Accepted Manuscript

Research paper

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PII: S0009-2614(16)30664-9
DOI: http://dx.doi.org/10.1016/j.cplett.2016.09.008
Reference: CPLETT 34149

To appear in: *Chemical Physics Letters*

Received Date: 8 July 2016
Revised Date: 31 August 2016
Accepted Date: 4 September 2016

Please cite this article as: L. Wu, Y. Wu, S. Jin, L. Zhang, Z. Xun, Gas sensitivity and photocatalytic performance of cuprous oxide with novel morphologies, *Chemical Physics Letters* (2016), doi: http://dx.doi.org/10.1016/j.cplett.2016.09.008

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Gas sensitivity and photocatalytic performance of cuprous oxide with novel morphologies

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Abstract:

In this work, Cu_2O nanoparticles (NPs) with quasi-spherical and bookmark-like morphologies were successfully synthesized via a new facile solution method. The morphologies of products were characterized to show porous surfaces and the size is as small as approximately 20~50 nm. Given the special morphology, Cu_2O NPs exhibited superior gas sensitivity to either ethanol or acetone vapors and strong adsorption abilities and high degradation activities for methyl orange under visible-light irradiation. The investigation provided not only a way of synthesizing Cu_2O particles with dozens of nanoscale, but also a way of improving its gas sensitivity and catalytic degradation ability.

1. Introduction

With high-speed development of social economy, environment pollution has become increasingly serious. In particular, haze weather, industrial and domestic wastewater have become serious problems needing urgent solutions. Photocatalytic degradation of organic pollutants is a simple, highly efficient and low-cost technology [1-4]. TiO_2 and ZnO semiconductor materials are widely used as photocatalysts [5-8]. However, the broad band gap of the TiO_2 and ZnO semiconductors (3.2 and 3.3 eV, correspondingly) made them to only respond to UV light. Hence, wide application of these semiconductors is limited to a certain extent. Cu_2O, a p-type direct band gap semiconductor, exhibits a forbidden band width of approximately 1.9 eV to 2.2 eV [2,7], corresponding to the highest energy density in the solar spectrum band. As a semiconductor material, the most significant advantage of Cu_2O is that it can absorb visible light and produce electron-hole pairs stimulated for catalytic degradation of some organic matter, which in a certain extent makes up for the defects of the photocatalytic degradation of ZnO and TiO_2 semiconductors in the visible-wavelength range. Therefore, Cu_2O offers potential applications in the field of photocatalysis. Moreover, micro-/nano-Cu_2O demonstrated many other excellent properties and important applications, such as gas-sensitive materials [9-12]. In the field of gas sensing, Cu_2O provides great potential applications in detecting pollutant gases because of its low cost and significant surface reactivity in both reducing and oxidizing gases. Reports revealed that Cu_2O can detect inorganic or volatile organic compound gases, including H_2S, NO_2, ethanol, and gasoline [13-18].

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