

Article

Efficient Synthesis of Mesoporous Nano ZSM-5 Zeolite Crystals without a Mesoscale Template

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Abstract: Hierarchical zeolites attract people's attention due to their enhanced mass transfer properties in catalytic reactions. The research over obtaining these zeolites in green and efficient methods is of great significance for the current post-treatments and templating strategies tend to be costly for hierarchical zeolite synthesis. In this research, nanosized mesoporous ZSM-5 (SN-ZSM-5) zeolites have been synthesized without the addition of mesoscale templates under highly concentrated conditions. The physicochemical characteristics were systematically investigated by XRD, SEM, N₂ sorption, TEM, and NMR. The SEM images showed ZSM-5 crystals with sizes between 50–110 nm were obtained. N₂ sorption and high-resolution TEM images gave direct evidence for the hierarchical structure of SN-ZSM-5. The forming mechanism for the hierarchical structure was proposed that the etching effect of the highly alkaline environment for the starting gels played a critical role in the formation of hierarchical structure. Catalytic tests in methanol-to-olefins (MTO) showed the SN-ZSM-5 performed a longer catalyst lifetime and higher propylene selectivity than the conventional ZSM-5 zeolites (C-ZSM-5) obtained from a traditional hydrothermal method. The features of hierarchical structure in the SN-ZSM-5 crystals and the sustainability for synthesis method could show a promising choice for wide applications of these SN-ZSM-5 zeolites in the future.

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Supporting Information

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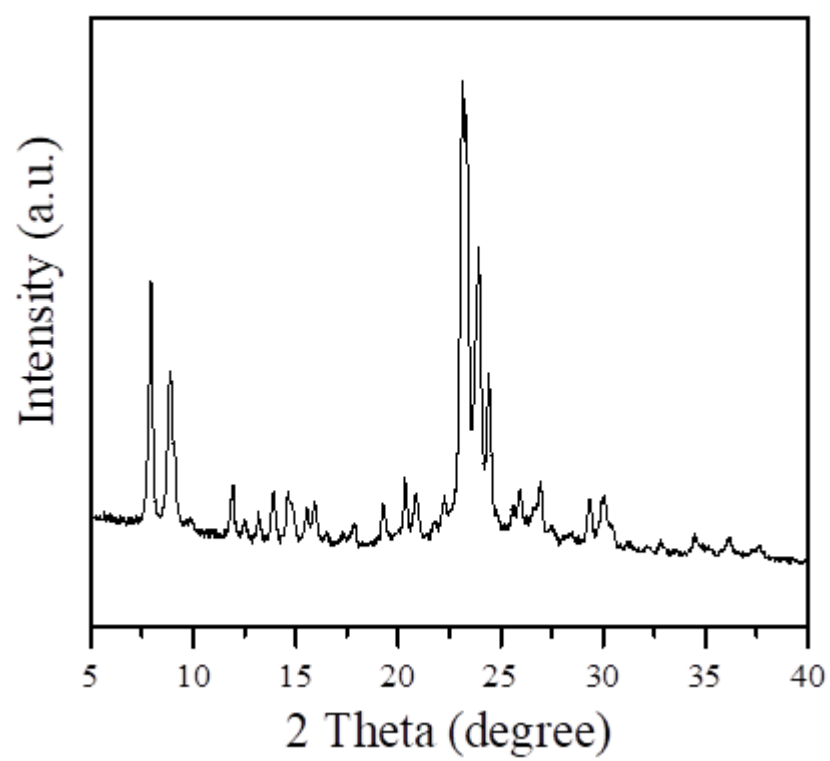


Figure S1. XRD pattern of C-ZSM-5.

