Electronic Supplementary Information (ESI)

Design of multi-shell Fe_2O_3@MnO_x@CNTs for the Selective Catalytic Reduction of NO with NH_3: improvement of catalytic activity and SO_2 tolerance

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Part I. Experimental details of the Fe-Mn@CNTs IM

The multi-walled CNTs were purchased from Qinghuangdao Tai Chi Ring Nano Product Co. Ltd (China). Before use, the CNTs were refluxed in 80% HNO_3 aqueous solution at 140 ^oC for 6 h, washed with deionized water to remove residual HCl, and then dried at 80 ^oC overnight.

The Fe-Mn@CNTs IM was prepared by an impregnation method for comparison. In a typical synthesis, according to the obtained molar percentage of Fe@Mn@CNTs catalysts by the XPS and the weight percentage by TGA analysis, 1.30 mmol of Manganese (II) nitrate hexahydrate, 1.88 mmol of Iron(III) nitrate nonahydrate and 200 mg of CNTs were dispersed in 40 ml deionized water with ultrasonic treatment for 30 min. After that, the mixed solution was dried at 60 ^oC for 20 h under stirring. Finally, the products were calcined in N_2 stream at 450 ^oC for 4 h with a ramping rate of 2 ^oC/min.

Table S1. Texture properties of the catalysts

sample	Specific surface ($m^2\ g^{-1}$) [a]	pore size (nm) [a]	pore volume (cc/g) [a]	metal oxides loading (wt%) [b]
Mn@CNTs	169.4	3.65	0.44	61.3%
Fe@Mn@CNTs	167.0	3.63	0.45	59.0%
Fe@CNTs	177.6	3.83	0.48	59.2%

a. *Determined by N_2 desorption measurements*
b. *Determined by TGA analysis*

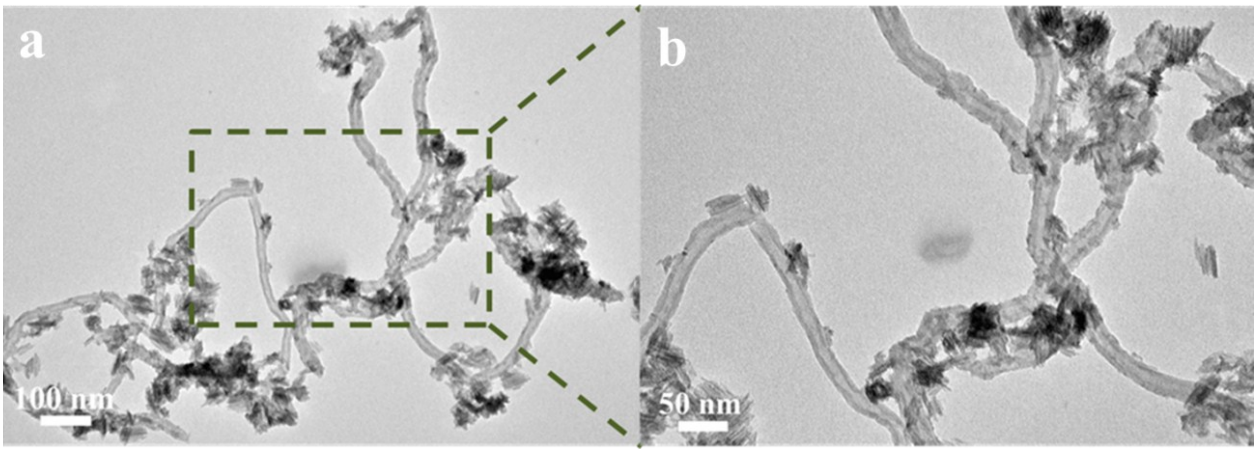

Fig.S1 (a) TEM image and (b) the magnified image of Fe@CNTs.

