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# Supplementary Information

## Reducing the dosage of the organic structure-directing agent in the crystallization of pure silica zeolite MFI (silicalite-1) for the volatile organic compounds (VOCs) adsorption

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# Content

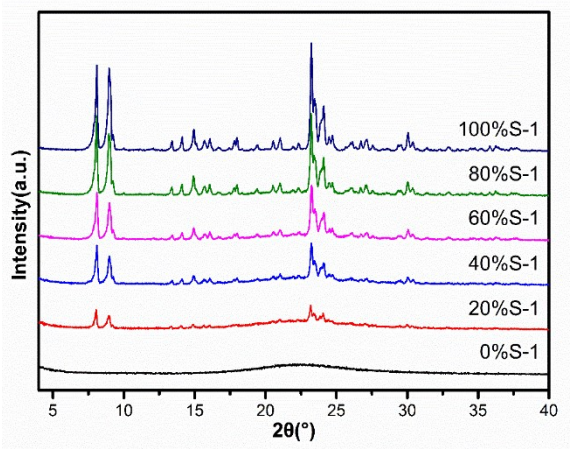


**Fig. S1** Experimental XRD patterns of the sample containing 0, 20, 40, 60, 80, and 100% standard silicalite-1 in amorphous silica.

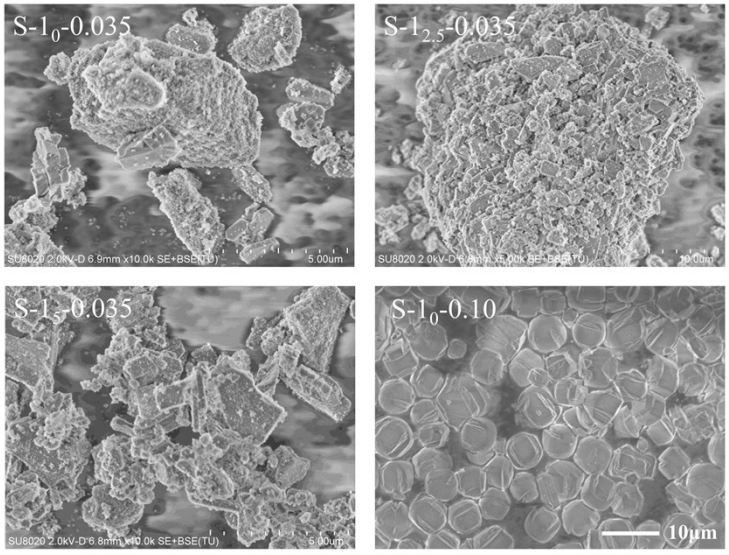


**Fig. S2** SEM images of silicalite-1 crystallized from the initial reaction mixture with a $TPA^+/SiO_2$ ratio of 0.035 and seed loading of 0, 2.5, and 5 wt.% respecting to $SiO_2$ and a $TPA^+/SiO_2$ ratio of 0.10 without seed.

