Supporting Information

Porous Hafnium Phosphonate: Novel Heterogeneous Catalyst for Conversion of Levulinic Acid and Esters into γ-Valerolactone

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Table S1. Physical properties of different catalysts.

Sample[a]	BET surface area (m^2 g^{-1})[b]	Pore volume (cm^3 g^{-1})[c]	Pore diameter (nm)[d]
Hf-ATMP	222.6	0.25	16.7
HfO_2	6.74	0.07	--
Hf-EDPA	206.8	0.39	13.9
Cr-ATMP	4.81	0.03	15.8
Zn-ATMP	31.71	0.13	47.3
Al-ATMP	62.54	0.36	41.4
Cu-ATMP	129.86	0.14	3.6

[a]The samples were degassed at 120 °C for 24 h. [b]Surface area based on multipoint BET method. [c]Pore volume based on BJH method. [d]Pore diameter based on BJH method.

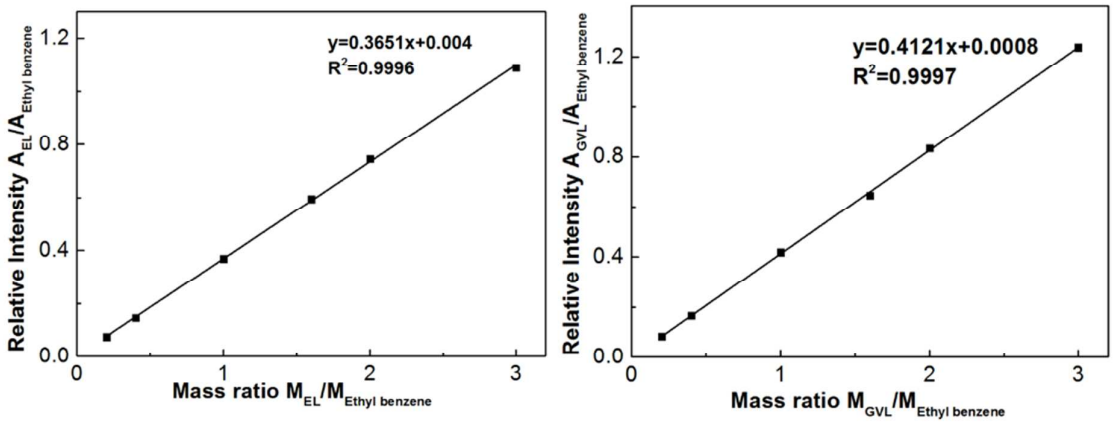
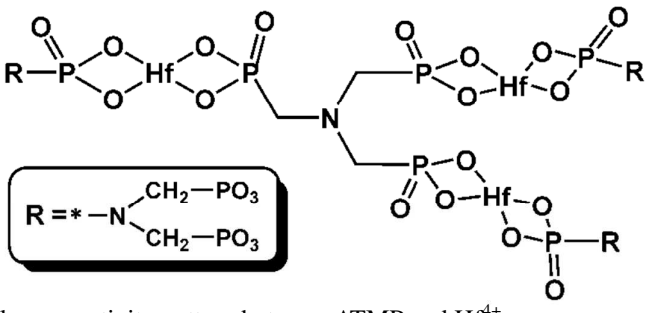


Figure S1. The calibration curves for GC using 0.05g ethylbenzene as the internal standard. (A=Peak area, M=Weight)



Scheme S1. The most plausible connectivity pattern between ATMP and Hf^{4+}.

