STUDY OF MO$_2$N CATALYST ACTIVITY AND STABILITY IN CO OXIDATION

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Abstract

Unsupported molybdenum nitride powder with $S_g$ of 115 m$^2$g$^{-1}$ (passivated) has been prepared by the temperature-programmed reaction of MoO$_3$ in H$_2$/N$_2$ mixture. It exhibited high catalytic activity in CO oxidation. DTA experiments in the air flow and O$_2$ temperature-programmed pulse reaction (TPPR) showed that the optimal oxidation temperature for the Mo$_2$N catalyst was under 450°C because of its instability at high temperature in the presence of O$_2$.

Keywords: Mo$_2$N, CO oxidation, instability

INTRODUCTION

In recent years, high specific surface area Mo$_2$N has received great attention in heterogeneous catalysis [1-4]. It has shown good catalytic activity in a wide variety of reactions: the hydrogenation of CO, synthesis of NH$_3$, methanation, hydrodenitrogenation and hydrodesulfurization [2, 3], and might be a promising catalytic material.

The preparation of Mo$_2$N as a catalytic material gave very good results. The production of Mo$_2$N with a high specific surface area (170 m$^2$g$^{-1}$) in temperature-programmed reactions (TPR) of MoO$_3$ in flowing NH$_3$ has been reported [1]. In our research group, Mo$_2$N powder with $S_g$ of 115 m$^2$g$^{-1}$ (passivated) was also obtained in the H$_2$/N$_2$ mixture by the TPR process [5].
At present, attention is mainly concentrated on hydrogenation catalyzed by Mo$_2$N. However, oxidation processes, such as CO oxidation, have not been studied.

In this paper, we evaluated the catalytic activity of Mo$_2$N for CO oxidation and studied its stability at high temperature in the presence of O$_2$ by means of TPRR and DTA technologies.

**EXPERIMENTAL**

**Preparation of Mo$_2$N**

A specially designed quartz reactor was used for the H$_2$/N$_2$ mixture with a volume ratio of 1.2 as feed gas. 3 g of MoO$_3$ were used and H$_2$/N$_2$ mixture was passed countercurrently through a boiling bed of MoO$_3$ at a space velocity of 34,000 h$^{-1}$ under temperature-programmed conditions. The TPR process was performed at a linear heating rate of 2.5 K/min up to 973 K. Then the system was kept at this temperature for 1 h. After the synthesis, the sample was further passivated at room temperature. The specific surface area was found to be 115 m$^2$/g$^{-1}$ by a CARLO-ERBA 1800 instrument.

**Activity measurement**

The activity of Mo$_2$N was evaluated with a fixed bed flow reactor at atmospheric pressure. CO + O$_2$ + N$_2$ (CO: 4 %, O$_2$: 20 %, N$_2$: 76 %) gas mixture was used as a feed gas and the reaction effluent was analyzed by gas chromatography. The activity of Mo$_2$N for the CO oxidation was indicated by the conversion of CO at an assigned temperature.

**Thermal analysis measurements**

The thermal stability of Mo$_2$N was determined by using a DuPont 1090 derivatograph. The DTA curves were recorded. The sample (17.46 mg) was heated in a platinum crucible. The heating rate was 10 K/min. The air flow rate was 50 mL min$^{-1}$.

**O$_2$ temperature programmed pulse reaction**

The Mo$_2$N catalyst mentioned above was heated in the N$_2$ flow in a quartz reactor from room temperature to 600 and held for 30 min. Then the flow was changed for He and the sample was cooled to room temperature. Oxygen was fed