

Supplementary Materials: Regenerable Subnanometer Pd Clusters on Zirconia for Highly Selective Hydrogenation of Biomass-Derived Succinic Acid in Water

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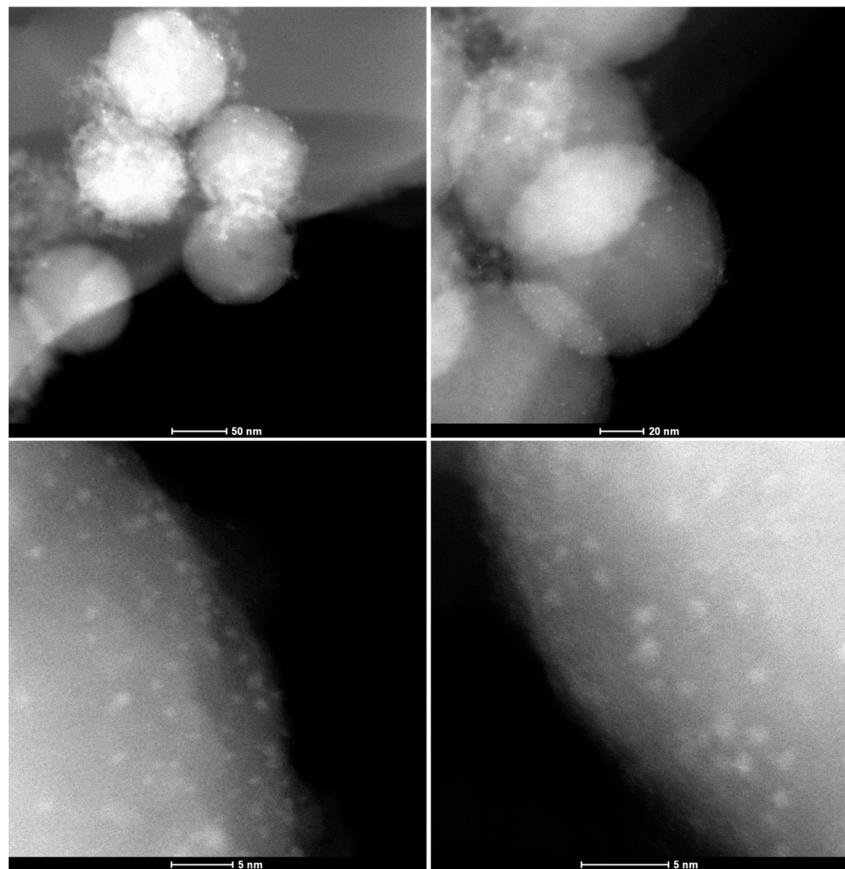


Figure S1. The aberration-corrected high-angle annular dark-field scanning transmission electron microscopy images of 0.2 Pd/ZrO₂ catalyst.

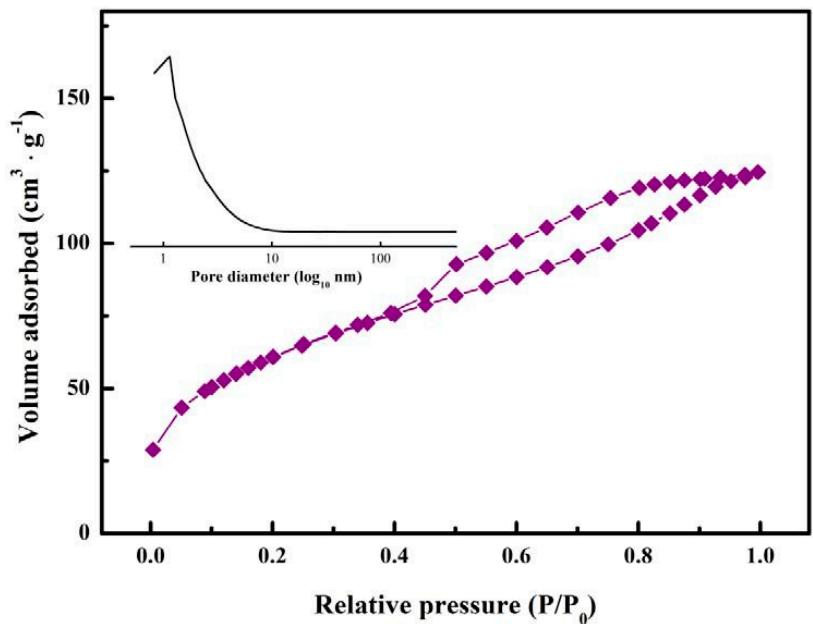


Figure S2. Nitrogen adsorption and desorption isotherms of 0.2 Pd/ZrO₂.

