Effect of pore structure of TiO_2 on the SO_2 poisoning over V_2O_5/TiO_2 catalysts for selective catalytic reduction of NO_x

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Selective catalytic reduction (SCR) of NO_x is a principal technology for the removal of NO_x from stationary and mobile sources. In practical SCR system, vanadium catalyst is widely used for $DeNO_x$ treatment [1]. SCR catalysts are generally deactivated in the presence of SO_2. However, a question about how the activity of the catalyst is affected in the presence of SO_2 remains unclear.

We prepared vanadium catalysts supported on TiO_2 containing 5wt% V_2O_5, denoted as 5wt% VT. Mesoporous TiO_2 (DT-51) and microporous TiO_2 [2] were used as support with anatase phase. In this work, two types of vanadium catalysts supported on TiO_2 with different pore structure were investigated when they were exposed to SO_2. Thus we aimed at examining the effect of pore structure of TiO_2 support on SO_2 poisoning when NH_3 SCR was carried out.

NO_x conversion of 5wt% VT(DT-51) decreased by 15% whereas only under 5% decline was observed on 5wt% VT(micro) at 350°C when SO_2 existed in the feed. Also, Fig.1 showed the amount of SO_2 desorption from pre-adsorbed sulfur species. Although all catalysts were treated with 300ppm SO_2 for 3h, 5wt% VT(DT-51) generated 2.5 times higher SO_2 than 5wt% VT(micro). In other words, different affinity with SO_2 is observed depending on the TiO_2 type.

Ammonium bisulfate (NH_4HSO_4: ABS) is known to form on the SCR catalysts via the reaction between NH_3 and H_2SO_4, generated from H_2O and SO_2. To distinguish the sulfate species formed on catalysts, model sulfate compounds, NH_4HSO_4 as diluted solution, was intentionally impregnated on VT catalysts [3]. Such approach allowed us to analyze the sulfur species of each catalyst. 0.1M ABS impregnated 5wt% VT samples had different weight loss patterns at similar temperature range during TG analysis. According to Fig. 2, sulfate species on the catalysts decomposed with different weight loss (%) at 420 - 440°C and 546 - 547°C. At low temperature range around 430°C, larger amount of sulfate species decomposed on 5wt% VT(micro) than 5wt% VT(DT-51).

Therefore, it is summarized that V_2O_5/TiO_2 (micro) has lower affinity with SO_2 and is also able to decompose sulfate species more readily than V_2O_5/TiO_2 (DT-51), which can explain the less decline of SCR activity in the presence of SO_2 over the former catalyst.

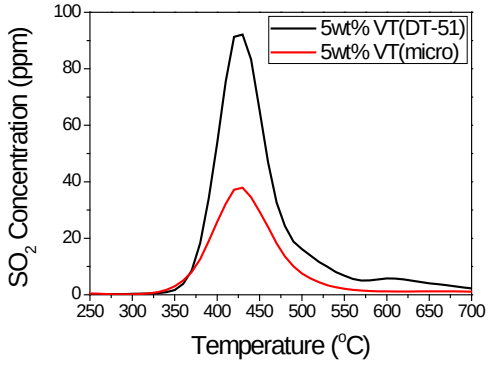

Fig. 1. Desorption of SO_2 of pre-sulfated 5wt% V_2O_5/TiO_2 catalysts.

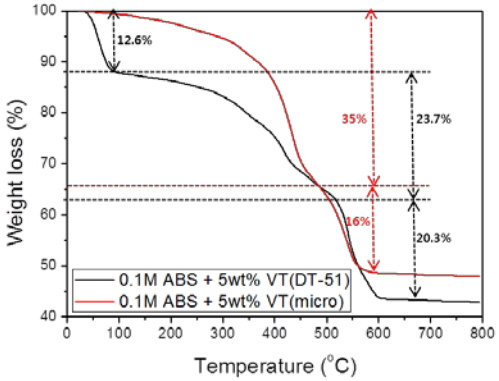

Fig.2. TG-DTA of ammonium bisulfate impregnated V_2O_5/TiO_2 catalysts.

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