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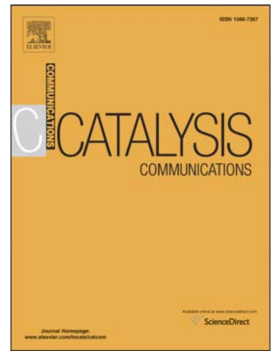

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Hydrothermal synthesis of sulfur-resistant MoS_2 catalyst for methanation reaction

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Abstract

The flower-like MoS_2 with high activity for sulfur-resistant methanation reaction was prepared by hydrothermal method. S/Mo mole ratios in feed and sulfidation condition during preparation were studied. The results show that higher S/Mo mole ratio increases the activity. Sulfidation in 3% H_2S/H_2 results in structure with longer and more ordered multi-layered MoS_2 which increases the activity and stability.

Keywords: Hydrothermal method; MoS_2; Sulfur-resistant catalyst；Methanation reaction; Sulfidation

1. Introduction

Since the crisis of environmental contamination and energy shortage, it has become increasingly important to use fossil resources efficiently and cleanly [1]. The development of synthetic natural gas (SNG) from syngas is a relatively reasonable and clean way to utilize coal [2]. Methanation is the key process for SNG production. Traditionally, Ni-based catalysts are adopted in the methanation reaction, in which they exhibit high CO conversions and good CH_4 selectivity from syngas [3]. However, sintering of the Ni particles and coke formation result in deactivation of Ni/Al_2O_3. These issues were addressed by the studies of Su. et al[4-6], leading to the significant improvement for Ni-based catalysts. In addition, Ni-based catalysts are sensitive to poisons such as sulfur and its compounds. Therefore, pre-treatment for syngas, i.e. desulfurization is necessary and essential before methanation, which will also increase the cost of methanation from SNG production on Ni-based catalysts [7].

In recent years, MoS_2-based catalysts have been widely explored in hydrotreatment processes, such as hydrodesulfurization (HDS) [8-10], water-gas-shift reaction [11] and sulfur-resistant methanation [12], because of their high catalytic activity and sulfur resistance property.

Due to the sulfur resistance property, MoS_2 catalysts for methanation received widespread concern. Mo-based catalyst can be applied not only to lower H_2/CO ratio, but also sulfur-contained atmosphere, which can eliminate both the water-gas-shift process and sulfur removal process, reducing the cost of methanation from syngas significantly.

Recently, preparation of Mo-based catalyst for sulfur-resistant methanation has been investigated such as sulfidation conditions [13], stepwise sulfidation [14] et al for supported Mo-based catalyst. In addition to the sulfidation process, it was found that Al_2O_3 [15], ZrO_2 [16] and composite supports, such as CeO_2-Al_2O_3 [17], MgO-Al_2O_3, TiO_2-Al_2O_3 or ZrO_2-Al_2O_3 [18] can function as supports. Also, promoters such as Co, Ni or La [19-20] and suitable precursor improve the performance [7] for methanation reaction. Jia Zhongbao et al studied Mo-Ni/γ-Al_2O_3 and the effect of promoter Co and W [21].

Few researches were focused on the unsupported MoS_2 catalysts, except the thermal decomposition with different Mo precursors [22-23]. In this work, we synthesized flower-like MoS_2 by hydrothermal synthesis method. Meanwhile, the performance of the catalysts was evaluated and the effects of sulfidation atomosphere have also been studied.