Supplementary information

The influence of alkali- treated zeolite on the oxide-zeolite syngas conversion process

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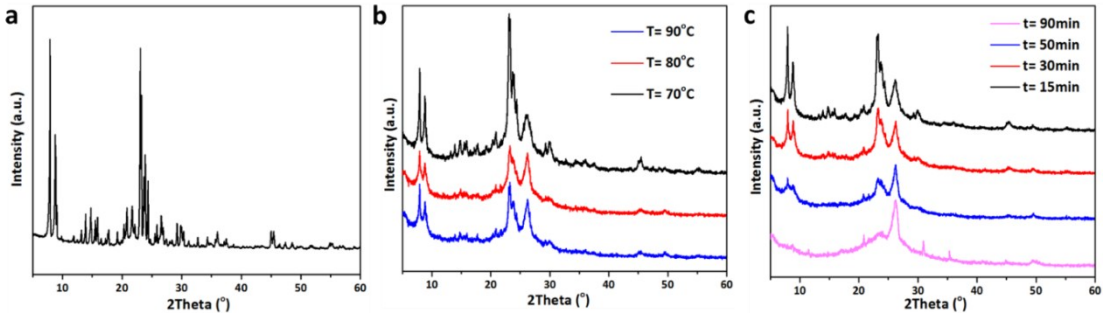

Fig. S1. XRD patterns of ZSM-5 treated at different conditions: (a) parent ZSM-5, (b) ZSM-5 treated with NaOH (0.5 mol L^{-1}) at different temperature for 30 min, (c) ZSM-5 treated with NaOH (0.5 mol L^{-1}) at 80 ^{o}C for different time.

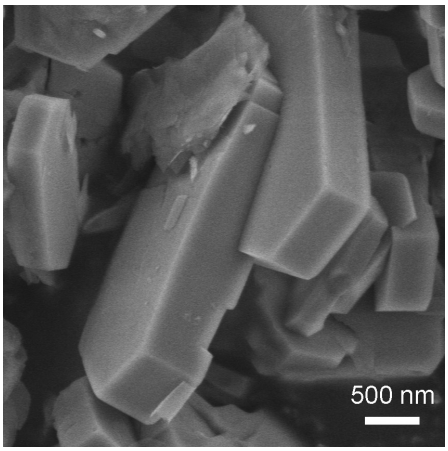

Fig. S2. SEM image of parent ZSM-5.

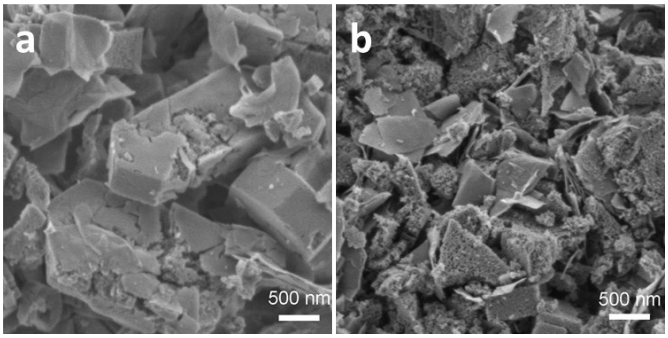

Fig. S3. SEM images of ZSM-5 treated with NaOH (0.5 mol L^{-1}) at (a) 70 ^{o}C and (b) 90 ^{o}C for 30 min.

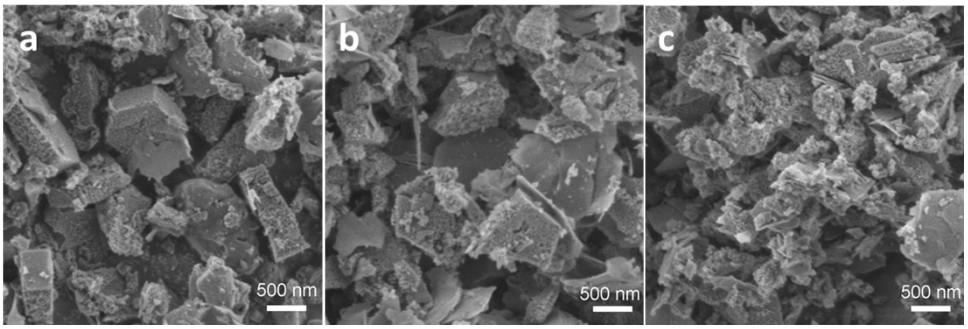

Fig. S4. SEM images of ZSM-5 treated with NaOH (0.5 mol L^{-1}) at 80 ^{o}C for different time (a) 15 min, (b) 50 min and (c) 90 min.

