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Short communication

A novel glass fiber catalyst for the catalytic combustion of ethyl acetate

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ABSTRACT

Supported CuO catalysts were prepared by wet impregnation into novel glass fiber corrugated honeycomb supports, and the catalytic combustion of ethyl acetate and the effect of copper loading were examined. Among the catalysts tested, Cu10/Al_2O_3-M showed the highest activity. For the catalyst, 100% conversion of ethyl acetate was achieved at 300 °C, feed concentration of 1802 mg/m^3 and the space velocity of 5000 h^{-1}. To reveal these phenomena, the supports and catalysts were characterized by SEM, BET, XRD, H_2-TPR and ethyl acetate-TPD. The catalyst activity was strongly related to the amount of highly dispersed CuO species and suitable porosity.

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1. Introduction

Volatile organic compounds (VOCs) are considered as great contribution to atmospheric pollution and harmful to health [1]. Catalytic combustion is considered as a promising method for the elimination of VOCs at low effluent concentration; it can convert organic hydrocarbon contaminant into carbon dioxide and water at lower temperature.

The most used catalysts are based on supported noble metals, such as platinum, palladium and rhodium [2], but the high costs of noble metals limit their wide applications [3]. Meanwhile, transition metal oxides, mainly of Co, Cu, Ni and Mn, have demonstrated a very good catalytic activity [4]. Furthermore, they have lower costs from the economical viewpoint and greater resistance to poisons from the practical view [5]. Yang et al. [6] reported that CuO supported on SBA-15 catalyst has the highest activity for benzene oxidation among granular pellets CuO/SBA-15, MnO/SBA-15, FeO/SBA-15 and NiO/SBA-15 catalysts. Chen et al. [7] also reported that CuO supported on zirconium-pillared montmorillonite (CuO/CZM) catalysts shows good catalytic performance and reasonable cost, compared with noble metal catalysts.

It is widely known that fine powdery/fabric catalysts have high mass/heat transfer properties, which could improve the efficiency of catalysts. Balzhinimaev et al. [8] reported that woven structure catalysts from glass fiber containing extra-low amounts of noble metals (0.01–0.02 wt.% of Pt or Pd) demonstrate unique performance in many catalytic reactions. Lopatin et al. [9] reported that structured cartridge catalysts with glass fiber have high mass transfer efficiency and low pressure drop.

In this work, the preparation of a novel glass fiber corrugated honeycomb catalysts has been reported. The main goal is to find out appropriate CuO loading in the catalysts for ethyl acetate catalytic combustion. Then, the highest catalytic performance of Cu10/Al_2O_3-M was proved by experiments including conversion vs. reaction time (prolonged) and conversion vs. contact time (space velocity).

2. Experimental

2.1. Preparation of the catalysts

2.1.1. Preparation of monolith supports

The monolith supports were prepared from corrugated papers (0.5 mm of thickness, 3 mm of sinusoidal pitch, Qingdao Huashijie Environment Technology Co.) of glass fiber (loss on ignition 5.20%, $A1_2O_3$ 35.35%, SiO_2 52.53%, MgO 3.57%, CaO 2.39% and Na_2O 0.96%, the content was measured with a X-ray fluorescence spectroscopy ARL9800XP+) by rolling round and bundling up with thread. Then, the structures were immersed into a commercial colloidal SiO_2 (10 wt.%, Sinopharm) for 5 min. The suspension excess was blown for 1 min. The pieces were dried at 120 °C. The entire cycle was repeated until total gain was around 50 wt.%. Finally, they were calcined at 650 °C for 4 h.