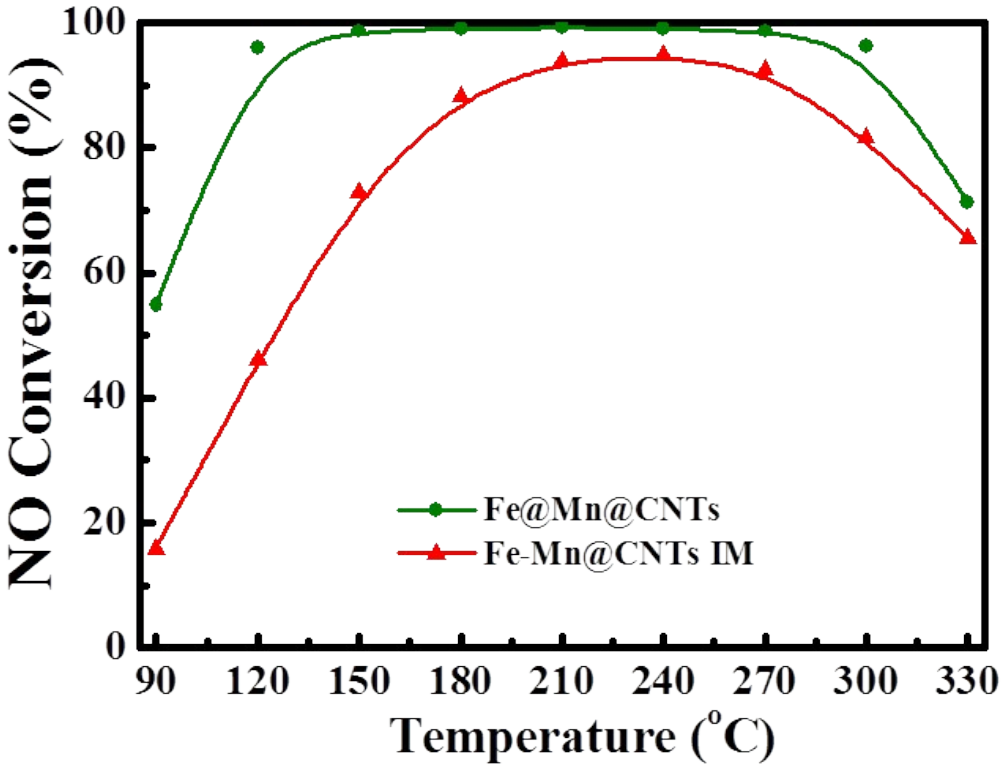

Fig.S2 NH_3-SCR performances of catalysts. *Reaction conditions*: [NH_3] = [NO] =550 ppm, [O_2] =5 vol. %, N_2 as balance gas, GHSV=20000 h^{-1}.

