Synergistic effect of metal oxidation states and surface acidity enhanced the trace ethylene adsorption of Ag/ZSM-5

Chunli Li*, Huaming Yang, Ying Qi, Hao Li*

National-Local Joint Engineering Laboratory for Energy Conservation in Chemical Process Integration and Resources Utilization, School of Chemical Engineering and Technology, Hebei University of Technology, Tianjin 300130, China

Supporting Information Table of Contents:

1. **Fig. S1**: The N\textsubscript{2} adsorption-desorption isotherms of Ag/ZSM-5(85), Ag/ZSM-5(130) and Ag/ZSM-5(200).

2. **Fig. S2**: (a), (b) The SEM images of Ag/ZSM-5(130); (c), (d) The TEM images of Ag/ZSM-5(130).

3. **Fig. S3**: The breakthrough curves of pristine ZSM-5(130), ZSM-5(85), and reduced Ag/ZSM-5(130) at the experiment conditions.

4. **Fig. S4**: (a) The breakthrough curves of Ag/ZSM-5(130) with six consecutive cycles; (b) The adsorption capacity of Ag/ZSM-5(130) with six consecutive cycles.

5. **Fig. S5**: (a) High-resolution XPS spectra of Ag/ZSM-5(130) and reduced Ag/ZSM-5(130); (b) The TEM image of reduce Ag/ZSM-5(130).

6. **Table S1**: Structural parameters of the adsorbents.
**Fig. S1.** The N\textsubscript{2} adsorption-desorption isotherms of Ag/ZSM-5(85), Ag/ZSM-5(130) and Ag/ZSM-5(200).
Fig. S2. (a), (b) The SEM images of Ag/ZSM-5(130); (c), (d) The TEM images of Ag/ZSM-5(130).
Fig. S3. The breakthrough curves of pristine ZSM-5(130), ZSM-5(85), and reduced Ag/ZSM-5(130) at the experiment conditions.
Fig. S4. (a) The breakthrough curves of Ag/ZSM-5(130) with six consecutive cycles; (b) The adsorption capacity of Ag/ZSM-5(130) with six consecutive cycles.
Fig. S5. (a) High-resolution XPS spectra of Ag/ZSM-5(130) and reduced Ag/ZSM-5(130); (b) The TEM image of reduce Ag/ZSM-5(130).
Table S1.

Structural parameters of the adsorbents.

<table>
<thead>
<tr>
<th>Adsorbent</th>
<th>$S_{\text{total}}^a$ (m$^2$g$^{-1}$)</th>
<th>$V_{\text{total}}^b$ (cm$^3$g$^{-1}$)</th>
<th>$V_{\text{micro}}^c$ (cm$^3$g$^{-1}$)</th>
<th>$D^d$ (nm)</th>
<th>$\text{Ag}^e$ (%)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Ag/ZSM-5(38)</td>
<td>304.98</td>
<td>0.205</td>
<td>0.163</td>
<td>0.731</td>
<td>-</td>
</tr>
<tr>
<td>Ag/ZSM-5(85)</td>
<td>370.84</td>
<td>0.247</td>
<td>0.174</td>
<td>0.758</td>
<td>0.504</td>
</tr>
<tr>
<td>Ag/ZSM-5(130)</td>
<td>361.31</td>
<td>0.248</td>
<td>0.178</td>
<td>0.639</td>
<td>0.495</td>
</tr>
<tr>
<td>Ag/ZSM-5(200)</td>
<td>362.30</td>
<td>0.227</td>
<td>0.173</td>
<td>0.773</td>
<td>0.498</td>
</tr>
<tr>
<td>Ag/ZSM-5(300)</td>
<td>358.37</td>
<td>0.208</td>
<td>0.166</td>
<td>0.652</td>
<td>-</td>
</tr>
<tr>
<td>ZSM-5-130</td>
<td>351.40</td>
<td>0.237</td>
<td>0.177</td>
<td>0.809</td>
<td>-</td>
</tr>
</tbody>
</table>

$^a$ Specific surface area obtained from BET equation (P/P$_0$ = 0.04-0.32).

$^b$ Total pore volume calculated by NLDFT methods.

$^c$ NLDFT micropore volume.

$^d$ Average pore size obtained by using the HK method.

$^e$ Silver loaded content determined by ICP-OES.