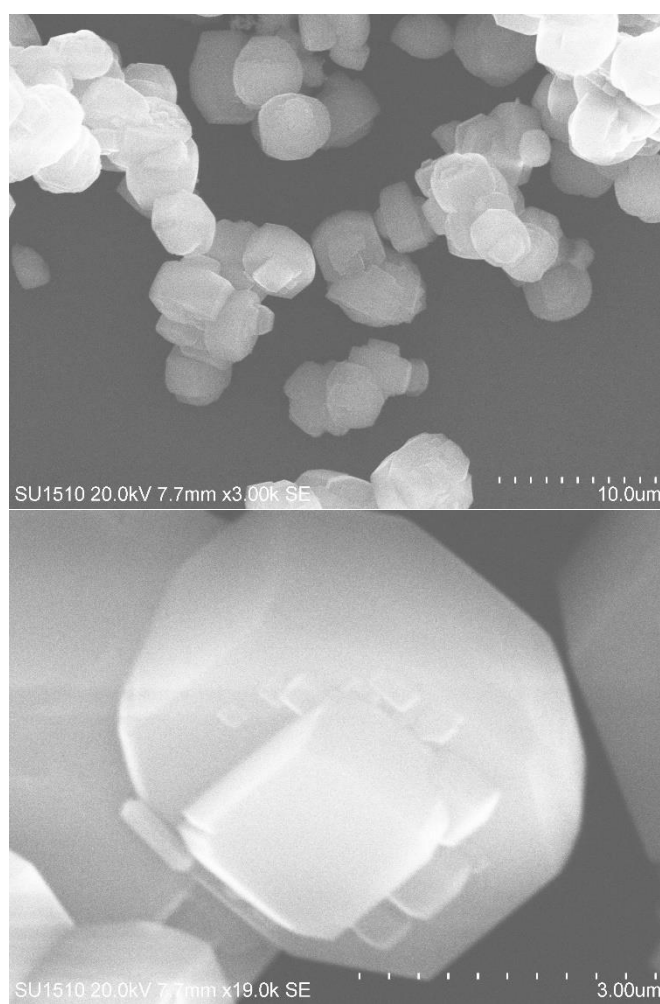


Figure S2. SEM images of C-ZSM-5.

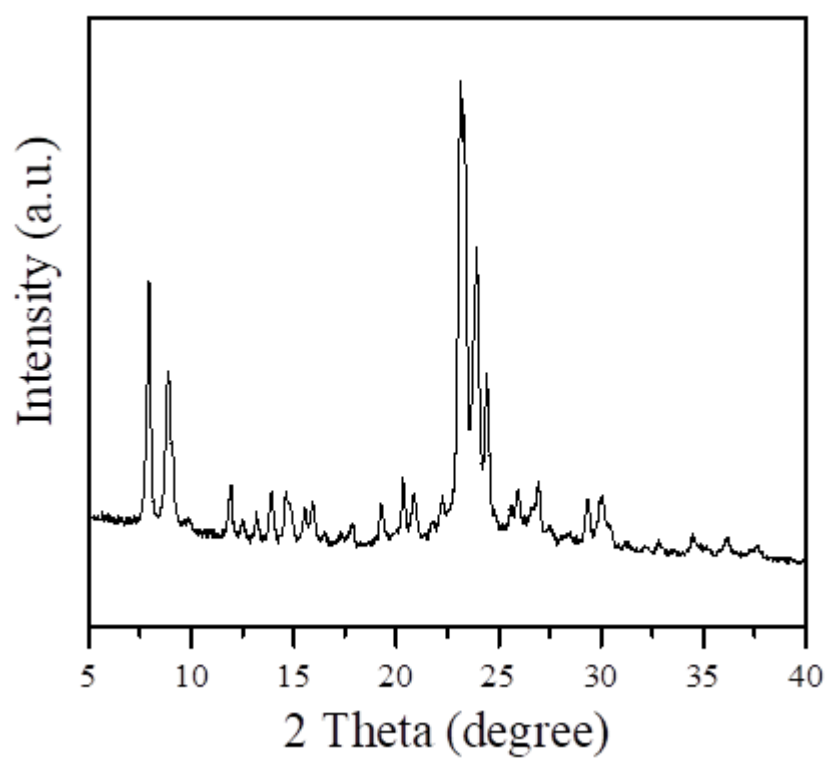


Figure S3. N₂ sorption isotherms of C-ZSM-5.