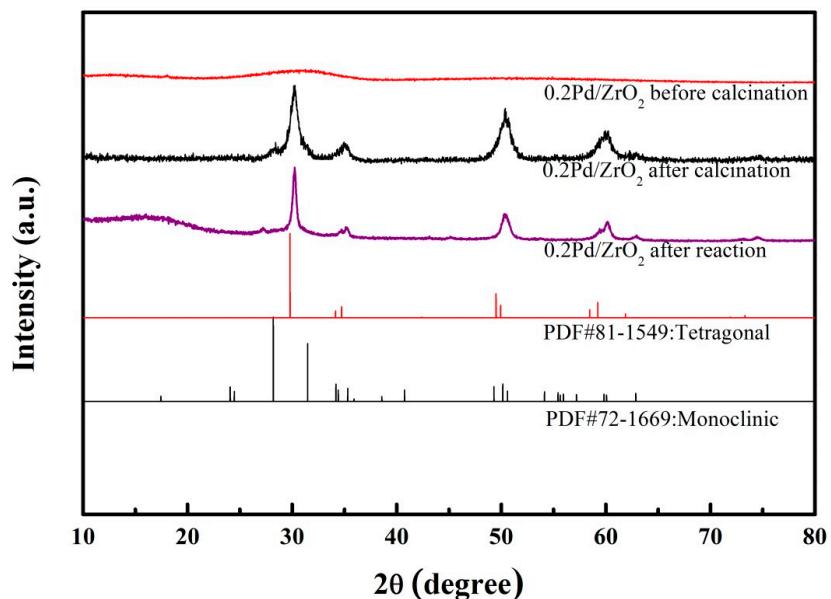


Figure S3. The X-ray diffraction patterns of Pd/ZrO₂ before and after reaction.

