

# Noble metal exchange of tunnel structured manganese oxides for NO reduction by CO in presence of excess O<sub>2</sub>

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**Abstract:** In this work, the tunnel structured manganese oxides with different pore size had been successfully synthesized. Then the ion-exchange method was employed for the deposition of the noble metal components for the activity test of NO reduction by CO. Results reveal that complete NO conversion was obtained in 200 °C for 5Pt-MnO<sub>2</sub>×2 sample. While, with the introduction of oxygen in the feeding gas, 5Pd-MnO<sub>2</sub>×2 sample showed the 100% CO conversion at 50 °C with 80% conversions of NO, and maintained the crystal phase of the catalyst in the presence of excess oxygen. It can be seen clearly from HAADF-STEM image that the MnO<sub>2</sub>×2 revealed straight tunnel structure with Pd nanoparticles well-dispersed in it.

**Keywords:** NO+CO+O<sub>2</sub>, Manganese catalyst, Noble metal.

## 1. Introduction

The selective catalytic reduction of NO in an oxidizing atmosphere has recently received extensive attention, since it has potential as a practical strategy for removing NO<sub>x</sub> emitted from diesel engines, lean-burn engines, and combustors. Numerous efforts have been taken for developing the advanced catalysts. Among them, considerable attentions have been paid to the tunnel structure manganese oxides due to their excellent catalytic performances<sup>1</sup>. Here, we synthesized manganese oxides with different pore size and exchanged by various metal components and investigated the catalytic performance of NO reduction by CO in the presence of excess oxygen.

## 2. Experimental

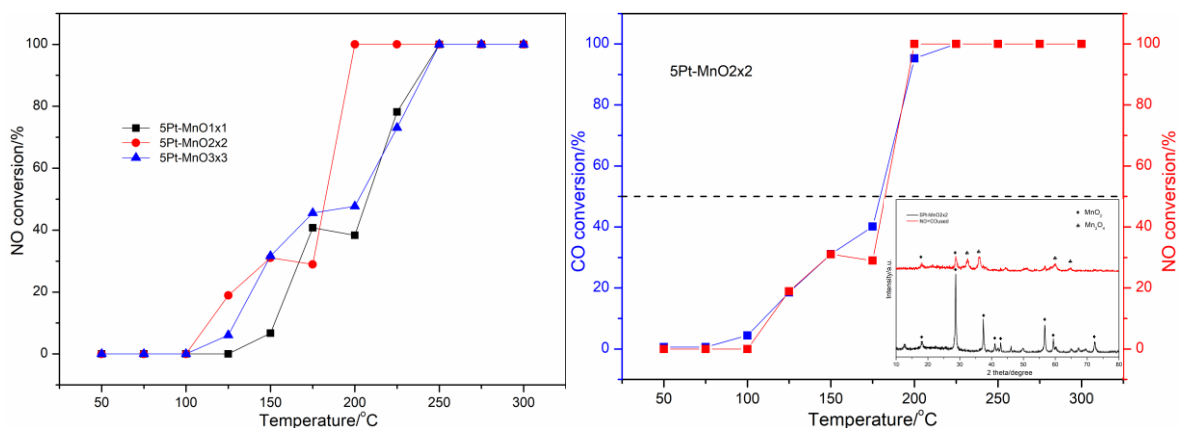
The tunnel structured manganese oxides with different pore sizes (denoted as MnO<sub>1</sub>×1, MnO<sub>2</sub>×2, and MnO<sub>3</sub>×3, respectively) were synthesized according to the reported literature<sup>2</sup>

The parent manganese support was subsequently doped with different metals (nominal loading = 5 wt.%) using the ion exchange procedure. A diluted aqueous solution of the corresponding metal precursor was refluxed with the manganese oxides at 80 °C for 24 h.<sup>3</sup>