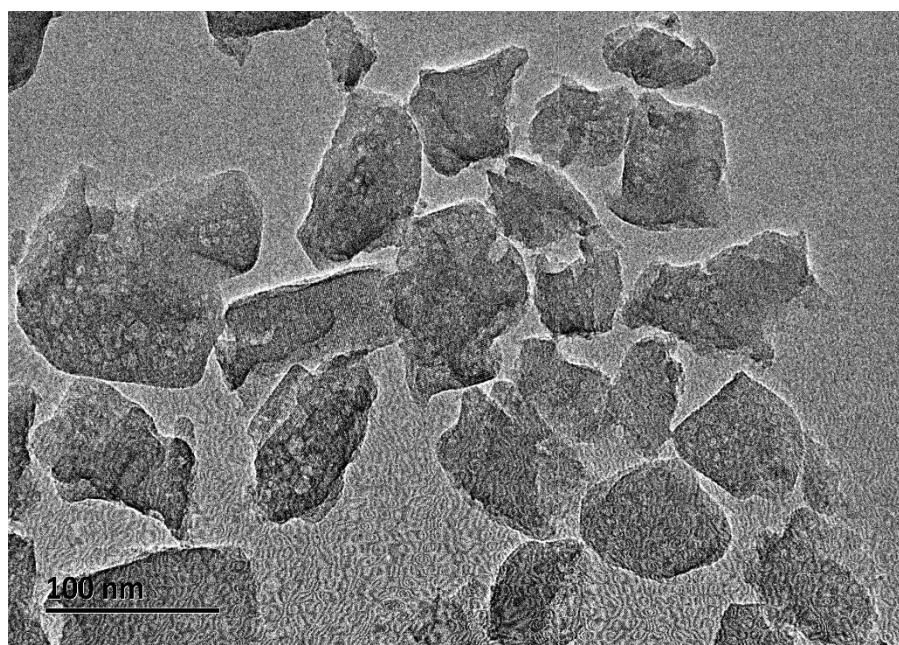


Figure S4. A TEM image of SN-ZSM-5 with different magnification compared with figure 1d.

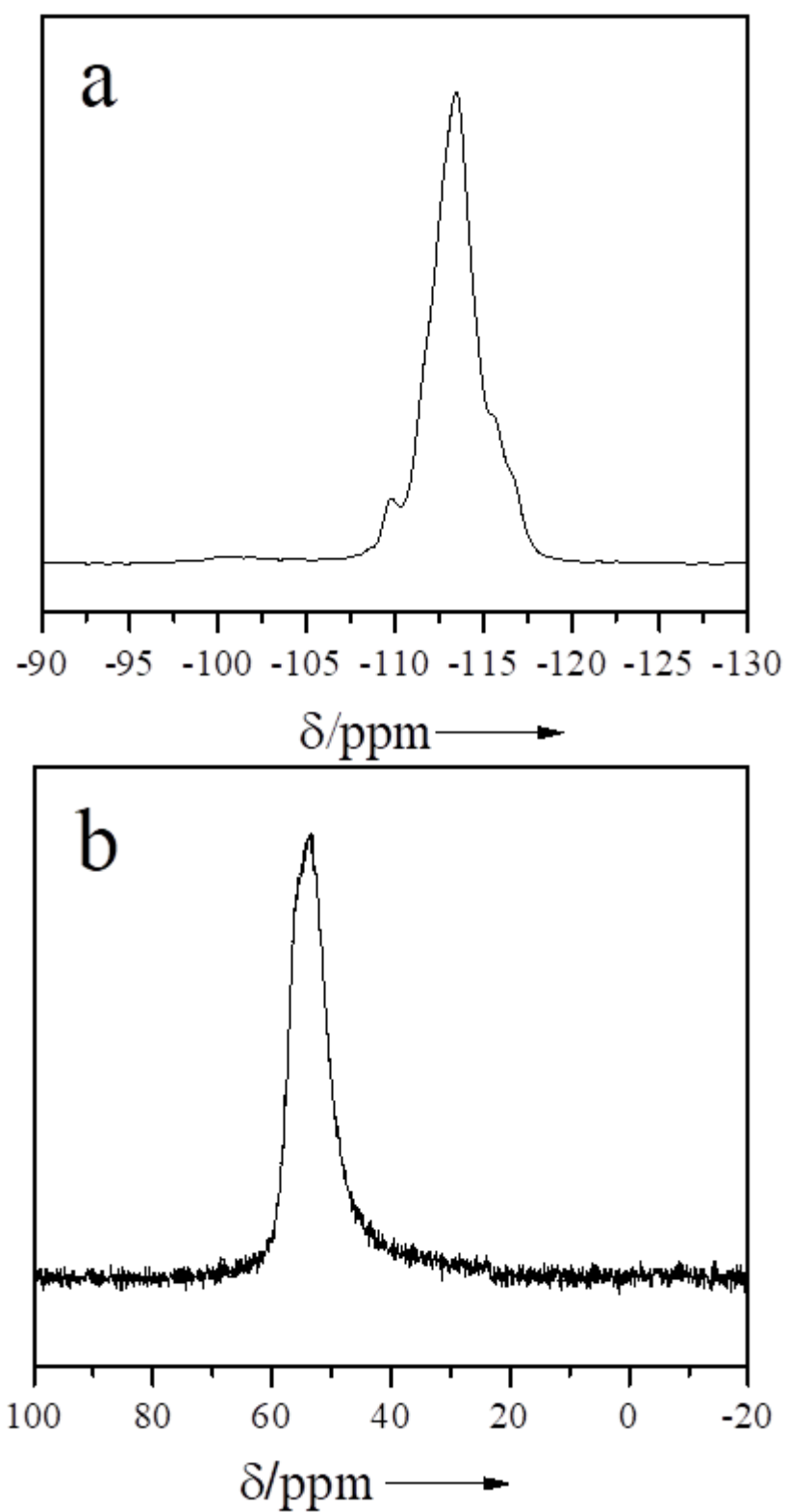


Figure S5. (a) ^{29}Si , and (b) ^{27}Al MAS NMR spectrum of C-ZSM-5 samples.