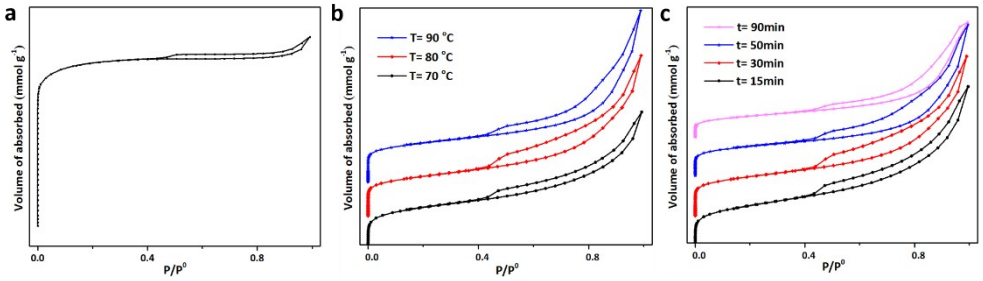

Fig. S5. Nitrogen adsorption-desorption isotherms of ZSM-5 treated at different conditions: (a) parent ZSM-5, (b) ZSM-5 treated with NaOH (0.5 mol L^{-1}) at different temperature for 30 min and (c) ZSM-5 treated with NaOH (0.5 mol L^{-1}) at 80 ^{o}C for different time.

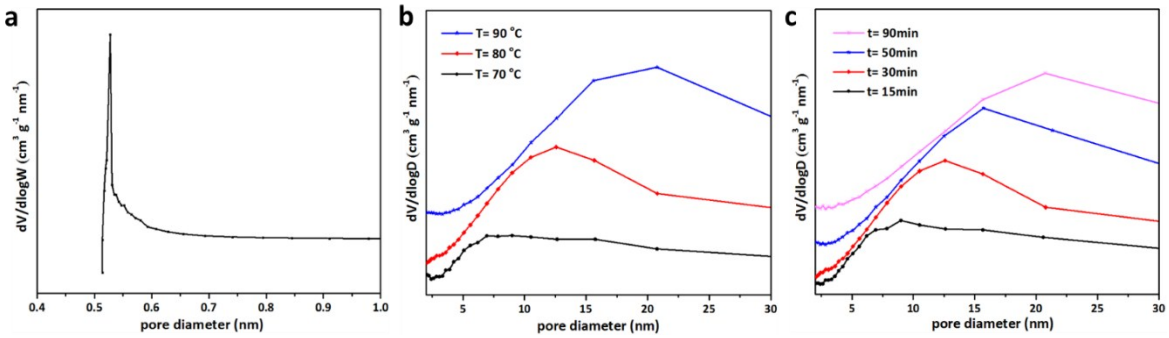

Fig. S6. The pore size distribution of ZSM-5 treated at different conditions: (a) parent ZSM-5, (b) ZSM-5 treated with NaOH (0.5 mol L^{-1}) at different temperature for 30 min, (c) ZSM-5 treated with NaOH (0.5 mol L^{-1}) at 80 ^{o}C for different time.

