Supplementary Information

Efficient synthesis of aluminosilicate RTH zeolite with good catalytic performances in NH$_3$-SCR and MTO reactions

Hao Xu,$^a$ Qinming Wu,*$^a$ Yueying Chu,$^b$ Jingang Jiang,$^c$ Ling Zhang,$^a$ Shuxiang Pan,$^a$
Changsheng Zhang,$^a$ Longfeng Zhu,$^{a,d}$ Feng Deng,$^b$ Xiangju Meng,$^a$ Stefan Maurer,$^e$
Robert McGuire,$^f$ Andrei-Nicolae Parvulescu,$^f$ Ulrich Müller,$^f$ and Feng-Shou Xiao*,$^a$

$a$ Key Lab of Applied Chemistry of Zhejiang Province, Department of Chemistry, Zhejiang University, Hangzhou 310007, China.
$b$ State Key Laboratory of Magnetic Resonance and Atomic and Molecular Physics, Wuhan Center for Magnetic Resonance, Wuhan Institute of Physics and Mathematics, Wuhan 430071, China.
$c$ Shanghai Key Laboratory of Green Chemistry and Chemical Processes, School of Chemistry and Molecular Engineering, East China Normal University, Shanghai 200062, China.
$d$ College of Biological, Chemical Sciences and Engineering, Jiaxing University, Jiaxing 314001, China.
$e$ BASF Catalysts (Shanghai) Co., Ltd., 239 Luqiao Road, Jinqiao Export Process Zone Pudong New District, Shanghai, 201206, China.
$f$ BASF SE, GCC/PZ-M311, 67056 Ludwigshafen, Germany.
Supplementary Figure Captions

**Figure S1** TG-DTA curves of as-synthesized RTH zeolite in the presence of 2,6-methyl-N-methylpyridinium.

**Figure S2** (A) XRD patterns and (B) SEM images of RTH zeolite synthesized at (a) 150 °C for 7 h, (b) 180 °C for 3 h and (c) 240 °C for 50 min, respectively.

**Figure S3** DRIFT spectra of H-RTH zeolites synthesized at (a) 130 °C, (b) 180 °C and (c) 240 °C, respectively.

**Figure S4** (A) XRD patterns and (B) SEM images of zeolite RTH crystallized at 130 °C for (a) 3, (b) 6, (c) 9, (d) 10, (e) 11, (f) 12, (g) 288, and (h) 432 h, respectively.

*: peaks of Y zeolite, ◆: peaks of RTH zeolite.

**Figure S5** Dependences of the RTH zeolite crystallinity on crystallization time using 1,2,3-trimethylimidazolium cation as organic template at (a) 180 °C, (b) 165 °C, (c) 150 °C, and (d) 130 °C, respectively.

**Figure S6** XRD patterns of (a) as-synthesized RTH zeolite, and RTH zeolites calcined at (b) 550 °C, (c) 700 °C and (d) 850 °C, respectively.

**Figure S7** (A) $^{29}$Si and (B) $^{27}$Al MAS NMR spectra of H-RTH zeolites calcined at (a) 550 °C, (b) 700 °C and (c) 850 °C, respectively.

**Figure S8** NH$_3$-TPD curves of the H-RTH zeolites calcined at (a) 550 °C, (b) 700 °C and (c) 850 °C, respectively.

**Figure S9** (a) Methanol conversion (◆) and product selectivities of (b) ethylene with propylene ($\blacktriangle$C$_2$H$_4$ + C$_3$H$_6$), (c) ethylene ($\blacksquare$C$_2$H$_4$), (d) propylene ($\blacklozenge$C$_3$H$_6$), and (e)
hydrocarbons higher than C₄ (▼ ▽ ≥ C₄) in MTO over (A) H-RTH catalyst (temperature at 400 °C and WHSV at 1.0 h⁻¹), (B) H-RTH catalyst (temperature at 480 °C and WHSV at 2.0 h⁻¹), (C) H-ZSM-5 catalyst (temperature at 400 °C and WHSV at 1.0 h⁻¹), and (D) H-ZSM-5 catalyst (temperature at 480 °C and WHSV at 2.0 h⁻¹).

Table S1 BET surface area and micropore volume of H-RTH zeolite samples with different crystallization temperature and calcination temperature.
Figure S1 TG-DTA curves of as-synthesized RTH zeolite in the presence of 2,6-methyl-N-methylpyridinium.
Figure S2 (A) XRD patterns and (B) SEM images of RTH zeolite synthesized at (a) 150 °C for 7 h, (b) 180 °C for 3 h and (c) 240 °C for 50 min, respectively.
Figure S3 DRIFT spectra of H-RTH zeolites synthesized at (a) 130 °C, (b) 180 °C and (c) 240 °C, respectively.
Figure S4 (A) XRD patterns and (B) SEM images of zeolite RTH crystallized at 130 °C for (a) 3, (b) 6, (c) 9, (d) 10, (e) 11, (f) 12, (g) 288, and (h) 432 h, respectively.

*: peaks of Y zeolite, ◆: peaks of RTH zeolite.
Figure S5 Dependences of the RTH zeolite crystallinity on crystallization time using 1,2,3-trimethylimidazolium cation as organic template at (a) 180 °C, (b) 165 °C, (c) 150 °C, and (d) 130 °C, respectively.
Figure S6 XRD patterns of (a) as-synthesized RTH zeolite, and RTH zeolites calcined at (b) 550 °C, (c) 700 °C and (d) 850 °C, respectively.
Figure S7 (A) $^{29}$Si and (B) $^{27}$Al MAS NMR spectra of H-RTH zeolites calcined at (a) 550 °C, (b) 700 °C and (c) 850 °C, respectively.
Figure S8 NH$_3$-TPD curves of the H-RTZ zeolites calcined at (a) 550 °C, (b) 700 °C and (c) 850 °C, respectively.
Figure S9 (a) Methanol conversion (◆) and product selectivities of (b) ethylene with propylene (▲ C₂H₄ + C₃H₆), (c) ethylene (■ C₂H₄), (d) propylene (● C₃H₆), and (e) hydrocarbons higher than C₄ (▼ ≥ C₄) in MTO over (A) H-RTH catalyst (temperature at 400 °C and WHSV at 1.0 h⁻¹), (B) H-RTH catalyst (temperature at 480 °C and WHSV at 2.0 h⁻¹), (C) H-ZSM-5 catalyst (temperature at 400 °C and WHSV at 1.0 h⁻¹), and (D) H-ZSM-5 catalyst (temperature at 480 °C and WHSV at 2.0 h⁻¹).
**Table S1.** BET surface area and micropore volume of H-RTH zeolite samples with different crystallization temperature and calcination temperature.

<table>
<thead>
<tr>
<th>Run</th>
<th>Crystallization temperature (°C)</th>
<th>Calcination temperature (°C)</th>
<th>BET surface area (m²/g)</th>
<th>Micropore volume (cm³/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>130</td>
<td>550</td>
<td>576</td>
<td>0.26</td>
</tr>
<tr>
<td>2</td>
<td>180</td>
<td>550</td>
<td>583</td>
<td>0.28</td>
</tr>
<tr>
<td>3</td>
<td>240</td>
<td>550</td>
<td>559</td>
<td>0.24</td>
</tr>
<tr>
<td>4</td>
<td>130</td>
<td>700</td>
<td>558</td>
<td>0.26</td>
</tr>
<tr>
<td>5</td>
<td>130</td>
<td>850</td>
<td>427</td>
<td>0.20</td>
</tr>
</tbody>
</table>