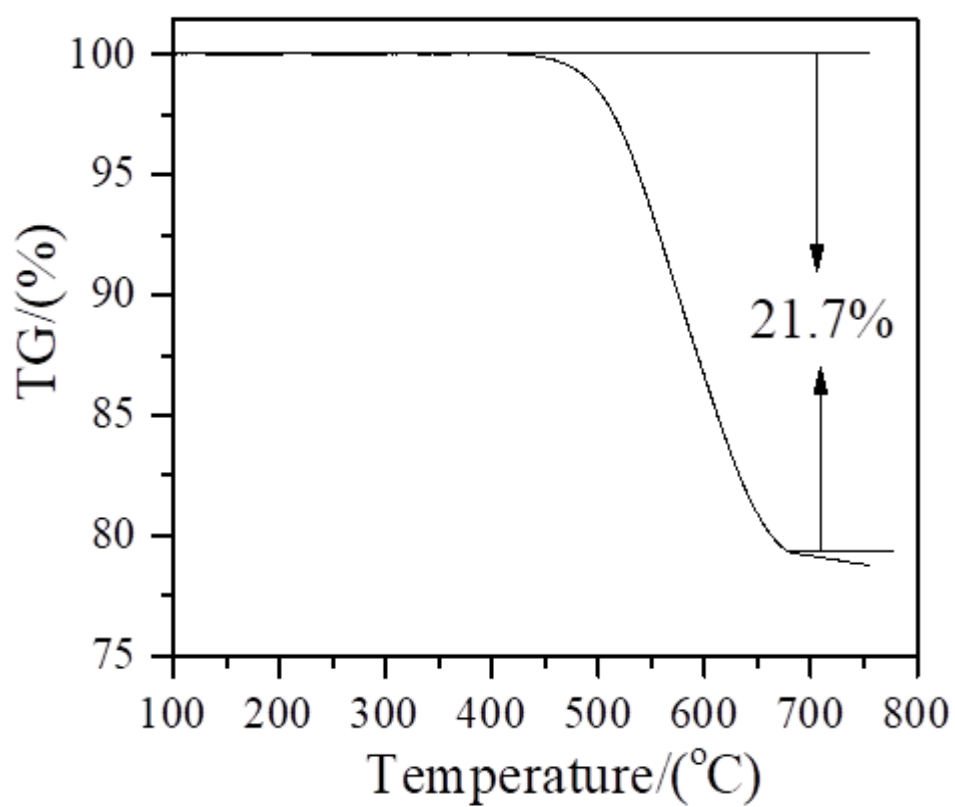


Figure S6. TG curve of deactivated SN-ZSM-5 catalysts.

