

Deposition-Precipitation Synthesized CuCo/Activated Carbon Catalysts for Benzyl Alcohol Oxidation Reaction

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The effect of Co_x addition in the range of 0.1-1 mol into Cu supported on activated carbon (AC) catalysts fabricated by deposition-precipitation method was assessed. CuCo_x/AC prepared via the same method under different calcination temperatures was studied to evaluate the properties and activity of the catalysts. The bimetallic Cu-Co catalysts are structurally characterized by X-ray diffraction and scanning electron microscopy. It was found that Co is well incorporated in Cu/AC lattice and improves the crystalline structure with optimum Co loading. CuCo_x/AC nanoparticles formed with uniform shapes and size under the present synthesis conditions. The catalytic performances of the as-prepared catalysts were evaluated towards the aerobic oxidation of benzyl alcohol using hydrogen peroxide as the oxidant. Cu/AC, Co/AC and CuCo_x/AC showed ability to oxidize benzyl alcohol to benzaldehyde. $\text{CuCo}_{0.2}/\text{AC}$ calcined at 450 °C showed the highest catalytic activity with 86% conversion of benzyl alcohol due to the high crystallinity compared to the monometallic counterpart. It was found that the crystallinity of the catalysts could be tuned by varying the amount of Co. The synergistic effects of Cu-Co in optimum mole ratio and calcination temperature influenced the availability of active sites participating in the catalytic activity.

Keywords: CuCo/activated carbon, Catalyst, Benzyl alcohol, Benzaldehyde, Oxidation

INTRODUCTION

Production of aldehydes from oxidation of alcohols has been extensively researched [1] as these aldehydes are valuable intermediates for industries such as fragrance, food additives and pharmaceuticals [2]. In search for oxidation process that are capable of overcoming the drawbacks of conventional use of excess stoichiometric metal oxidants [3,4], noble metal nanoparticles including Au [5,6] and Pd [7] have been widely recognized as the most efficient catalysts for oxidation reactions. The limited availability and high cost have prompted the use of transition metals such as Cu [8,9] and Co [10,11] as catalyst for the oxidation of benzyl alcohol to benzaldehyde with oxygen or hydrogen peroxide as an oxidant. The presence of weak Co-O bond strength causes the reactivity of Co_3O_4 toward oxidation, releasing reactive oxygen species from the lattice structure

[12]. In addition, incorporating another transition metal into Co_3O_4 to form bimetallic structure mitigates particle sintering on account of the phase segregation in oxidizing reaction conditions [13]. The interfaces formed from the Cu-Co heterostructures would provide active sites for the activation of oxygen molecules, resulted in the enhanced activity of bimetallic systems for aerobic oxidation reactions [13]. Moreover, structural properties of bimetallic catalysts are easily tuned over a broad range by simply varying the metal composition. In prior studies, bimetallic CuNi catalysts were used to investigate the catalytic conversion for oxidation of benzyl alcohol [14]. As an improvement, in this study Ni is replaced by employing Co as metal dopant, in addition to the tailoring of calcination temperature.

The catalytic activity of transition metal catalysts could be further enhanced by anchoring them to a support. The role of the support is to disperse the active catalysts to achieve high mass activity and prevent the agglomeration of metal oxide catalysts. When the catalysts are well

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