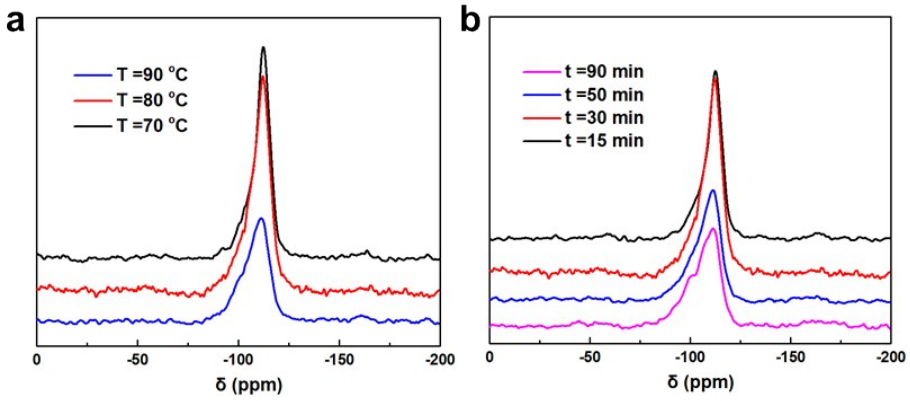

Fig. S7. ^{29}Si MAS NMR spectra of ZSM-5 treated at different conditions: (a) ZSM-5 treated with NaOH (0.5 mol L^{-1}) at different temperature for 30 min, (b) ZSM-5 treated with NaOH (0.5 mol L^{-1}) at 80 ^{o}C for different time.

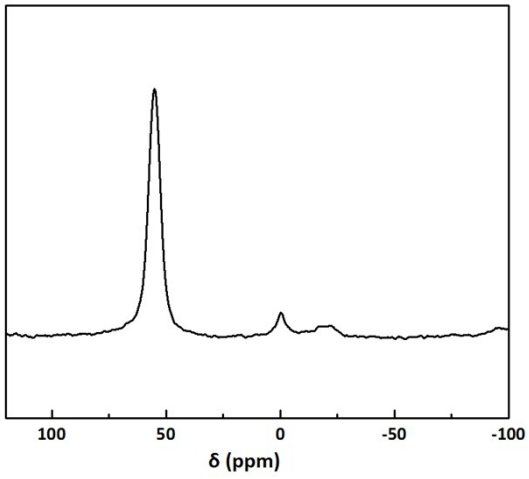

Fig. S8. ^{27}Al MAS NMR spectra of parent ZSM-5.

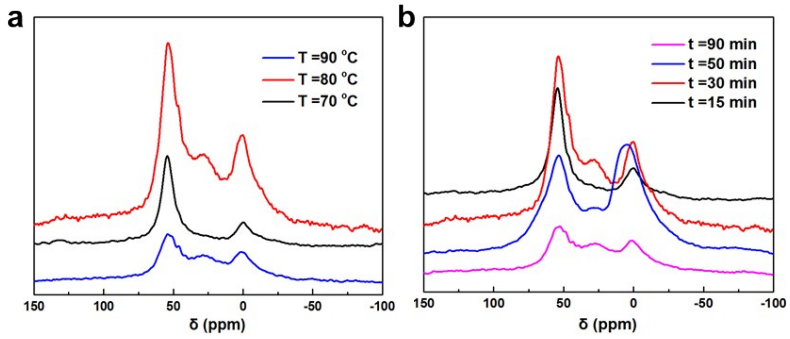

Fig. S9. ^{27}Al MAS NMR spectra of ZSM-5 treated at different conditions: (a) ZSM-5 treated with NaOH (0.5 mol L^{-1}) at different temperature for 30 min, (b) ZSM-5 treated with NaOH (0.5 mol L^{-1}) at 80 ^{o}C for different time.

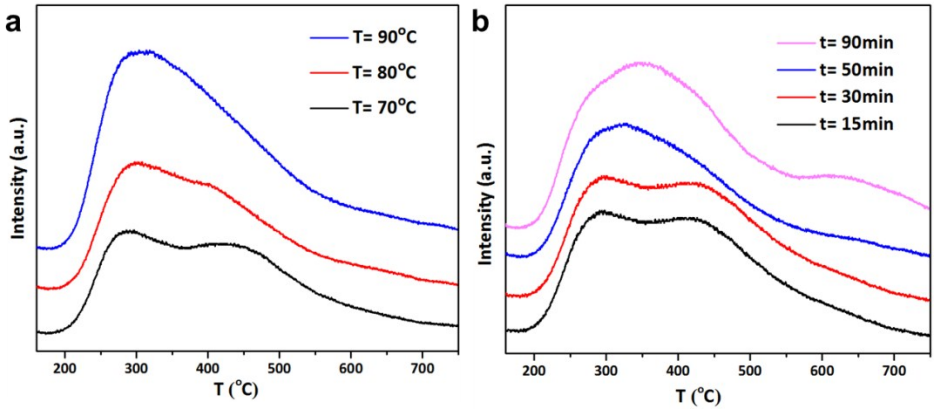

Fig. S10. NH_3-TPD spectra of ZSM-5 treated at different conditions: (a) ZSM-5 treated with NaOH (0.5 mol L^{-1}) at different temperature for 30 min and (b) ZSM-5 treated with NaOH (0.5 mol L^{-1}) at 80 ^{o}C for different time.