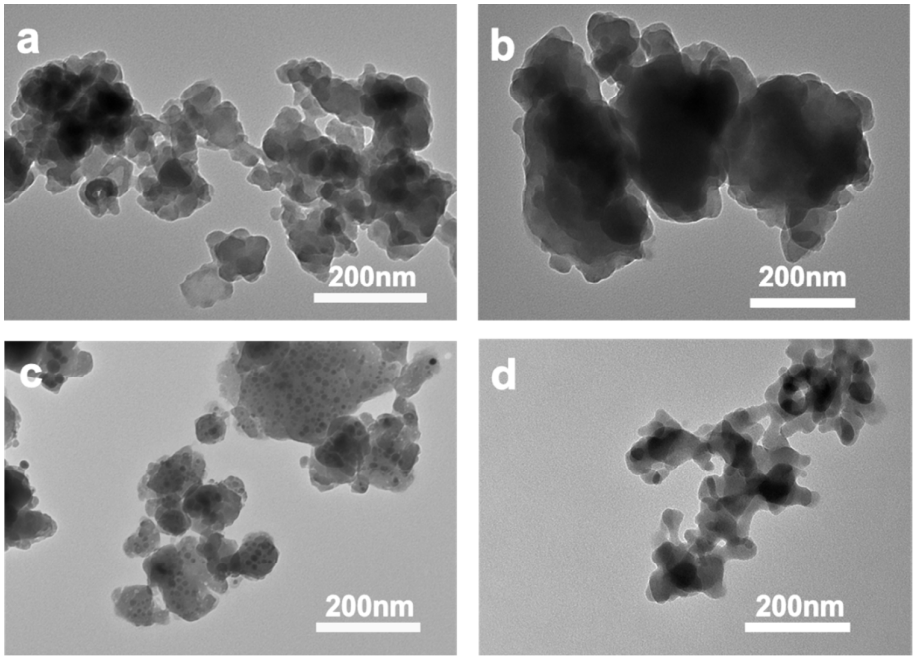


Figure S2. The TEM images of Al-ATMP (a), Cr-ATMP (b), Cu-ATMP (c), and Zn-ATMP (d).

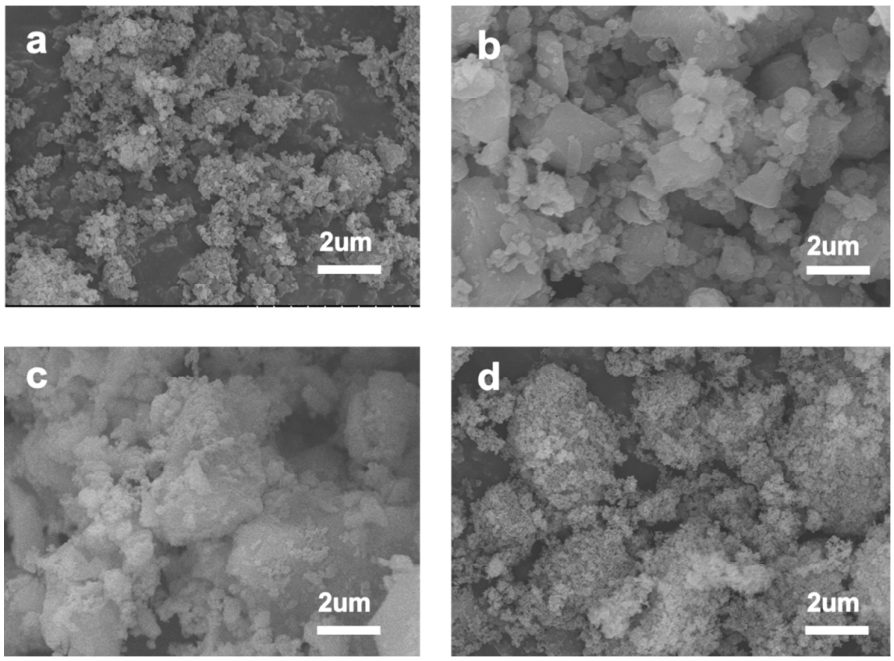


Figure S3. The SEM images of Al-ATMP (a), Cr-ATMP (b), Cu-ATMP (c), and Zn-ATMP (d).

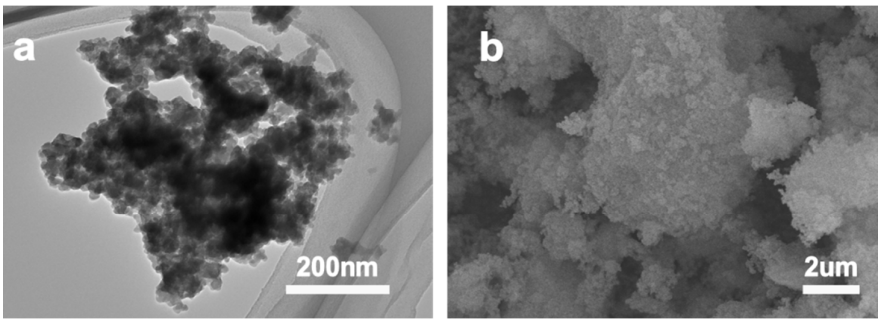


Figure S4. The TEM (a) and SEM (b) images of Hf-EDPA.

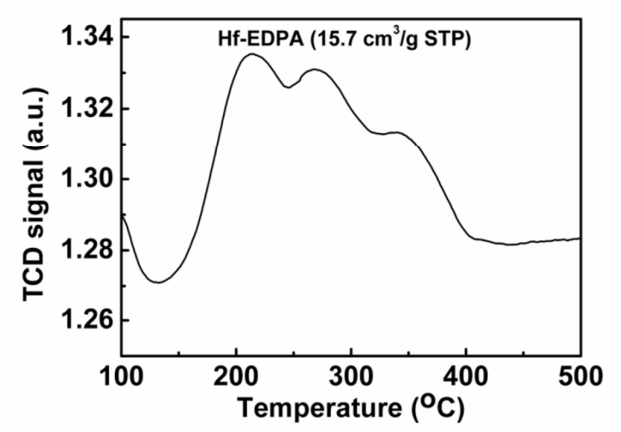


Figure S5. CO_2-TPD examination for Hf-EDPA.