Electronic Supporting Information for

Methane to Methanol over Copper Mordenite: Yield Improvement Through Multiple Cycles and Different Synthesis Techniques

by

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1. Catalytic Activity

Figure S1 Mass spectrometer-detected signals of H$_2$O (m/z = 18), and methanol (m/z = 31) during the treatment of wet He at 200 °C after methane interaction of CuMOR$_S$ during 2$^{nd}$ cycle.

2. N$_2$ Adsorption

Table S1 BET Number of the materials used in this study

<table>
<thead>
<tr>
<th>Material</th>
<th>BET surface area [m$^2$/g]</th>
</tr>
</thead>
<tbody>
<tr>
<td>Na-MOR</td>
<td>411</td>
</tr>
<tr>
<td>H-MOR</td>
<td>464</td>
</tr>
<tr>
<td>CuMOR$_A$</td>
<td>386</td>
</tr>
<tr>
<td>CuMOR$_S$</td>
<td>410</td>
</tr>
<tr>
<td>CuMOR$_A$, after 2 cycles of R1</td>
<td>328</td>
</tr>
<tr>
<td>CuMOR$_S$, after 8 cycles of R1</td>
<td>202</td>
</tr>
</tbody>
</table>
3. XAS spectra taken during in situ synthesis of Cu-MOR$_S$

Figure S2 XANES and FT EXAFS spectra taken during in situ synthesis of Cu-MOR by heating of CuCl and H-MOR
Figure ES3-2. XANES spectra of standard copper compounds

4. Linear Combination Fitting

Figure S4 XANES spectra of standard copper compounds used in the LCF.
Figure S5 XANES Spectra taken during $O_2$ activation (a, c, e) and $CH_4$ reaction (b, d, f) of Cu-MOR$_S$ at the corresponding cycle with the linear combination fit, its components and the residual.
Figure S6 XANES Spectra taken during O\textsubscript{2} activation (a, c, e) and CH\textsubscript{4} reaction (b, d, f) of Cu-MOR\textsubscript{A} at the corresponding cycle with the linear combination fit, its components and the residual.