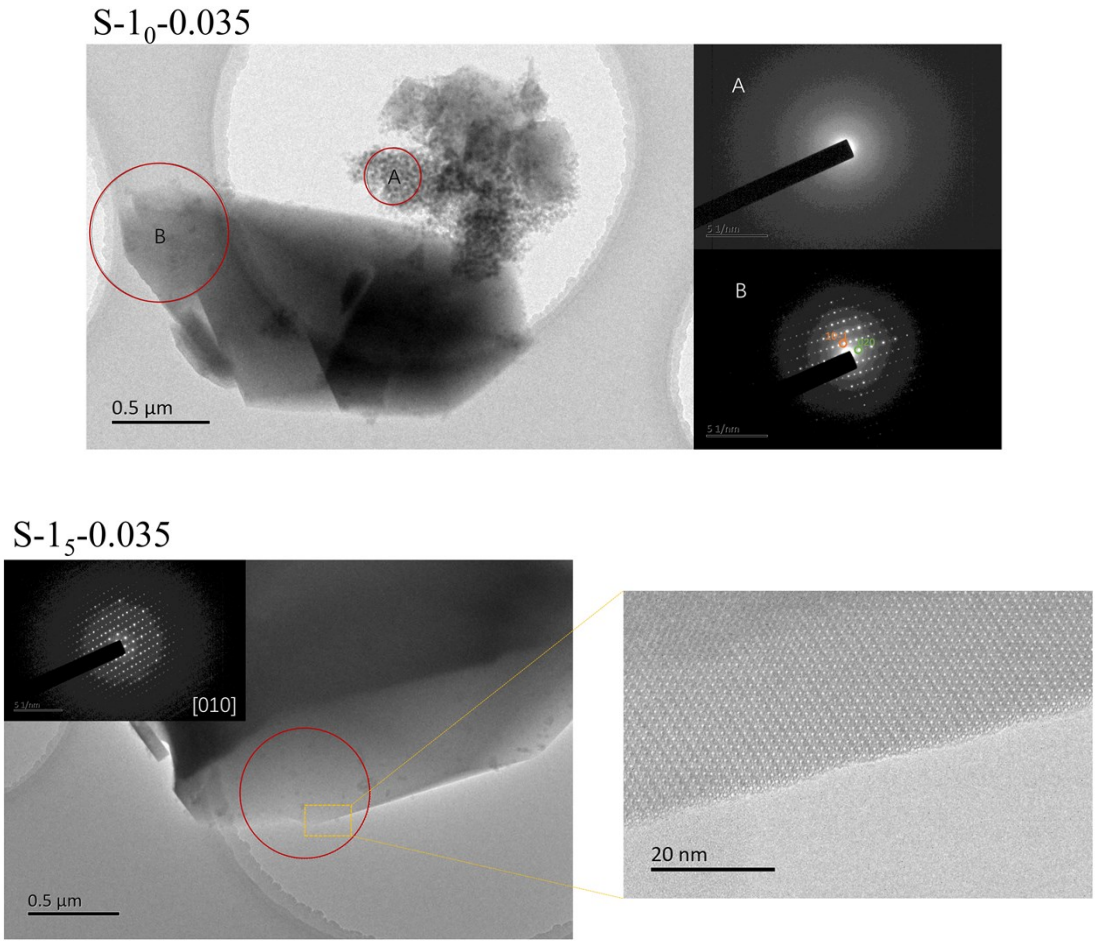


**Fig. S3** HRTEM images and selected area electron diffraction (SAED) of silicalite-1 crystallized from the initial reaction mixture with a $TPA^+/SiO_2$ ratio of 0.035 and seed loading of 0, and 5 wt.% respecting to $SiO_2$.

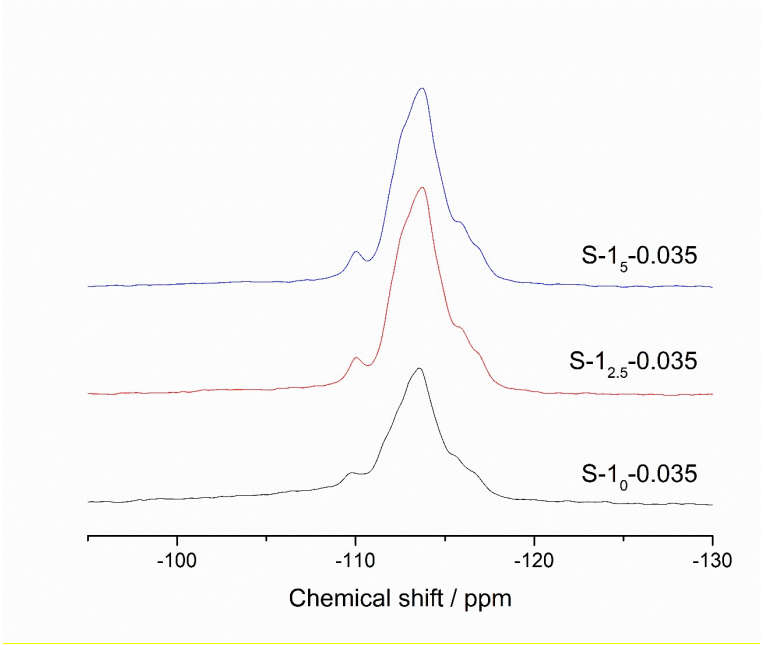


**Fig. S4** Solid-state $^{29}$Si MAS NMR spectra of silicalite-1 crystallized from the initial reaction mixture with a $TPA^+/SiO_2$ ratio of 0.035 and seed loading of 0, 2.5, and 5 wt.% respecting to $SiO_2$.

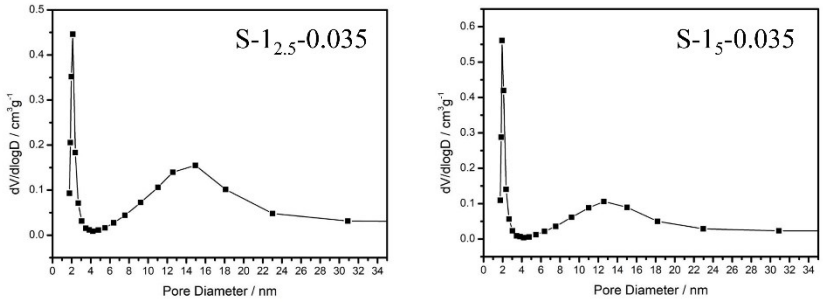


**Fig. S5** Pore size distribution of silicalite-1 crystallized from the initial reaction mixture with a $TPA^+/SiO_2$ ratio of 0.035 and seed loading of 2.5, and 5 wt.% respecting to $SiO_2$.

