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ORIGINAL PAPER

Controllable one-step synthesis of ZnO nanostructures using molybdophosphoric acid

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ZnO nanostructures were synthesised in a hydrothermal reaction of zinc acetate in the presence of molybdophosphoric acid ($H_3[PMo_{12}O_{40}]$) as well as its vanadium-substituted acid ($H_4[PMo_{11}VO_{40}]$) at various times, temperatures, and concentrations. The ZnO nanostructures were characterised by X-ray diffraction, transmission electron microscopy, and Fourier transform infrared spectroscopy. The results demonstrated that the synthesised products are crystalline with a zincite hexagonal phase. Various ZnO nanostructures, such as nanoparticles, microrods, and nanosheets, were produced by changing the experimental conditions. The photocatalytic degradation of methyl orange was also investigated using the ZnO nanoparticles thus prepared. These particles exhibited high performance in the photocatalytic degradation of MO and almost 100 % decolourisation occurred within only 20 min.

Keywords: ZnO, nanoparticle, nanosheet, hydrothermal, molybdophosphoric acid, photodegradation

Introduction

ZnO nanostructures are promising materials for use as catalysts in photocatalytic degradation (Hong et al., 2005, 2006; Fang et al., 2013; Kaur et al., 2013), preparing solar cells (Wang et al., 2001), electrostatic dissipative coating (Kitano & Shiojiri, 1997), gas sensors (Song et al., 2012), chemical absorbents (Turton et al., 2004), electrical and optical devices (Zheng et al., 2002; Feldmann, 2003), and catalysts for liquid phase hydrogenation (Hamminga et al., 2004). Therefore, investigations into the synthesis of nanosized and nanostructured ZnO have attracted a great deal of attention.

Various methods are used for the preparation of ZnO nanostructures including mechanochemical processing (Tsuzuki & McCormick, 2001), sol–gel technique (Tokumoto et al., 2003), micro emulsion synthesis (Singhai et al., 1997), spray pyrolysis and drying (Okuyama & Wuled Lenggoro, 2003), thermal decomposition of organic precursor (Rataboul et al., 2002), supercritical-water processing (Viswanathan et al., 2003), self-assembly (Koh et al., 2004), vapour transport process (Yu et al., 2005), sonochemical synthesis (Hu et al., 2004), direct and homogeneous precipitation (Wang & Gao, 2003; Kim et al., 2005), and hydrothermal processing (Ang et al., 2013; Fang et al., 2013; Kiomarsipour & Shoja Razavi, 2013; Zhou et al., 2013; Wang et al., 2013). Of these, hydrothermal synthesis is an effective method for wet chemistry, entailing low cost, easy operation, and simple equipment. In recent years, hydrothermal synthesis

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