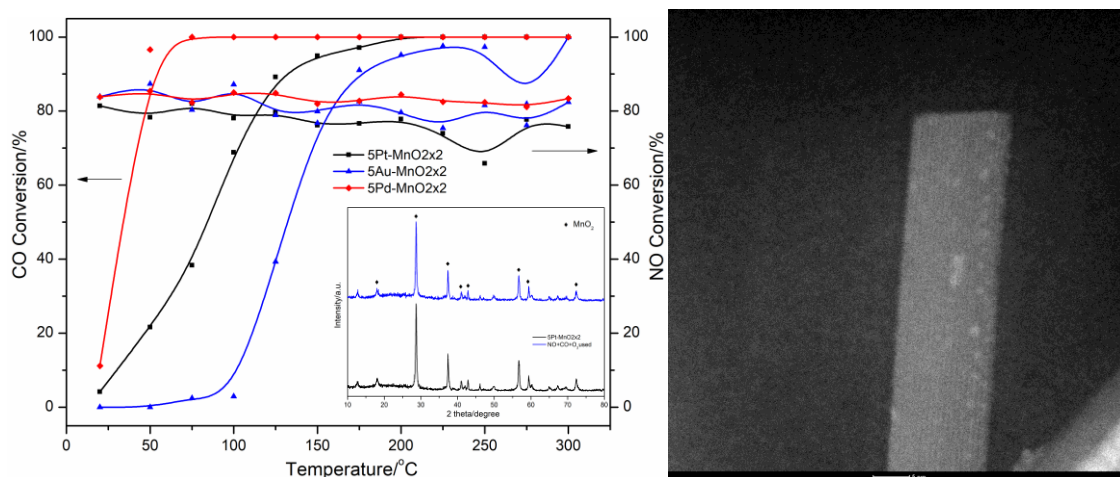
## 3. Results and discussion

Firstly, activity tests of NO+CO over the Pt exchanged different type of manganese oxides was shown in **Figure 1**. Results revealed that platinum exchanged 2×2 structured manganese oxide has the best activity for completely conversion of NO at 200 °C, and CO conversion maintains the similar pace with NO at the same time. Theoretically, however, CO conversion should reach to 50% when NO was completely converted since the CO concentration was 2 times of NO in inlet gas flow. From the XRD patterns of 5Pt-MnO<sub>2</sub>×2 before and after used (embedded in **Figure 1**), it can be seen that the main phase of sample transformed from MnO<sub>2</sub> to Mn<sub>2</sub>O<sub>3</sub> during the reaction, suggesting that the excessive CO was oxidized by lattice oxygen of MnO<sub>2</sub>. After 7% O<sub>2</sub> introducing, as presented in **Figure 2**, the conversions of NO and CO showed distinct differences over the different catalysts. The oxidation of CO increased dramatically with the elevated temperature, meanwhile NO conversion almost constant at about 80%. Specifically, Pd-MnO<sub>2</sub>×2 showed the lowest T<sub>100</sub> (temperature required to reach 100% conversion) of CO at 50 °C. Moreover, the

main crystal phases of all samples were maintained in this condition. While, the Pd nanoparticles confined in the straight tunnel of  $\text{MnO}_2 \times 2$  may lead to the best activities (the HAADF-STEM image in Figure 2).



**Figure 1.** NO+CO activities of Pt exchanged different type of manganese oxides.



**Figure 2.** NO+CO+O activities of various noble metal exchanged  $\text{MnO}_2 \times 2$  and HAADF-STEM of 5Pd- $\text{MnO}_2 \times 2$  sample.

#### 4. Conclusions

Herein, the tunnel structured manganese oxides with different pore sizes were synthesized and exchanged with various noble metal components, both NO and CO could be completely abated at 200 °C by Pt exchanged  $\text{MnO}_2 \times 2$  catalyst but simultaneously with the reduction of catalyst. In the presence of excess oxygen, 5Pd- $\text{MnO}_2 \times 2$  indicated the best catalytic activities with the lowest 100% conversion temperature and maintained 80% NO conversion at 50 °C, which may be due to the confined Pd nanoparticles in the tunnel of  $\text{MnO}_2 \times 2$ .

#### References

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