

1. Temperature-programmed technology

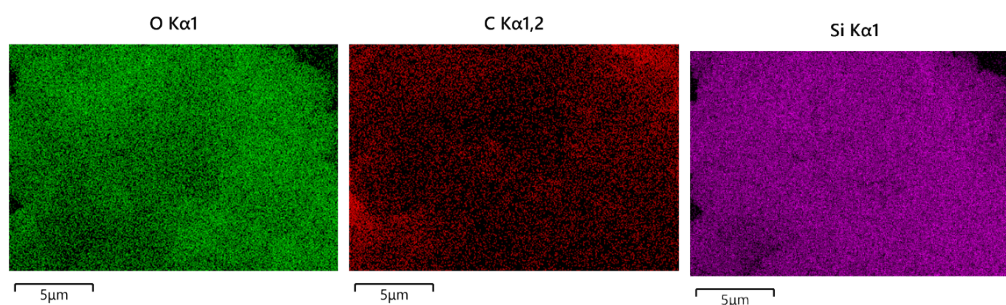
Temperature-programmed reduction of H₂ (H₂-TPR) and temperature-programmed desorption of NH₃ or NO (NH₃-TPD; NO-TPD) was conducted on the TP-5076 analyzer (Xianquan, China) with a thermal conductivity detector (TCD). For H₂-TPR, about 50 mg sample was pretreated at 300 °C in a highly pure He (20 mL/min) for 60 min and then cooled to 50 °C. After that, the gas was switched to a 5% H₂/He mixture (30 mL/min), and when the baseline was stable, the sample was heated from room temperature to 700 °C with the heating rate of 10 °C/min. The consumption of H₂ was detected online by TCD. For NH₃-TPD or NO-TPD, about 100 mg sample was pretreated in highly pure He (10 mL/min) for 60 min at 300 °C and then cooled to 50 °C. Subsequently, the sample was exposed to a mixture of 1% NH₃/N₂ or 1% NO/N₂ (10 mL/min) for 60 min and then purged in highly pure He (10 mL/min) to remove weakly adsorbed NH₃ or NO. Finally, after the baseline was stable, the sample was heated from 50 to 500 °C. The heating rate was 10 °C/min. The amount of NH₃ or NO desorbed was on-line detected by TCD.

2. *In-situ* DRIFT

The experiments of *in-situ* DRIFT were conducted on a Thermo Scientific Nicolet iS50 FTIR spectrometer (Thermo Nicolet Corporation, USA) with a MCT detector. Before the testing, the samples were put into infrared reaction pool, pretreated by a highly pure N₂ at 300 °C for 60 min and then cooled to 50 °C. For NH₃ (or NO+O₂) adsorption, the gas was switched to NH₃ (or NO+O₂) for 60 min and then purged by a highly pure N₂ stream. The spectra were recorded at target temperatures. For the

transient studies, after the pretreated sample in a highly pure N_2 at 300 °C for 60 min was cooled to 200 °C, the catalysts were exposed to NH_3 for 60 min at 200 °C and then a highly pure N_2 gas was switched to purge for 30 min. After that, $NO+O_2$ were introduced in the reaction pool. All spectra were collected after reaching the desired conditions. During the DRIFT testing, the reaction conditions were as following: 1000 ppm NH_3 or 1000 ppm $NO +5\% O_2$, and N_2 as balance, with a total flow rate of 200 mL/min. The heating rate was 10 °C/min.

For the influence of SO_2 on NH_3 -SCR reaction, the samples were put into the reaction pool and pretreated by a highly pure N_2 with a flow rate of 150 mL/min in 300 °C for 60 min and then cooled to 200 °C. For SO_2 adsorption, 1000 ppm SO_2 with a flow rate of 50 mL/min and 5% O_2 with a flow rate of 10 mL/min was added into the reaction pool. After 180 min, the SO_2 and O_2 were shut off. For the transient studies, after the catalysts were pre-exposed to 1000 ppm $SO_2+5\% O_2$ for 120 min at 200 °C and then shut off, a highly pure N_2 was switched to purge for 30 min. After that, 1000 ppm NH_3 , 1000 ppm NO and 5% O_2 were simultaneously introduced into the reaction pool. N_2 was as balance, and the total flow rate of gas was 200 mL/min. All spectra were recorded to describe the relationship between the peak intensity and time.