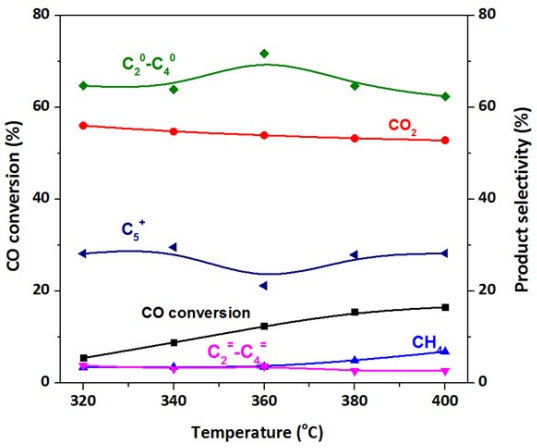

Fig. S11. The CO conversion and product selectivity of syngas conversion at different reaction temperature for composite catalyst containing Zn-Cr oxide and parent ZSM-5.

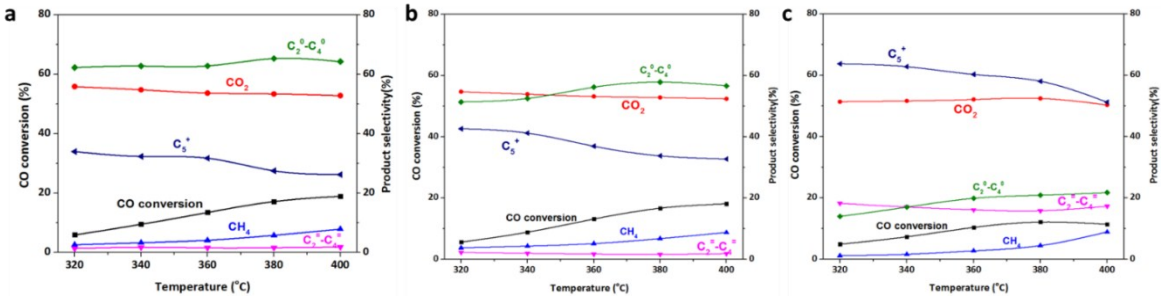

Fig. S12. The CO conversion and product selectivity of syngas conversion at different reaction temperature for composite catalyst containing Zn-Cr oxide and ZSM-5 treated by NaOH with different concentrations at 80 °C for 30 min: (a) 0.1 mol L^{-1}, (b) 0.2 mol L^{-1} and (c) 1.0 mol L^{-1}.

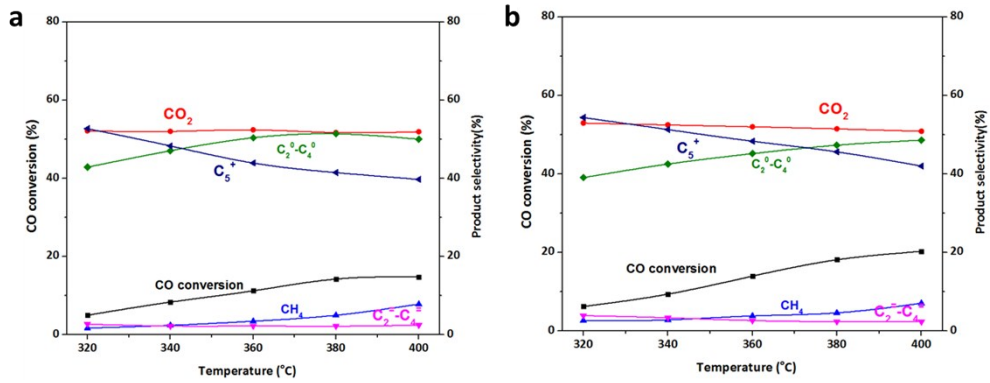

Fig. S13. The CO conversion and product selectivity of syngas conversion at different reaction temperature for composite catalyst containing Zn-Cr oxide and ZSM-5treated with NaOH (0.5 mol L^{-1}) at different temperature for 30 min: (a) 70 °C and (b) 90 °C.

