Electronic Supplementary Information

Synthesis and crystal growth mechanism of nanosheet ZSM-22 zeolite

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1. Experimental section

ZSM-22 zeolites with different SiO_2/Al_2O_3 molar ratios were hydrothermally synthesized using Ludox (40wt % SiO_2 in water), NaOH (96wt %), $NaAlO_2$ (35wt % Na_2O, 43wt % Al_2O_3), 1-ethylpyridinium bromide (99wt %, SDA) and distilled water as source materials. The molar composition of the gel is 1 SiO_2 : 1/x Al_2O_3 : 0.075 Na_2O : 0.25 R : 18 H_2O, where x=100, 200, 300, and 400, respectively. The starting gels with identical compositions were transformed into stainless steel autoclaves (50 mL), and crystallized dynamically (20 rpm) at 423K for 3 days. After crystallization, the autoclaves were cooled and the solid products were separated by filtration, washed and dried. The organic template was removed by calcination at 550 °C for 5 h in air. Needle-like ZSM-22 zeolite was synthesized according to reference 18.

2. Characterization

X-ray powder diffraction (XRD) patterns were recorded on a D8 Advance SS X-ray diffractometer using CuKα radiation at 40 kV and 40 mA. The data was collected from 2° to 50° with a sampling interval of 0.020° at a scanning rate of 5°/min. The crystallinity of the product was calculated by comparison of the integrated area of selected peaks (five main peaks assigned to the (110), (021), (131), (330), and (400) reflections) with that of physical mixtures of the amorphous phase withdrawn at the beginning of the synthesis and well-crystallized ZSM-22 zeolite product. Scanning electron microscopy (SEM) images were taken on a field emission XL30E scanning electron microscopy (FEI Company). Transmission electron microscopy (TEM) images were performed using Tecnai G^2 20 S-TWIN electron microscopy (FEI Company). Surface areas and pore volumes were obtained from N_2 adsorption/desorption isotherms using multipoint BET and t-plot methods. Prior to analysis, each sample was degassed under vacuum at 350 °C for 10 h. The experiments were performed on a

Micromeretic ASAP2020M physisorption apparatus at liquid nitrogen temperature of -196 °C. The SiO_2/Al_2O_3 molar ratios of all samples were quantified by inductively coupled plasma (ICP) on a Varian 725-ES instrument. The X-ray photoelectron spectroscopy (XPS) analyses were performed on a Kratos Axis Ultra DLD spectrometer (Kratos Analytical, UK) equipped with a non-mono-chromatised magnesium X-ray source.

Table S1 N_2 adsorption characterization results of nanosheet and needle-like ZSM-22 zeolites.

Samples [a]	S_{BET} (m^2/g) [b]	S_{micro} (m^2/g) [c]	S_{ext} (m^2/g) [c]	V_{micro} (cm^3/g) [c]
Nanosheet-48h	52	5	47	0.002
Nanosheet-54h	38	10	28	0.004
Nanosheet-60h	78	29	49	0.013
Nanosheet-66h	243	196	47	0.091
Nanosheet-72h	247	188	59	0.087
Needle-like	196	164	32	0.076

[a] synthesized with different crystallization time, [b] BET method, [c] *t*-plot method

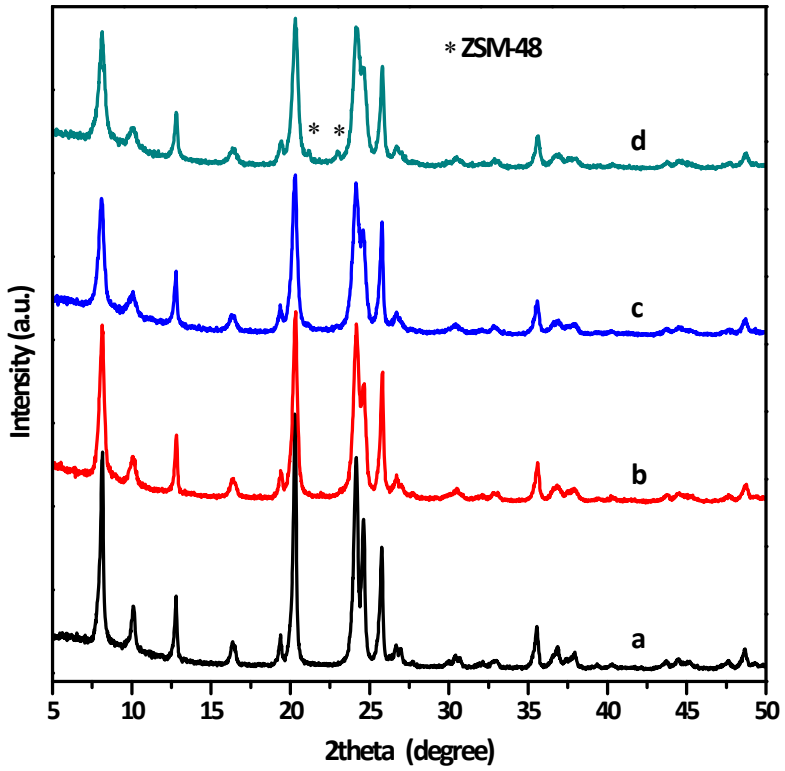

Fig. S1 XRD patterns of ZSM-22 zeolite synthesized with different SiO_2/Al_2O_3 ratios of a) 100, b) 200, c) 300 and d) 400.

Table S2 Texture properties of ZSM-22 zeolites synthesized with different SiO_2/Al_2O_3 molar ratios

Sample [a]	SiO_2/Al_2O_3		S_{BET} [b]	S_{micro} [c]	S_{ext} [c]	V_{micro} [c]	Average thickness
	Gel	ICP analysis	(m^2/g)	(m^2/g)	(m^2/g)	(cm^3/g)	(T nm) [d]
1	100	104	206	188	18	0.087	50
2	200	198	247	188	59	0.087	12
3	300	317	251	190	61	0.089	10
4	400	414	252	186	66	0.086	8

[a] Synthesized through hydrothermal crystallization under rotation (20 rpm) at 423 K for 3 days, with starting molar composition of 1 SiO_2 : 1/x Al_2O_3 : 0.075 Na_2O : 0.25 R : 18 H_2O, where x=100, 200, 300, and 400, respectively.
[b] BET method, [c] *t*-plot method, [d] determined by SEM and TEM.