

Supporting information

# Ordered Mesoporous MnAlO<sub>x</sub> Oxides Dominated by Calcination Temperature for the Selective Catalytic Reduction of NO<sub>x</sub> with NH<sub>3</sub> at Low Temperature

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## S1. Experimental details

### S1.1 Synthesis of catalysts

All reagents were analytical grade and used as received without further purification. In a typical synthesis, approximately 4.0 g of Pluronic P123 ((EO)<sub>20</sub>(PO)<sub>70</sub>(EO)<sub>20</sub> triblock copolymer) and 1.9 mmol Mn(CH<sub>3</sub>COO)<sub>2</sub>·4H<sub>2</sub>O was successively added to 25.0 mL of anhydrous ethanol, and the resultant mixture was sealed and vigorously stirred at room temperature for 5 h. Then, approximately 48 mmol of aluminum isopropoxide (Al(OC<sub>3</sub>H<sub>7</sub>)<sub>3</sub>) was dissolved in 8.0 mL of HNO<sub>3</sub> (68 ~ 70 wt %) and 50.0 mL of anhydrous ethanol, the resultant mixture was sealed and vigorously stirred at room temperature for 5 h. Once dissolved, the two solutions were mixed and 25.0 mL of anhydrous ethanol was used to thoroughly transfer the Al(OC<sub>3</sub>H<sub>7</sub>)<sub>3</sub> solution. The final solution was sealed and allowed to continue stirring for at room temperature 4 h. Solvent evaporation was performed at 60 °C for 48 h in drying oven without stirring.

Calcination of the resulting light-yellow xerogel at 450 °C was carried out in a horizontal quartz tube furnace with a heating rate of 1 °C/min and held at the target temperature for 4 h. High-temperature (550, 700 and 800 °C) calcination was performed in two steps with the first step to 450 °C (1 °C/min heating rate) and the second step to final temperature (10 °C/min heating rate), held at 450 °C and final temperature for 1 h, respectively.

The final materials were labeled starting with mesoporous manganese alumina oxides (MnAlO<sub>x</sub>) followed by calcination temperature (T) in the general form MnAlO<sub>x</sub>-T. For instance, MnAlO<sub>x</sub>-450 refers to a mesoporous manganese aluminum oxide sample calcined at 450 °C for 4 h.

### S1.2. Characterization of catalysts

#### In situ DRIFTS experiments

Prior to each experiment, the samples were pretreated at 350 °C in N<sub>2</sub> for 1 h to remove any adsorbed species at first. At each required temperature, the background spectrum was recorded under N<sub>2</sub> flow (100 mL/min) and was subtracted from the sample spectrum that was recorded at the same temperature.

For NH<sub>3</sub> adsorption/desorption experiments, the sample was exposed to a flow of 500 ppm of NH<sub>3</sub>/N<sub>2</sub> for 1 h at 50 °C, then the sample was purged by N<sub>2</sub> for 0.5 h and following by raising the temperature from 50 °C to 350 °C, while the spectra were recorded from the beginning of adsorption.

For NO + O<sub>2</sub> co-adsorption/desorption experiments, the sample was exposed to a flow of 500 ppm of NO/N<sub>2</sub> + 6.5 vol.% O<sub>2</sub> for 1 h at 50 °C, then the sample was purged by N<sub>2</sub> for 0.5 h and following by raising the temperature from 50 °C to 350 °C, while the spectra were recorded from the beginning of adsorption.

For NH<sub>3</sub> adsorption and followed by NO + O<sub>2</sub> co-adsorption experiments, the sample was exposed to a flow of 500 ppm of NH<sub>3</sub>/N<sub>2</sub> for 1 h at 210 °C, then the sample was purged by N<sub>2</sub> for 0.5 h and following by exposing to a flow of 500 ppm of NO + 6.5 vol.% O<sub>2</sub>, while the spectra were recorded from the beginning of adsorption.

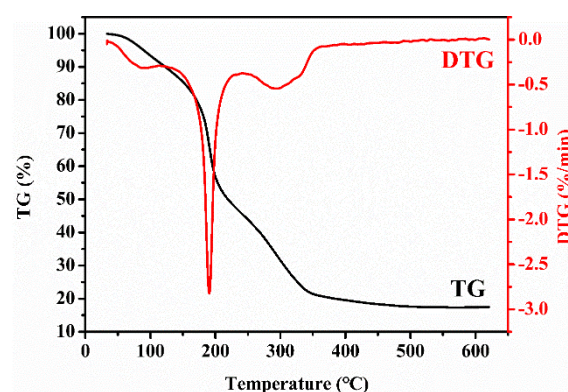
For NO + O<sub>2</sub> co-adsorption and followed by NH<sub>3</sub> adsorption experiments, the sample was exposed to a flow of 500 ppm of NO + 6.5 vol.% O<sub>2</sub> for 1 h at 210 °C, then the sample was purged by N<sub>2</sub> for 0.5 h and following by exposing to a flow of 500 ppm of NH<sub>3</sub>, while the spectra were recorded from the beginning of adsorption.

### S1.3. Catalytic activity measurement

A 1.0 g amount of catalysts with particle size between 40 and 60 mesh were used. The reaction gas was composed of 500 ppm NO, 500 ppm NH<sub>3</sub>, 6.5% O<sub>2</sub>, and the balance as N<sub>2</sub>. The total flow rate was 400 mL/min with the gas hourly space velocity (GHSV) was about 12000 h<sup>-1</sup>. After the reaction reached steady state, the concentrations of NO and NO<sub>2</sub> remaining in the reaction gases were monitored by using chemiluminescence analyzer (Kane KM9106), and the concentration of NH<sub>3</sub> and N<sub>2</sub>O was detected from Gasmeter DX4000.

## S2. Results and Discussion

### S2.1. TG-DTG analysis



**Figure S1.** TG -DTG curves for manganese alumina samples.

TG-DTG profiles recorded in air were first used to determine the thermal treatment temperature of the as-prepared composites. Figure S1 shows that all the TG/DTG curves have three stages of the weight loss at different temperatures, and the highest weight loss is centered around 195 °C. The corresponding total weight losses for the manganese alumina samples are 80.0%. In the case of the first step, ~16% of the weight loss was observed up to 150 °C, which is attributable to the loss of physically adsorbed species such as water and the evaporation of solvent [1]. The second step represents the largest weight loss, ~40%, located in the 150 ~ 250 °C range, which corresponds to the almost complete decomposition of the Pluronic P123 template. The third step represents the remaining weight loss of ~24% located in the 250 ~ 600 °C range, which is attributed to the dihydroxylation of OH groups and conversion of hydrated alumina into transitional alumina. Note that after calcinated at 450 °C in the flowing air, the mass of samples almost keep constant, indicating that the template removal and dehydration of hydrated alumina. Therefore, we determined the calcination temperature of samples to be ≥ 450 °C.

## Reference

- [1] Cai, W.; Yu, J.; Anand, C.; Vinu, A.; Jaroniec, M. Facile Synthesis of Ordered Mesoporous Alumina and Alumina-Supported Metal Oxides with Tailored Adsorption and Framework Properties. *Chem. Mater.* **2011**, *23*, 1147–1157.