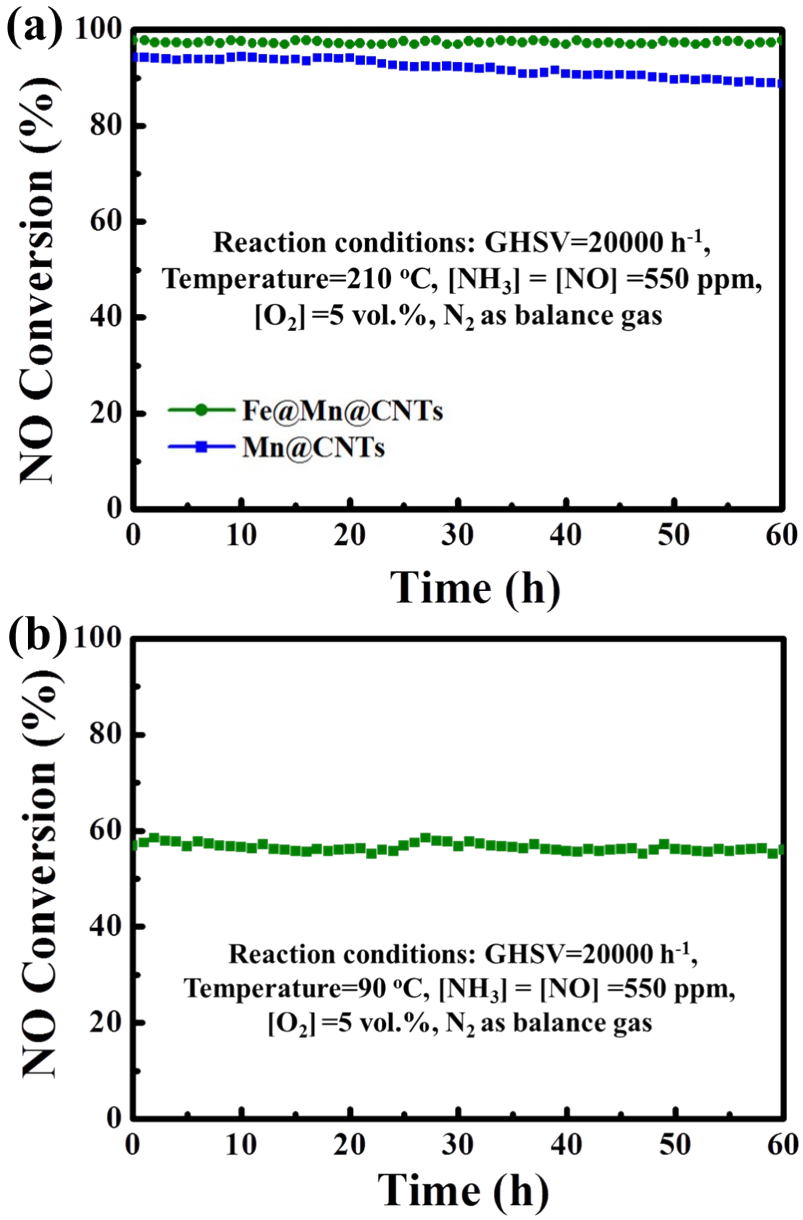

Fig.S3 a) Stability test of the catalysts at 210 °C and b) stability test of Fe@Mn@CNTs at 90 °C.