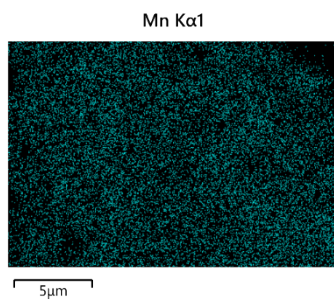


Fig. S1 EDS element mappings of Mn-MCM-41

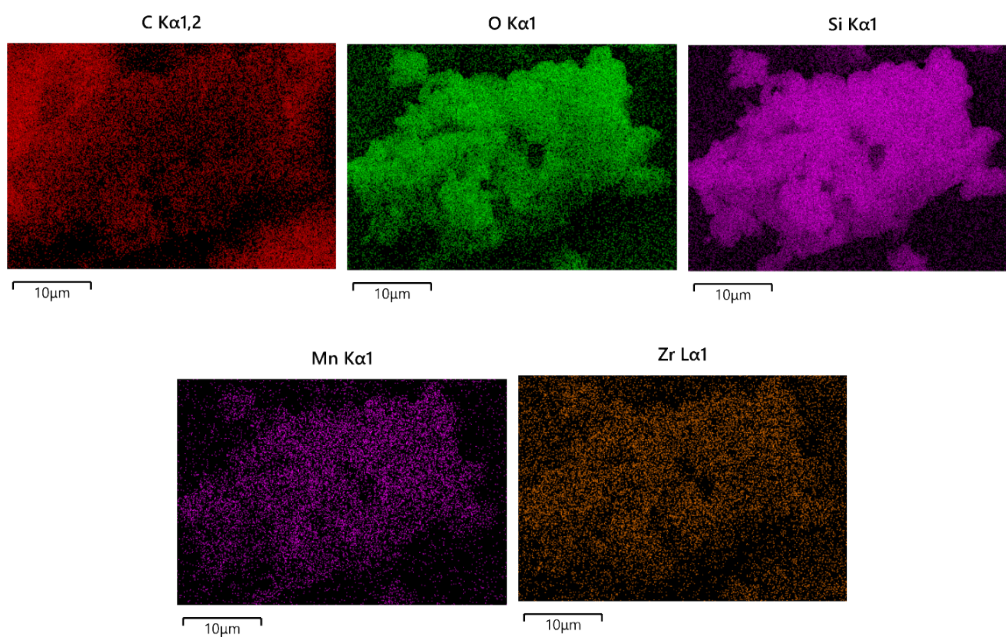


Fig. S2 EDS element mappings of Mn/Zr-MCM-41

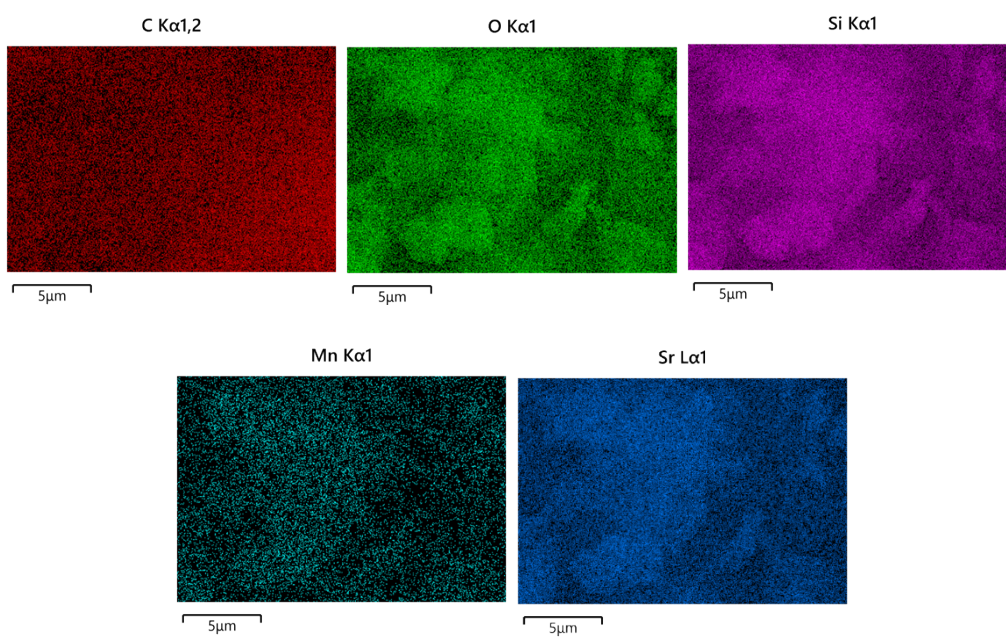


Fig. S3 EDS element mappings of Mn/Sr-MCM-41

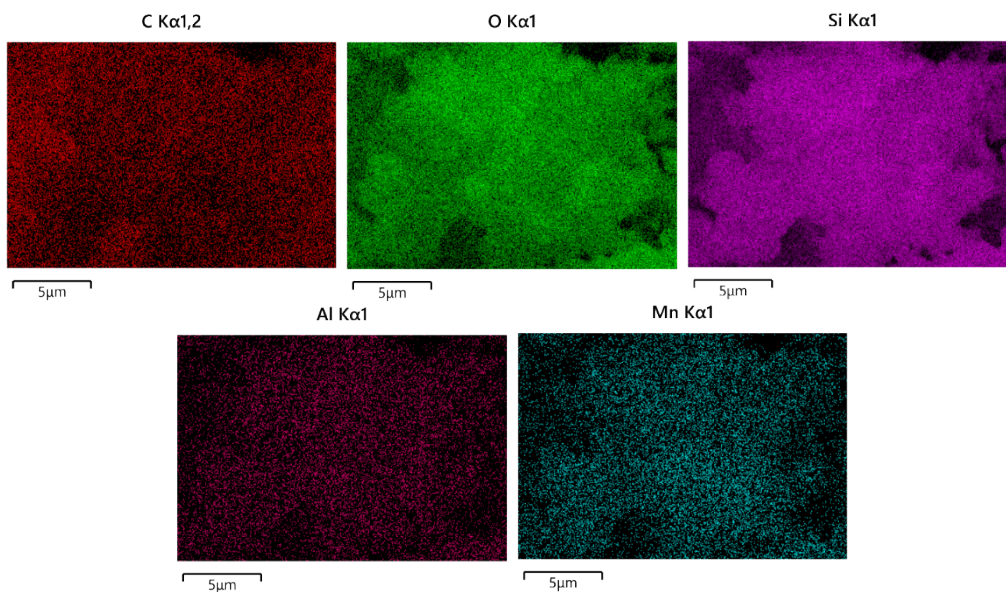


Fig. S4 EDS element mappings of Mn/Al-MCM-41