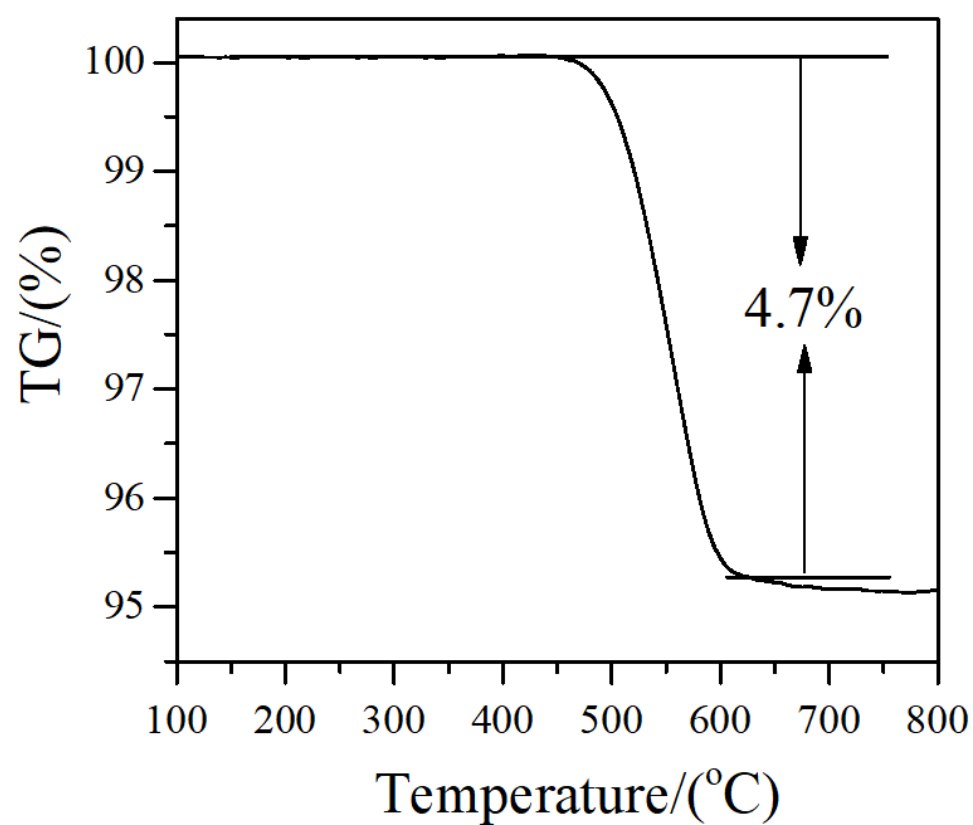


Figure S7. TG curve of deactivated C-ZSM-5 catalysts.

