Supporting Information

Fe$_3$O$_4$@HKUST-1 and Pd/Fe$_3$O$_4$@HKUST-1 as magnetically recyclable catalysts prepared via conversion from a Cu-based ceramic

Takashi Toyao,$^{a,b}$ Mark J. Styles,$^c$ Tokuichiro Yago,$^a$ Muhammad M. Sadiq,$^d$ Raffaele Riccò,$^{c,e}$ Kiyonori Suzuki,$^d$ Yu Horiuchi,$^a$ Masahide Takahashi,$^a$ Masaya Matsuoka,$^{a*,e}$ and Paolo Falcaro$^{c,e*}$

$a$ Department of Applied Chemistry, Graduate School of Engineering, Osaka Prefecture University, 1-1 Gakuen-cho, Naka-ku, Sakai, Osaka 599-8531, Japan

$b$ Institute for Catalysis, Hokkaido University, N-21, W-10, Sapporo 001-0021, Japan

$c$ CSIRO Manufacturing, Private Bag 10, Clayton South, Victoria 3169, Australia

$d$ Department of Materials Science and Engineering, Monash University, Clayton, Victoria, 3168, Australia

$e$ Graz University of Technology, Institute of Physical and Theoretical Chemistry, Stremayrgasse 9/Z2, 8010 Graz, Austria

* E-mail: matsumac@chem.osakafu-u.ac.jp, paolo.falcaro@tugraz.at
Figure S1. SEM images of materials after (a) 10 seconds and (b) 30 seconds of the conversion from Fe₃O₄@Cu₂(OH)₃NO₃ into Fe₃O₄@HKUST-1.

Figure S2. FT-IR spectra of Fe₃O₄@HKUST-1 and Fe₃O₄@Cu₂(OH)₃(NO₃).
Figure S3. TGA curves of Fe$_3$O$_4$@HKUST-1, Fe$_3$O$_4$@Cu$_2$(OH)$_3$(NO$_3$), HKUST-1 and Cu$_2$(OH)$_3$(NO$_3$).

Figure S4. The results of (a) deacetalization and (b) Knoevenagel condensation using Fe$_3$O$_4$/HKUST-1 as a catalyst. Reaction conditions: (a) Catalyst (50 mg), benzaldehyde dimethylacetal (1 mmol), 1,4-dioxane (4 mL), 363 K, in air. (b) Catalyst (50 mg), benzaldehyde (1 mmol), malononitrile (3 mmol), 1,4-dioxane (4 mL), 363 K, in air.
Figure S5. SEM image of HKUST-1_ref.

Figure S6. Leaching test for the one-pot deacetalization-Knoevenagel condensation reaction over Fe₃O₄@HKUST-1. After 0.5 h of the reaction time, the catalyst was filtrated. The reaction solution was further kept at reaction conditions without solid catalyst.
Figure S7. XRD pattern of Pd/Fe$_3$O$_4$@HKUST-1.

Figure S8. Pd K-edge (a) XANES and (b) FT-EXAFS spectra of Pd/Fe$_3$O$_4$@HKUST-1, PdCl$_2$, PdO and Pd foil.
Figure S9. TEM images of (a) Pd/HKUST-1 and (b) Pd/Fe₃O₄@HKUST-1.

Figure S10. (a) Recycling tests for the hydrogenation of 1-octene to octane over Pd/Fe₃O₄@HKUST-1 and (b) XRD patterns of Pd/Fe₃O₄@HKUST-1 before and after the reaction.
Figure S11. Leaching test for the hydrogenation of 1-octene over Pd/Fe$_3$O$_4$@HKUST-1. After 0.5 h of the reaction time, the catalyst was filtrated. The reaction solution was further kept at reaction conditions without solid catalyst.