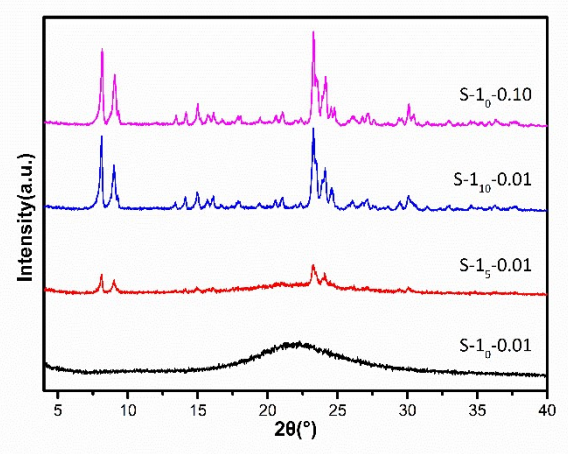


**Fig. S6** Experimental XRD patterns of the silicalite-1 crystallized from the initial reaction mixture with $TPA^+/SiO_2$ ratio of 0.01 and seed loading of 0, 5, and 10 wt.% respecting to $SiO_2$.

**Table S1** Gel compositions for the crystallization of silicalite-1

| Gel composition | $TPA^+/SiO_2$ | Reference |
|---|---|---|
| $SiO_2$:0·4TPAOH:35$H_2O$ | 0.4 | [1] |
| $SiO_2$:0·256TPAOH:30$H_2O$ | 0.256 | [2] |
| $SiO_2$: 0.24TPAOH: 24$H_2O$: 4EtOH | 0.24 | [3] |
| 1.0NaOH:3.4TPAOH: 12.6TEOS: 889$H_2O$ | 0.27 | [4] |
| 9TPAOH: 25$SiO_2$: 480$H_2O$ | 0.36 | [5] |
| 1 TEOS: 0.2 TPAOH: 100 $H_2O$ | 0.2 | [6] |
| 1TEOS:0.12TPAOH:0.008NaOH:19.2 $H_2O$ | 0.12 | [7] |

**Table S2** The area of the five characteristic diffraction peaks at 7.8, 8.8, 23.2, 23.8, and 24.3° (2θ) of the sample containing 0, 20, 40, 60, 80, and 100% standard silicalite-1 in amorphous silica against the proportion of silicalite-1

| Sample | Seed loading | The area of the diffraction peak | | | | | Sum of the integrated area |
|---|---|---|---|---|---|---|---|
| | | 7.8° | 8.8° | 23.2° | 23.8° | 24.3° | |
| 1 | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| 2 | 20% | 5865 | 6706 | 7479 | 3998 | 772 | 24820 |
| 3 | 40% | 13747 | 14321 | 15422 | 6111 | 913 | 50514 |
| 4 | 60% | 17998 | 18497 | 23788 | 17310 | 1044 | 78637 |
| 5 | 80% | 28311 | 31645 | 39639 | 24089 | 5154 | 128838 |
| 6 | 100% | 31433 | 41712 | 49434 | 29365 | 6301 | 158245 |

**Table S3** Relative crystallinity of the products crystallized from the initial reaction mixtures with $TPA^+/SiO_2$=0.01 and in the presence of 0, 5, and 10 wt.% seed (respects to $SiO_2$)

| Sample | Sum of the integrated area | Relative crystallinity[a] |
|---|---|---|
| S-$1_0$-0.01 | 0 | 0 |
| S-$1_5$-0.01 | 8560 | 17.68% |
| S-$1_{10}$-0.01 | 47973 | 99.07% |
| S-$1_0$-0.10 | 48425 | 100.00% |

[a] The standard silicalite-1 used in calculating the relative crystallinity of the products is crystallized from the initial reaction mixture with a $TPA^+/SiO_2$ ratio of 0.10 in the absence of seed.

**References**


1. D. Laprune, C. Theodoridi, A. Tuel, D. Farrusseng and F. C. Meunier, Effect of polyaromatic tars on the activity for methane steam reforming of nickel particles embedded in silicalite-1, *Appl. Catal. B: Environ*, 2017, **204**, 515-524.
2. M. Liu, Z. Chang, H. Wei, B. Li, X. Wang and Y. Wen, Low-cost synthesis of size-controlled TS-1 by using suspended seeds: From screening to scale-up, *Appl. Catal., A*, 2016, **525**, 59-67.
3. H. Li, Y. Wang, F. Meng, F. Gao, C. Sun, C. Fan, X. Wang and S. Wang, Controllable fabrication of single-crystalline, ultrafine and high-silica hierarchical ZSM-5 aggregates via solid-like state conversion, *RSC Adv.*, 2017, **7**, 25605-25620.
4. J. Gao and Y. Tao, Synthesis and characterization of small-mesopore-added silicalite-1 zeolites using single wall carbon nanohorn templating, *Adsorption*, 2016, **22**, 1059-1063.
5. T. Butt and L. Tosheva, Synthesis of colloidal silicalite-1 at high temperatures, *Micropor. Mesopor. Mater.*, 2014, **187**, 71-76.
6. Z. Wang, T. Yu, P. Nian, Q. Zhang, J. Yao, S. Li, Z. Gao and X. Yue, Fabrication of a Highly b-Oriented MFI-Type Zeolite Film by the Langmuir–Blodgett Method, *Langmuir*, 2014, **30**, 4531-4534.
7. F. Wei, W. Song, F. Wei and C. Cao, Ordered mesoporous silcalite-1 zeolite assembled from colloidal nanocrystalline precursors, *Chinese J.Catal.*, 2015, **36**, 838-844.