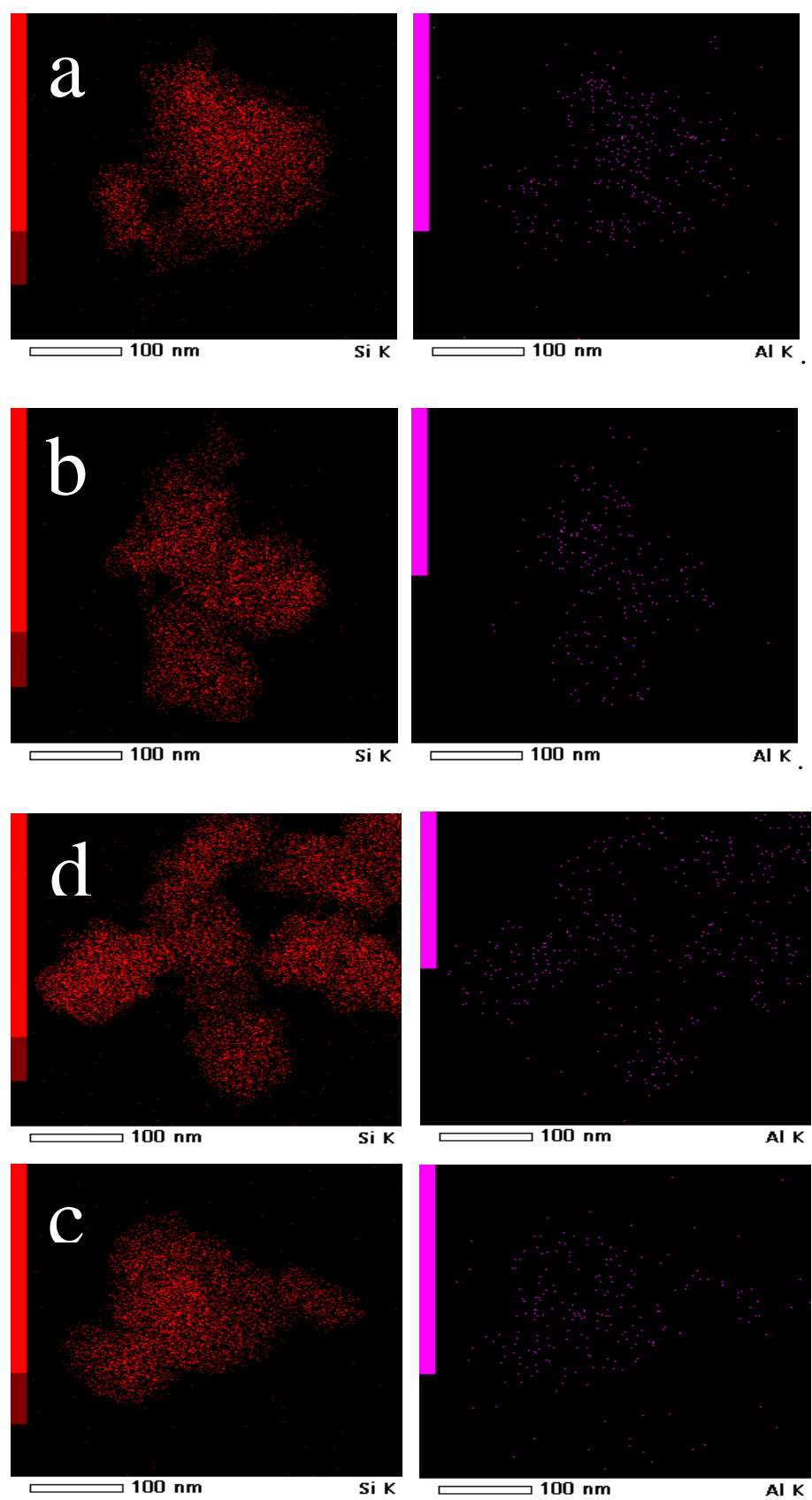


Figure S8. Element mapping images of SN-ZSM-5 with crystallization time at (a) 0, (b) 90, (c) 110 and (d) 240 min.

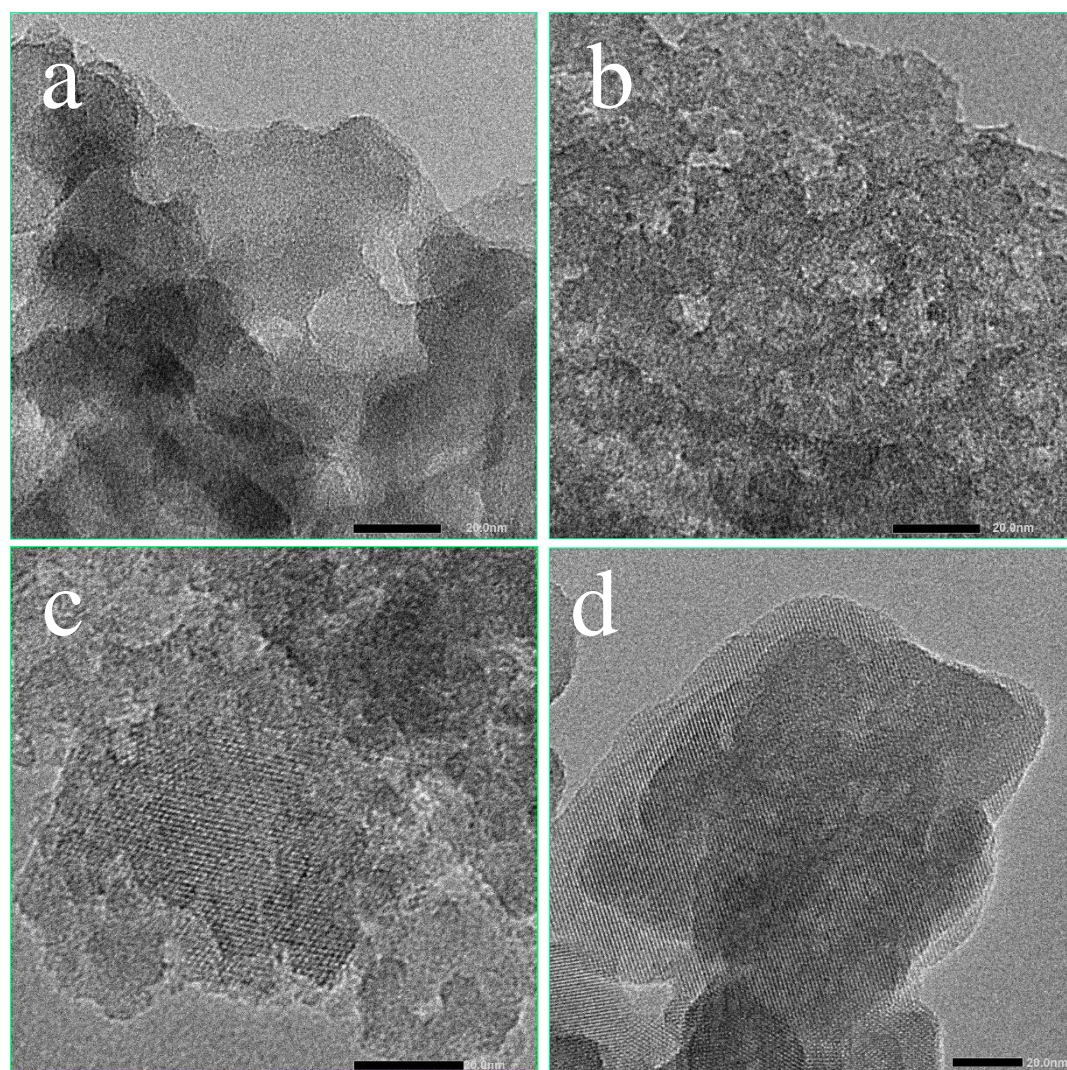


Figure S9. HR-TEM images of SN-ZSM-5 synthesized with different crystallization time at (a) 0, (b) 60, (c) 110, and (d) 240 min.