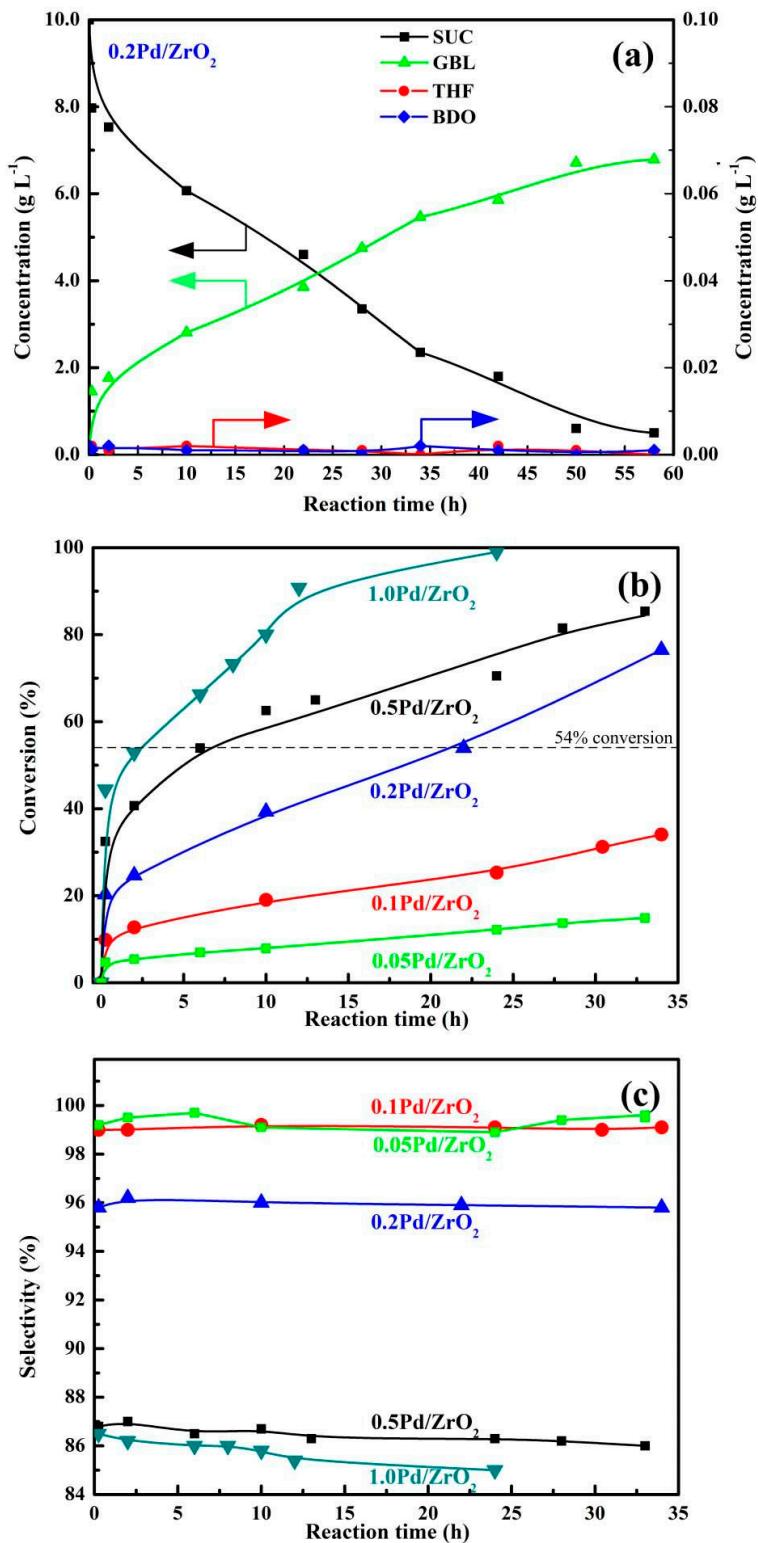


Figure S4. Catalytic activities of succinic acid hydrogenation over $0.2\text{ Pd}/\text{ZrO}_2$ catalysts (a) and different Pd loadings (b,c).

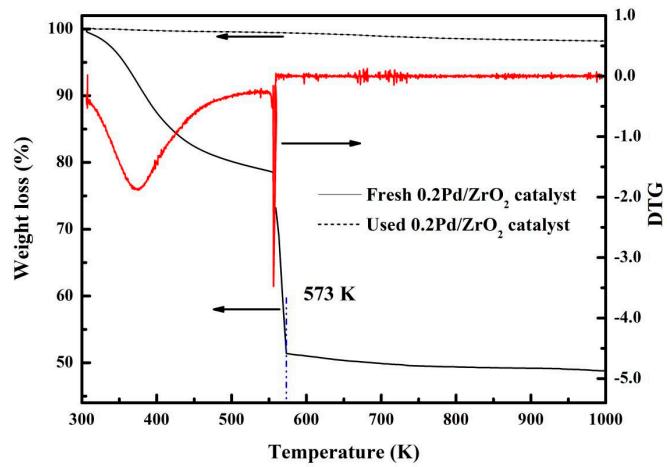


Figure S5. The thermogravimetric analysis patterns of 0.2 Pd/ZrO₂ and used 0.2 Pd/ZrO₂ catalysts.

Table S1. Physicochemical properties of Pd/ZrO₂ catalysts.

Catalysts and reaction solution	Pd Loading by ICP (wt. %)	BET (m ² ·g ⁻¹)
1.0 Pd/ZrO ₂	0.88	208
0.2 Pd/ZrO ₂ ^a	0.22	216
0.2 Pd/ZrO ₂ ^b	0.21	205
0.05 Pd/ZrO ₂	0.042	220
Reaction solution	0	-

^a fresh catalyst; ^b used catalyst.