received 8 September 2012
Received in revised form 8 December 2012
Accepted 26 December 2012
Available online 7 January 2013

Keywords:
$PbWO_4$ nanocrystals
Hierarchical microsphere
Morphology control
Enhanced photocatalytic performance
Acid orange II

ABSTRACT

Novel $PbWO_4$ crystals with different morphologies, 14-faceted polyhedrons, hierarchical microspheres and nanoparticles, were fabricated by adjusting pH value under hydrothermal conditions. The as-prepared $PbWO_4$ samples were characterized by nitrogen-physical adsorption, powder X-ray diffraction, scanning electron microscopy, transmission electron microscopy, UV–vis diffuse reflectance spectra, photoluminescence emission spectroscopy, and Fourier transform infrared spectroscopy. The photocatalytic performance of the $PbWO_4$ crystals with different nanostructures in degradation of the acid orange II dye under UV light (365 nm) was investigated. The plausible growth mechanisms for $PbWO_4$ crystals with different morphologies were proposed. Photocatalytic tests showed that the performance of $PbWO_4$ crystals strongly depended on their morphologies. $PbWO_4$ microspheres with hierarchical nanostructures prepared under pH 7.0 at 140 °C exhibited the highest activity and stability in recycling reaction. The degradation kinetics of dye over $PbWO_4$ crystals was found to conform to the pseudo-first order model. The enhanced photocatalytic performance was attributed to the unique hierarchical nanostructures with high surface area and improved surface properties. Moreover, the high crystallinity of $PbWO_4$ microspheres exhibited an enhanced catalytic activity owing to lower recombination rate of photo-generated electron/hole pairs. These novel hierarchical $PbWO_4$ microspheres hold promise in applications of environmental purification.

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http://dx.doi.org/10.1016/j.cej.2012.12.064