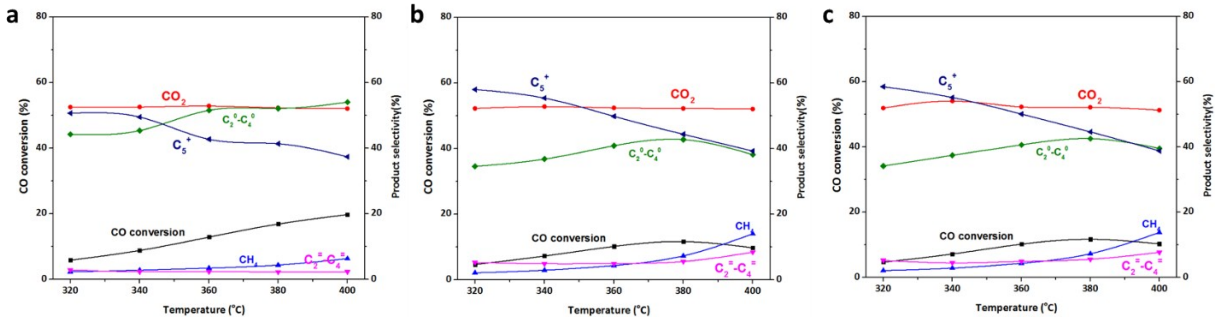

Fig. S14. The CO conversion and product selectivity of syngas conversion at different reaction temperature for composite catalyst containing Zn-Cr oxide and ZSM-5 treated with NaOH (0.5 mol L^{-1}) at 80 °C for different time: (a) 15 min, (b) 50 min and (c) 90 min.

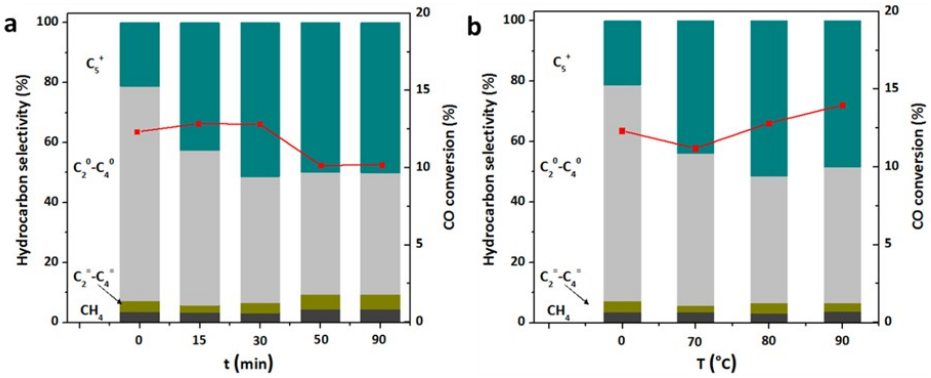

Fig. S15. Hydrocarbon selectivity and CO conversion of syngas conversion at 360 °C for composite catalyst containing Zn-Cr oxide and ZSM-5: (a) treated with NaOH (0.5 mol L^{-1}) at different tempreture for 30 min and (b) treated with NaOH (0.5 mol L^{-1}) at 80 °C for different time.

Table S1. The product distribution of liquid phase for composite catalyst containing Zn-Cr oxide and ZSM-5 treated with NaOH (0.5 mol L^{-1}) at 80 ^{o}C for 30 min.

Main product	Content
Toluene	1.18%
p-xylene	11.52%
o-xylene	3.61%
m-trimethylbenzene	34.94%
0-trimethylbenzene	3.22%
tetramethylbenzene	20.14%
O-methyl ethyl benzene	2.26%
O-dimethyl ethyl benzene	1.23%
pentamethylbenzene	3.12%
Others	18.78%

Table S2 The acid strength distribution of NaZSM-5 and HZSM-5 zeolite.

sample	Medium acid / mmol g^{-1}	Strong acid / mmol g^{-1}	Total acid /mmol g^{-1}	M/S acid	150 ^{o}C		
					B acid /mmol g^{-1}	L acid /mmol g^{-1}	B/L
HZSM-5	0.12	0.25	0.37	0.48	0.39	0.34	1.16
NaZSM-5	0.26	0.11	0.37	2.34	0.06	0.37	0.16