Appendix A. Supplementary data

Enhanced Catalytic Benzene Oxidation over a Novel Waste-derived Ag/Eggshell Catalyst

Yunlong Guo, a Da-Peng Yang, b,* Minghuan Liu, b Xiaoyan Zhang, b Yisong Chen, b Jiale Huang, a,* Qingbiao Li a and Rafael Luque c,d,*

a Department of Chemical and Biochemical Engineering, College of Chemistry and Chemical Engineering, Xiamen University, Xiamen 361005, PR China
b College of Chemical Engineering and Materials Science, Quanzhou Normal University, Quanzhou 362000, Fujian Province, PR China, Tel:+86-22870772; E-mail address: yangdp@qztc.edu.cn

c Departamento de Quimica Organica, Universidad de Cordoba, Campus de Rabanales, Edificio Marie Curie (C-3), Ctra Nnal IV-A, Km. 396 E-14014, Cordoba (Spain), Tel: +34-957211050; fax: +34-957212066. E-mail address: rafael.luque@uco.es
d Peoples Friendship University of Russia (RUDN University), 6 Miklukho-Maklaya str., 117198, Moscow, Russia
**Fig. S1** (a-b) SEM images of Ag$_2$/Eggshell and the corresponding EDX elemental mapping images of Ag, C, Ca and O.

**Fig. S2** SEM image of the pure Ag NPs.
**Fig. S3** Benzene conversion as a function of reaction temperature over pure eggshell at SV=20,000 mL/g/h.

**Fig. S4** SEM images and the corresponding histograms of Ag NPs distribution (insets) of xAg/Eggshell with different Ag loadings: (a) Ag₁/Eggshell, (b) Ag₂/Eggshell and (c) Ag₃/Eggshell.
Fig. S5 XRD patterns of Ag$_2$/Eggshell with different calcined temperatures.

Fig. S6 SEM images and the corresponding histograms of Ag NPs distribution (insets) of Ag$_2$/Eggshell with different calcined temperatures: (a) 300, (b) 400, (c) 500 and (d) 600 °C.
**Fig. S7** (A) SEM image (insert: the histogram of Ag NPs distribution), (B) TG/DTG profile, (C) XRD pattern, (D) Ag 3d XPS spectrum and (E) O 1s XPS spectrum (F) UV-vis DRS spectra of the Ag$_2$/Eggshell after reaction of 200 h at 230°C.

**Fig. S8** Effects of different SV onto the catalytic activity of the Ag$_2$/Eggshell catalyst, (A) the relationship between benzene conversion and temperatures (B) the relationship between CO$_2$ yield and temperatures.
**Fig. S9** (a) SEM image and (b) the corresponding histogram of size distribution of Ag NPs of Ag$_2$/com-CaCO$_3$ catalyst.

**Fig. S10** SEM images of (a) pure eggshell and (b) Ag$_2$/Eggshell catalyst.
**Fig. S11.** Nitrogen adsorption-desorption isotherm and the corresponding pore size distribution curves (inlet) of various supports and Ag catalysts.

**Table S1.** Textural properties of various supports and Ag catalysts.

<table>
<thead>
<tr>
<th>Sample</th>
<th>BET surface area (m²/g)</th>
<th>Pore volume (cm³/g)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Eggshell</td>
<td>&lt;5</td>
<td>0.008</td>
</tr>
<tr>
<td>Ag₅/Eggshell</td>
<td>&lt;5</td>
<td>0.004</td>
</tr>
<tr>
<td>com-CaCO₃</td>
<td>&lt;5</td>
<td>0.006</td>
</tr>
<tr>
<td>Ag₅/com-CaCO₃</td>
<td>&lt;5</td>
<td>0.003</td>
</tr>
</tbody>
</table>

*a* Calculated from the volume adsorbed at P/P₀ = 0.99. *b* Calculated from the desorption branch of nitrogen isotherm by using the BJH model.
Fig. S12 *In situ* FTIR spectra reacted in 1000 ppm benzene/N\(_2\) stream at 260 °C over Ag\(_2\)/Eggshell at different times.

**Table S2** Catalytic performance comparison of various catalysts on benzene oxidation reported in the literature.

<table>
<thead>
<tr>
<th>Catalyst</th>
<th>Preparation method</th>
<th>Concentration (ppm)</th>
<th>Space velocity (mL/g·h)</th>
<th>T(_{90%}) (°C)</th>
<th>Ref.</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.0Pt/CeO(_2)/Al(_2)O(_3)</td>
<td>Wet impregnation</td>
<td>1000</td>
<td>8,400</td>
<td>245</td>
<td>1</td>
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<tr>
<td>5Ag/ZrO(_2)</td>
<td>Impregnation</td>
<td>395</td>
<td>120,000</td>
<td>315</td>
<td>2</td>
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<tr>
<td>0.2Pd-Ni/SBA-15</td>
<td>Co-impregnation</td>
<td>1000</td>
<td>120,000</td>
<td>258</td>
<td>3</td>
</tr>
<tr>
<td>2.0Au/p-SnO(_2)</td>
<td>Deposition-precipitation</td>
<td>2000</td>
<td>18,000</td>
<td>367</td>
<td>4</td>
</tr>
<tr>
<td>0.8Pd/Ceramic-S</td>
<td>Impregnation</td>
<td>1500</td>
<td>90,000</td>
<td>225</td>
<td>5</td>
</tr>
<tr>
<td>0.2Pd/La-ZSM-5-OM</td>
<td>Chemical impregnation</td>
<td>1000</td>
<td>20,000 (^1)</td>
<td>250</td>
<td>6</td>
</tr>
<tr>
<td>Ag(_2)/Eggshell</td>
<td>Impregnation</td>
<td>1000</td>
<td>20,000</td>
<td>225</td>
<td>This work</td>
</tr>
</tbody>
</table>
References