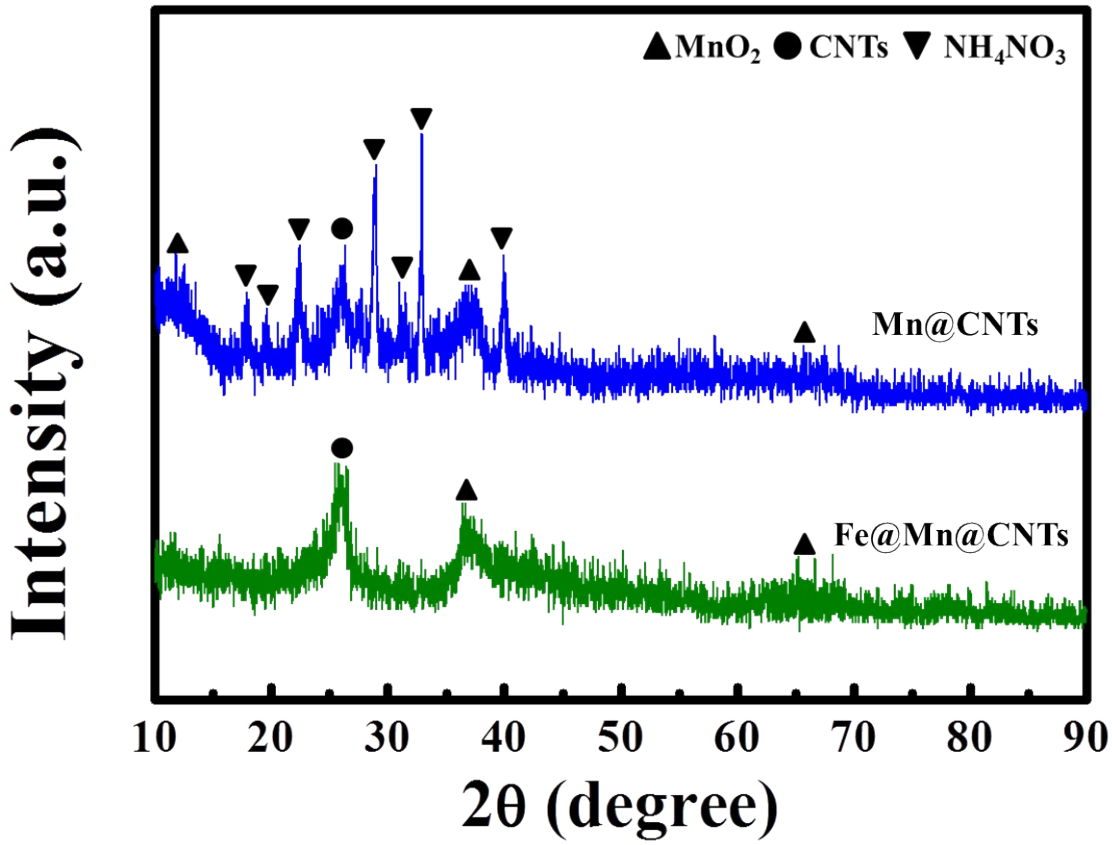

Fig.S4 XRD patterns of the catalysts after the stability test.

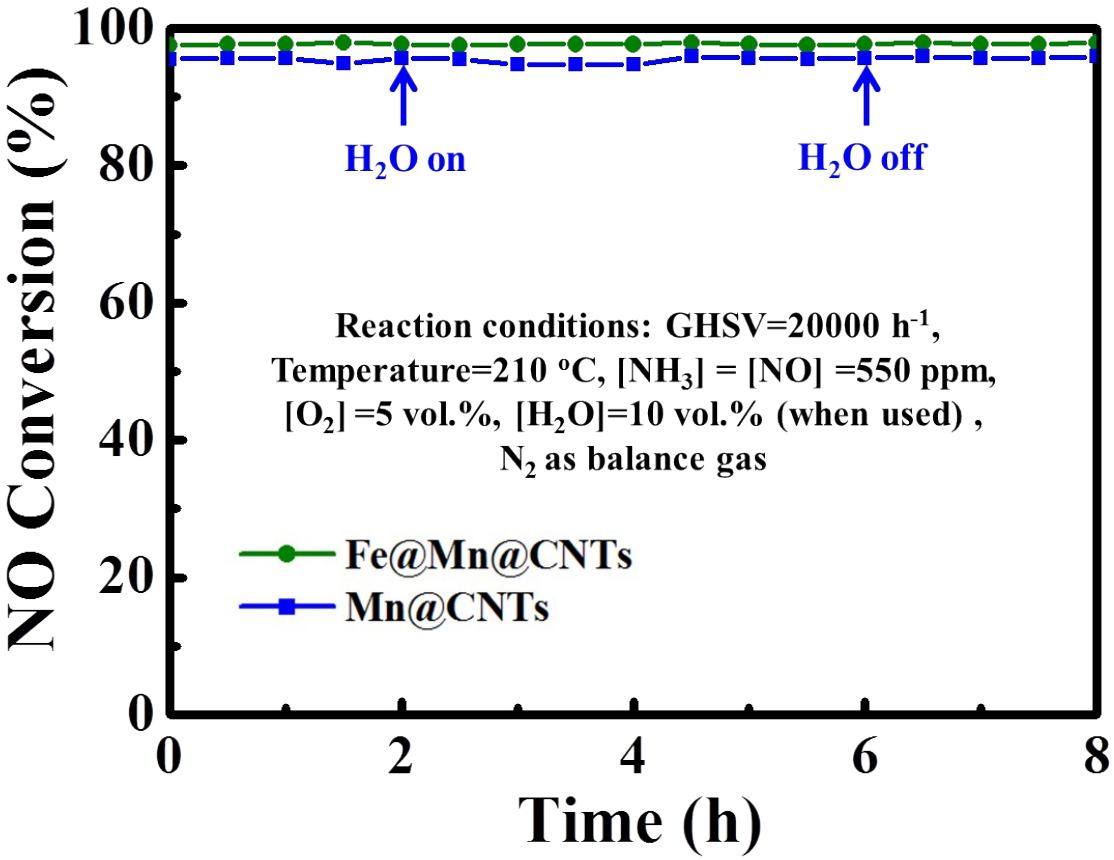

Fig.S5 H_2O resistance test of the catalysts.