

**Research on Performance and Mechanism of the NH₃-SCR
Reaction over Fly Ash-derived Mn-Ce/Zeolite X.**

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Details of Optimal Synthesis:

We focused on the effects of NaOH/CFA, Si/Al molar ratio, crystallization temperature and time on the synthesis of zeolite X. Figure S1 (a) shows that the zeolite with a NaOH/CFA of 1.2 had the biggest intensity diffraction lines, while the small diffraction lines were disappeared, consistent with the SEM micrographs. It is observed from the figure that zeolite with faujasite structure was well dispersed and composed of less impurities. It is also seen that the zeolite obtained at Si/Al of 2.4 has the best performance (Fig. S1(b)). Crystallization temperature and time also affect the nucleation process and morphology of zeolites. The results of characterization are shown in Fig. S1 (c), (d). The pretreatment sample synthesized at 90°C for 18 h to obtain the pure phase of zeolite X. It is worth noting that excessively long reaction time can also lead to transformation of phase structure.

The chemical compositions of different samples determined by XRF are presented in Table S1. It can be seen that the impurity elements of CFA-derived zeolite X were reduced and the composition was similar to that of commercial zeolite X.

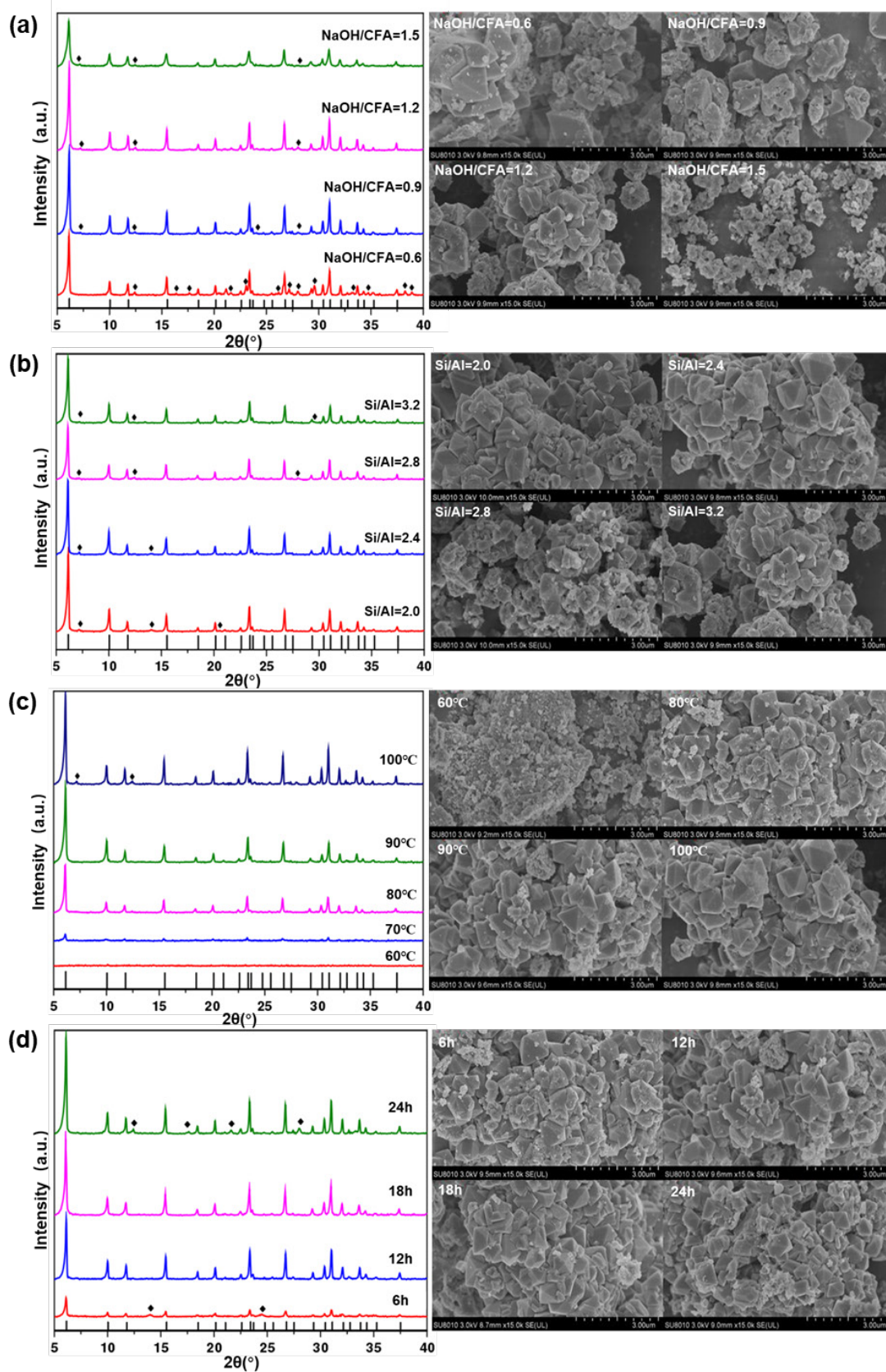


Fig. S1. XRD patterns and SEM micrographs of CFA-derived zeolite X under different synthesis conditions, including (a) $x\text{NaOH/CFA}$ ($x=0.6, 0.9, 1.2, \text{ and } 1.5$), (b) $y\text{Si/Al}$ ($y=2.0, 2.4, 2.8, \text{ and } 3.2$), (c) synthesis temperature ($60\text{-}100^\circ\text{C}$), and (d) synthesis time ($6\text{-}24\text{ h}$)

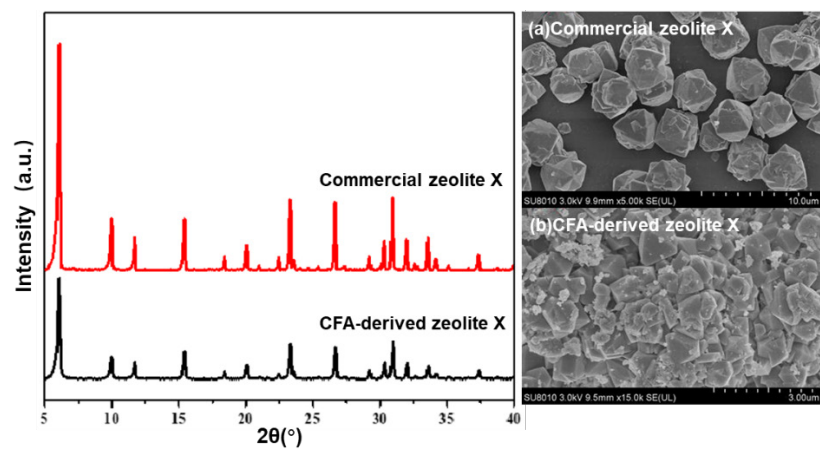


Fig. S2. Morphology and Structure of (a) commercial zeolite X and (b) CFA-derived zeolite X.

Table S1 Elemental composition of CFA and its pretreatment product (10%HCl), CFA-derived zeolite X, and commercial zeolite X

Element	Coal fly ash (CFA, %)	Preprocessed CFA (10% HCl, %)	Zeolite X (CFA, %)	Zeolite X (Commercial, %)
SiO ₂	44.66	59.77	46.93	55.45
Al ₂ O ₃	26.24	25.21	28.16	31.91
CaO	10.36	2.42	1.01	0.60
Fe ₂ O ₃	8.97	5.35	1.88	0.11
Na ₂ O	0.76	0.66	19.97	11.69