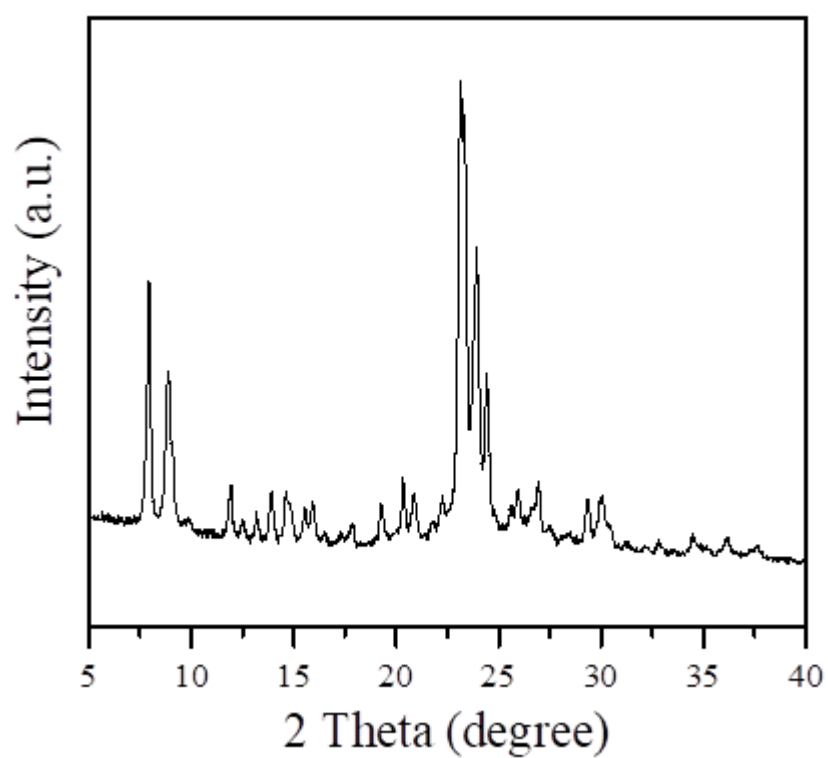


Figure S10. XRD pattern of ZSM-5 (calcined) synthesized with $\text{H}_2\text{O}/\text{SiO}_2$ ratio at 26.

