

Decolorization of Dye Water by Hydrogen Peroxide with CuS Micro-Flake as Catalyst

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Abstract

In this study, CuS micro-flake with average sizes of about 5–10 μm grows on 3D copper foam was synthesized by solvothermal method. This material was characterized using X-ray diffraction (XRD) and scanning electron microscopy (SEM). Besides, this CuS material was used to degrade methylene blue (MB) dye, water as catalyst and the effect of reaction temperature was also discussed.

Keywords: X-ray Diffraction (XRD); Scanning Electron Microscopy (SEM); Methylene Blue (MB)

Introduction

Decolorization of dye wastewater as potential environmental pollutant attracted considerable attention in the past two decades [1-3]. In order to degrade toxic substances in dye wastewater, many approaches have been developed in recent years [4-6]. As far as we know, the most feasible and economical method is H_2O_2 catalytic oxidation, with transition metal oxides and sulfides as catalysts [7,8]. CuS is one of these materials having a wide range of potential applications in nonlinear optical devices, solar radiation absorbers, high capacity cathode materials and photocatalysts [9-11]. Recently, we have succeeded in synthesizing CuS with different morphologies and decoloring methylene blue (MB) as catalysts [12], but did not relate the effect of temperature on catalyst for dye decolorization. Here, we describe a facile route to CuS micro-flake structure grow on 3D copper foam, and studied this material as catalyst for the degradation of methylene blue (MB) on different temperatures.

Experimental

In this approach, a piece of copper foam (1×1 cm; Thickness: 1 mm; 0.09 g) which used as the template and about 0.09 g sulfur powder were first loaded into a 20 ml Teflon-lined autoclave, then 11 ml ethylenediamine and 5 ml ethylene glycol was added. The autoclave was maintained at 160°C for 24 h and cooled to room temperature naturally. The dark product was put in carbon disulfide for more than half an hour, then washed with distilled water and alcohol in sequence for three times separately, and dried in an oven at 60°C.

Results and Discussion

The phase composition and crystal structure of CuS product was first examined using X-ray diffraction (XRD) analysis (Figure 1). All primary diffraction peaks of the curve are in good agreement with the standard data of CuS (JCPDS No.06-0464). The cell parameters of the product are $a=3.792 \text{ \AA}$ and $c=16.344 \text{ \AA}$, indicating the high purity of the obtained sample.

The morphology and structure of the CuS micro-structure were investigated by SEM. Figure 2a shows the low-magnification SEM image of CuS, we can see that many CuS micro-structure grown and maintained the original foam-like structure very well. The high-magnification SEM image (Figure 2b) reveals that the as-prepared CuS

sample consists of many micro-flakes with each diameter distribution of 5–10 μm , and the thickness of this CuS sample is about 2-3 μm .

Here, the as-prepared CuS material (0.06 g) was used to decolorize 5 mg/L (30 mL) MB with the assistance of H_2O_2 (10 mL) on 5°C and 30°C, separately. Changes in UV-vis spectra during the removal of MB by as-obtained CuS are illustrated in Figure 3. We can see that when the temperature was 5°C, it needed more than 80 min that the MB's decoloring degree can reach to 95%. Under the same conditions (expect temperature), the decoloring rate of MB can exceed 95% after only 25 min when the temperature is 30°C. Based on these experimental datas,

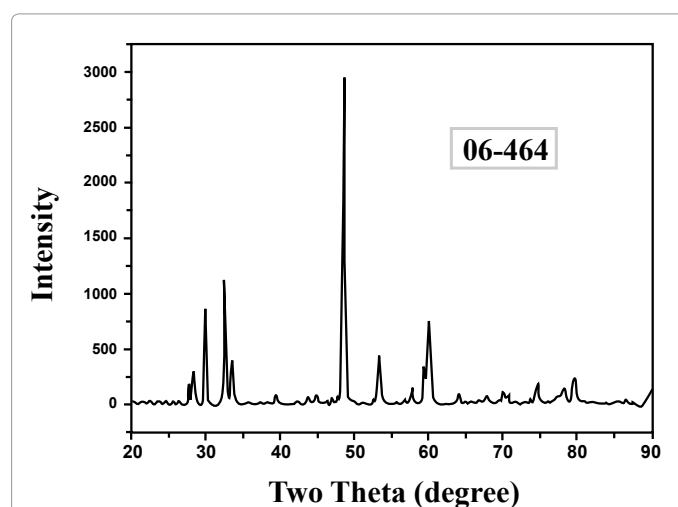


Figure 1: The PXRD pattern of CuS products synthesized at 160°C for 24 h.

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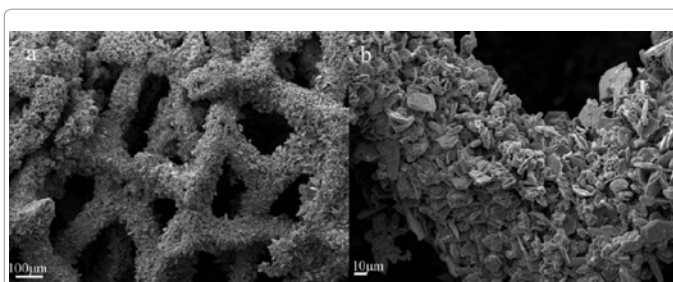


Figure 2: (a) Low-magnification SEM image of CuS (200 times) and (b) for 1000 times.

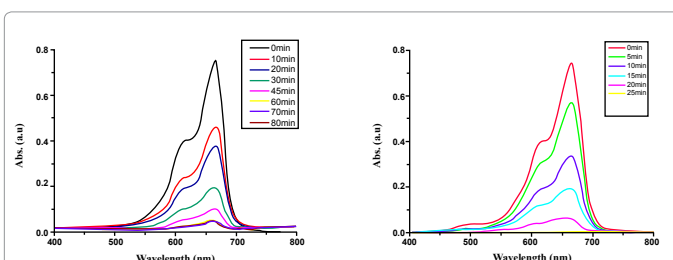


Figure 3: (a) Changes of UV-vis spectra during the removal of MB by as-obtained CuS(5°C) and (b) 30°C.

to sum up, the decoloring degree of MB could be influenced mostly by the reaction temperature.

Conclusions

In conclusion, CuS micro-flake has been successfully fabricated within template by using the solvothermal method. Ethylenediamine and ethylene glycol were used as mixed solvents. By XRD and SEM, the phase and morphologies were clearly detected. Meanwhile, this material can be used to decolorize MB dye solution without any kind of light source and this material was studied as catalyst for the degradation of MB on different temperatures, and finally found that temperature can influence the decoloring degree to a great extent.

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