

Electronic Supplementary Information for

One-pot conversion of furfural to alkyl levulinate over
bifunctional Au-H₄SiW₁₂O₄₀/ZrO₂ without external H₂

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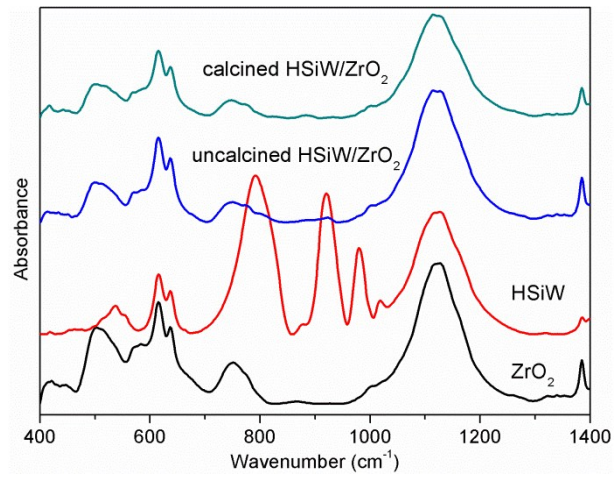


Fig. S1 FTIR spectra of calcined and uncalcined HSiW/ZrO₂.

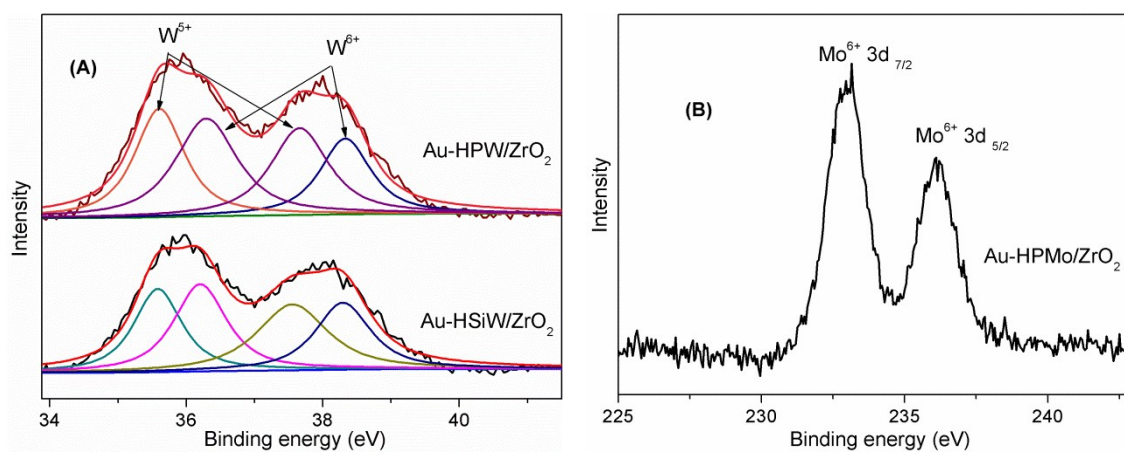


Fig. S2 (A) W⁶⁺ or W⁵⁺ 4f and (B) Mo⁶⁺ 3d XPS spectra of Au-HPA catalysts.

Table S1 The total acidity from titration method

| Catalyst | Au/ZrO ₂ | Au-HSiW/ZrO ₂ | Au-HPW/ZrO ₂ | Au-HPMo/ZrO ₂ |
|------------------|---------------------|--------------------------|-------------------------|--------------------------|
| Acidity (mmol/g) | 0.33 | 1.84 | 1.51 | 1.10 |

The procedure of titration method is described below:^{S1-S2} 0.25 g catalyst was added into 30 mL 0.05 mol/L NaOH aqueous solution at room temperature under stirring for 60 min. After centrifugal separation, the supernatant solution was titrated by 0.05 mol/L HCl aqueous solution with phenolphthalein as an indicative.

Table S2 The turnover frequencies based on active Au or acidic sites

| Catalyst | TOF _{Au} (mol _{furfural} ·mol _{Au} ⁻¹ ·h ⁻¹) | TOF _{acidity} (mol _{AL} ·mol _{acid} ⁻¹ ·h ⁻¹) |
|--------------------------|--|---|
| Au-HSiW/ZrO ₂ | 0.188 | 0.024 |
| Au-HPW/ZrO ₂ | 0.195 | 0.018 |
| Au-HPMo/ZrO ₂ | 0.174 | 0.010 |

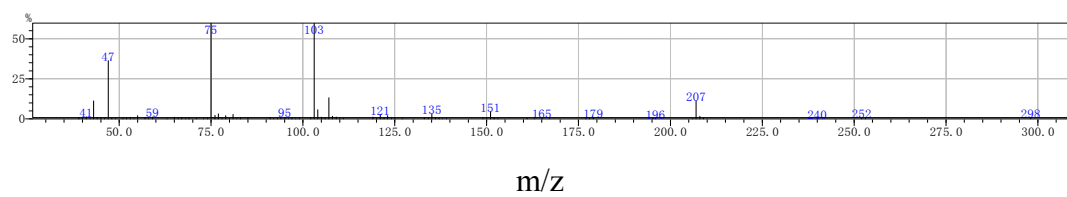


Fig. S3 The possible GC-MS data of TPP.

References:

- S1 J. Wang, W. Xu, J. Ren, X. Liu, G. Lu and Y. Wang, *Green Chem.*, 2011, **13**, 2678–2681.
- S2 P. P. Upare, J. Yoon, M. Y. Kim, H. Kang, D. W. Hwang, Y. K. Hwang, H. H. Kung and J. Chang, *Green Chem.*, 2013, **15**, 2935–2943.