2.1.2. Al_2O_3 immersing into monolith walls

Alumina sols were obtained by mixing 53.1 g aluminum nitrate nonahydrate, 50.0 g of deionized water, 6.4 g of sucrose, and 20.0 g of 25 wt.% ammonia in a glass beaker, using a magnetic stirrer at room temperature for 24 h. The SiO_2 treated monoliths were immersed into alumina sols for 2 min. The suspension excess was blown for 30 s. Then, the pieces were dried at 120 °C. The entire cycle was repeated until total gain was around 38 wt.%. Finally, they were calcined at 650

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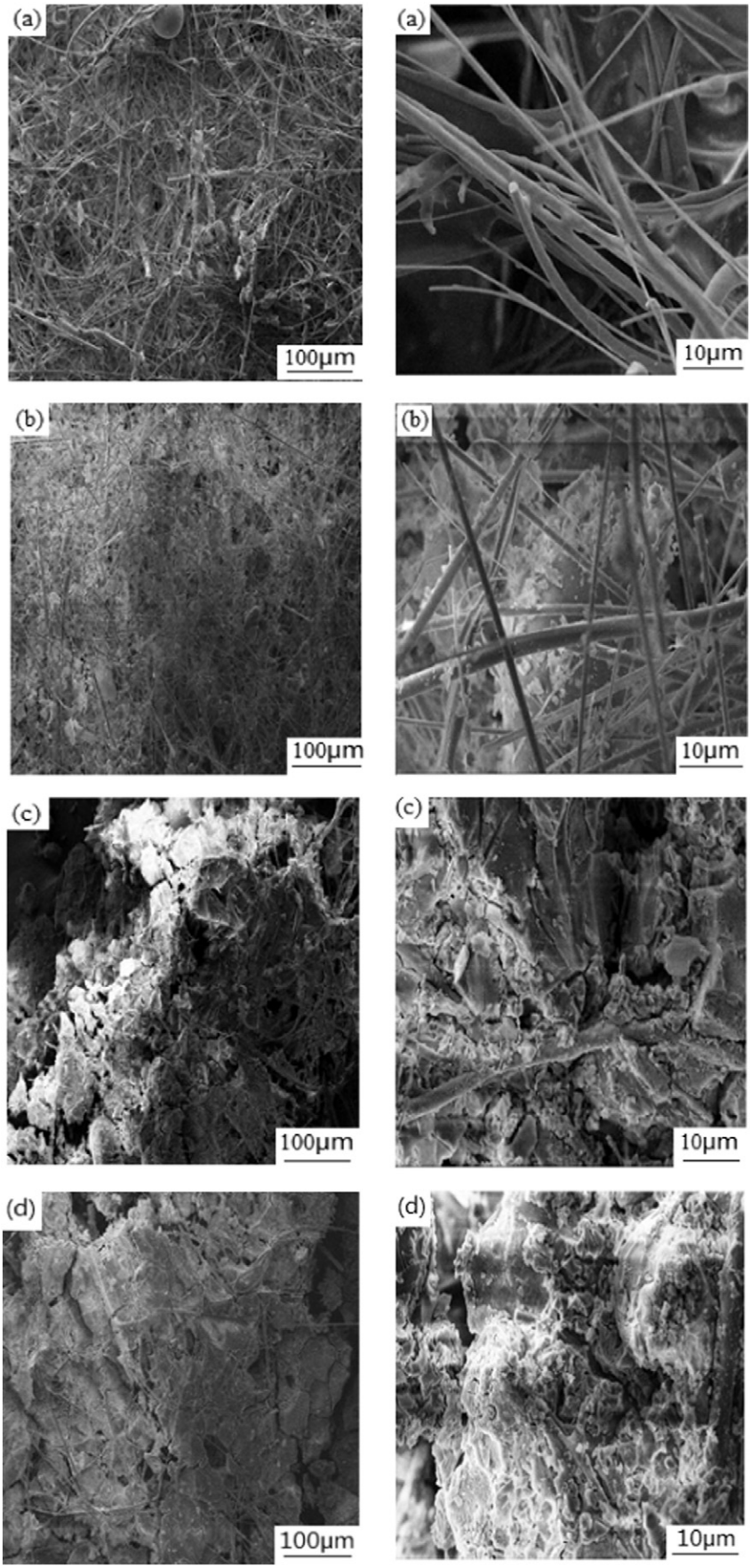

Fig. 1. SEM photographs of glass fiber corrugated paper (a), monolithic support (b), Al_2O_3-M (c) and Cu10/Al_2O_3-M (d).

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