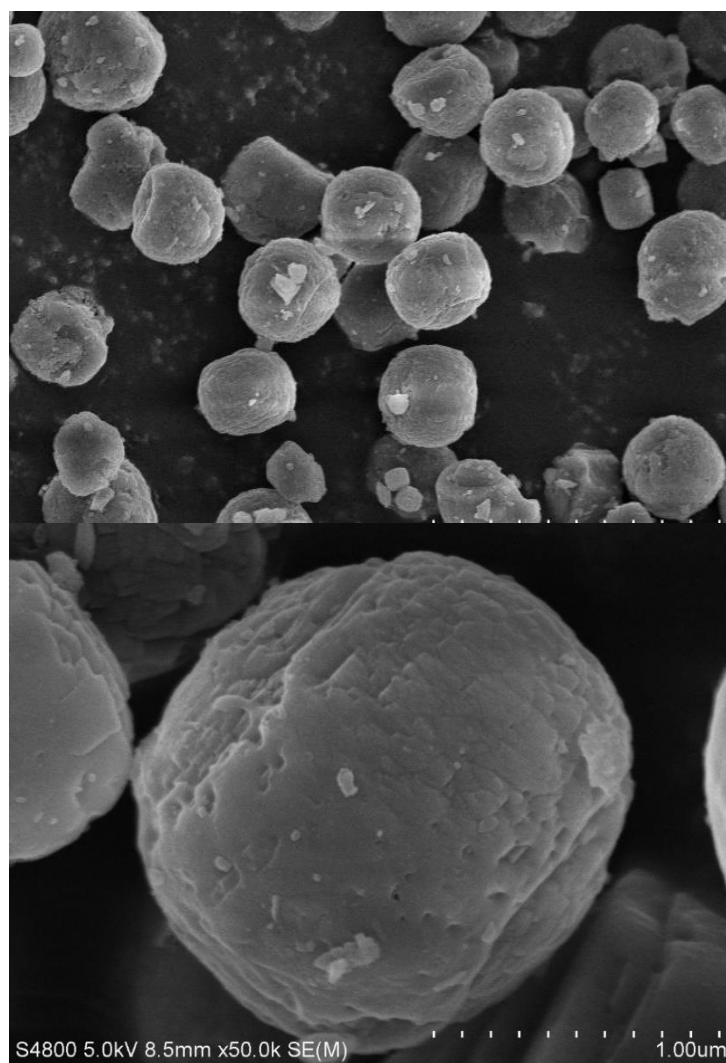


Figure S11. SEM images of ZSM-5 zeolite synthesized with $\text{H}_2\text{O}/\text{SiO}_2$ ratio at 26.

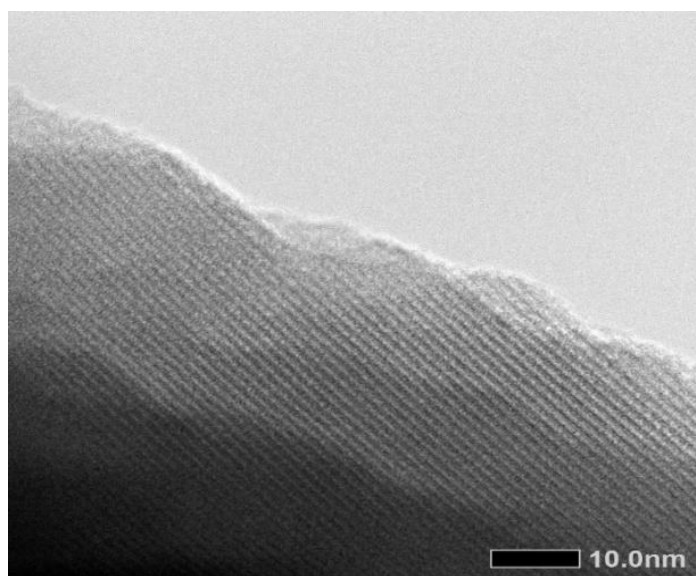
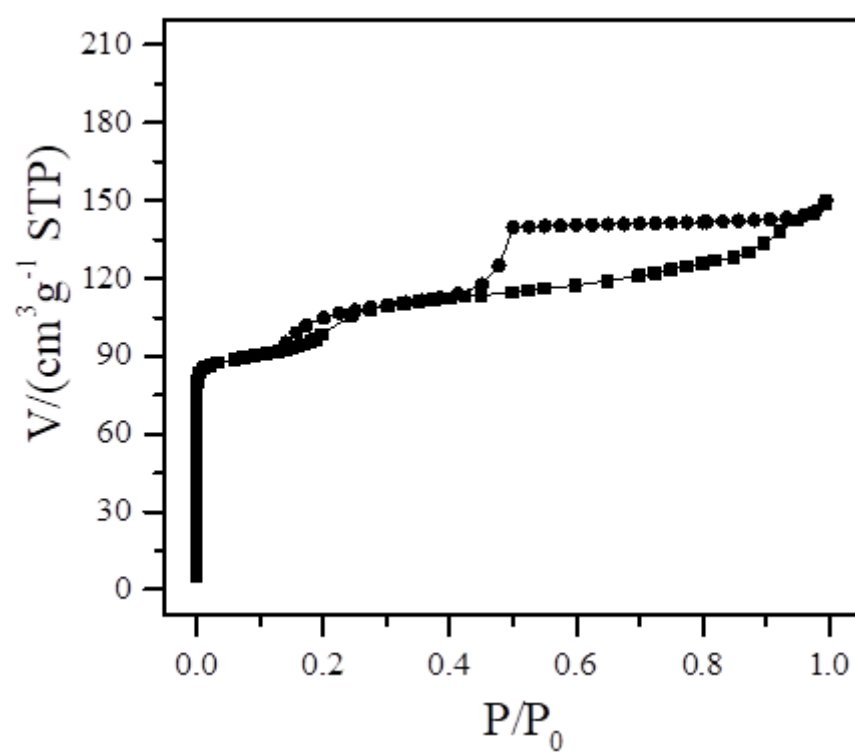


Figure S12. N_2 sorption isotherms and TEM image of ZSM-5 synthesized with $\text{H}_2\text{O}/\text{SiO}_2$ ratio at 26.