Electronic Supplementary Material (ESI) for RSC Advances

Electronic Supplementary Information

Conversion of Biomass-derived Ethyl Levulinate into γ-Valerolactone via Hydrogen Transfer from Supercritical Ethanol over ZrO_2 Catalyst

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Table S1 Conversion of EL into GVL in various alcohol solvents [a]

Entry	Solvent	Pressure[b] (bar)	GVL yield (%)	EL conversion (%)	Other levulinates (%)
1	methanol	98	14.9	72.3	39.9 (ML)[b]
2	ethanol	70	62.5	81.5	
3	isopropanol	64	93.4	97.2	IPL[c]
4	1-butanol	26	84.4	95.5	2.9 (BL)[d]

[a] Reaction conditions: EL, 2 g; ZrO_2-573 catalyst, 1 g; alcohol, 38 g; reaction time, 1 h; reaction temperature, 523 K. [b] ML means methyl levulinate. [c] IPL means isopropyl levulinate, a very small quantity of IPL was detected. [d] BL means butyl levulinate.

Table S2 The specific surface area of ZrO_2-573 before reaction and after multiple reactions

Cycle	S_{BET} [a] (m^2g^{-1})
fresh	157.2
1	126.9
4	129.1
regeneration[b]	130.7

[a] Determined by BET analysis of N_2 adsorption isotherms. [b] ZrO_2-573 calcination at 573 K for 4 h after cycle 4.

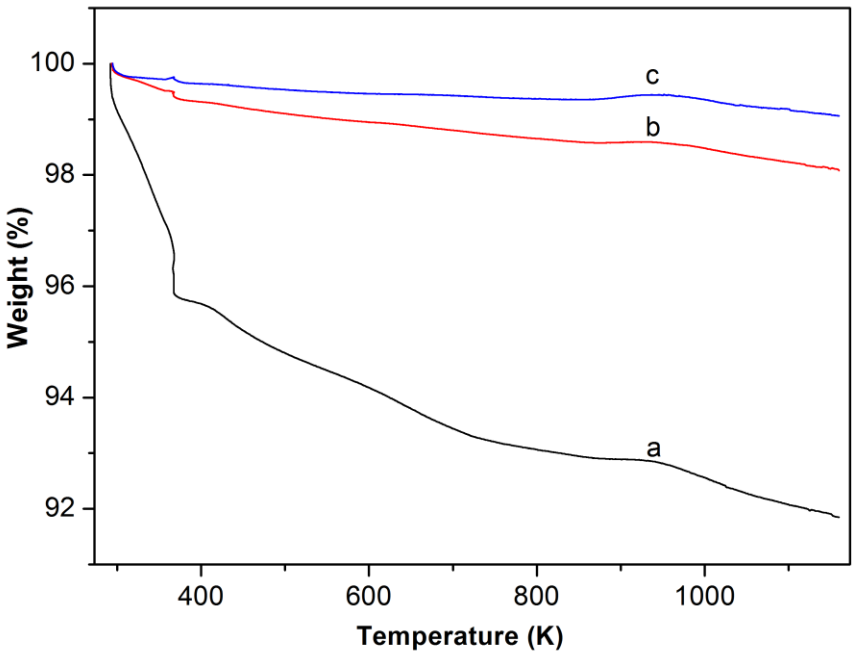


Fig. S1 TGA profiles for (a) ZrO_2-573, (b) ZrO_2-773 and (c) ZrO_2-973.

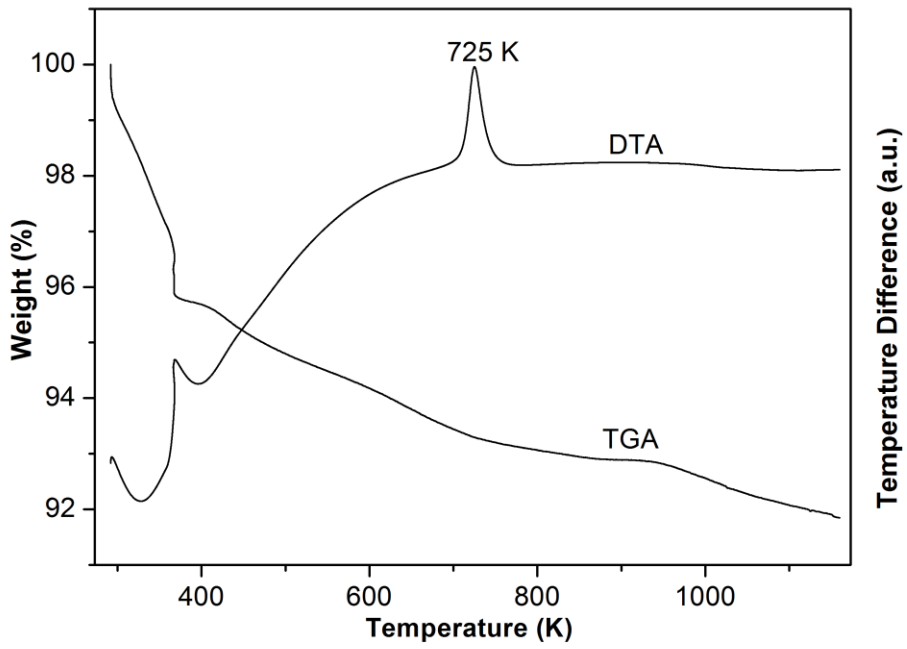


Fig. S2 TGA and DTA curves of the ZrO_2-573 catalyst.

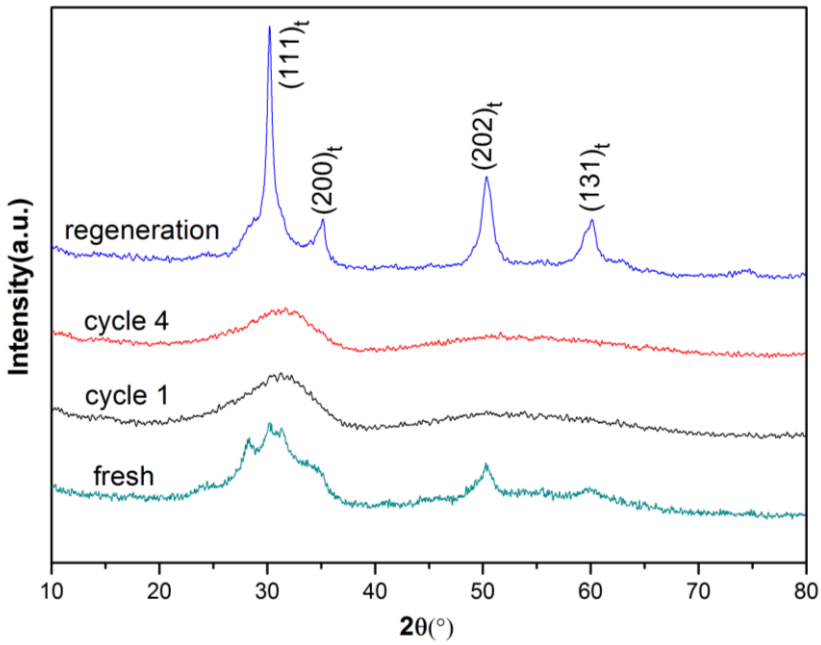


Fig. S3 X-Ray diffraction (XRD) patterns for ZrO_2-573 before and after reaction. Catalyst was regenerated at 573 K for 4 h.

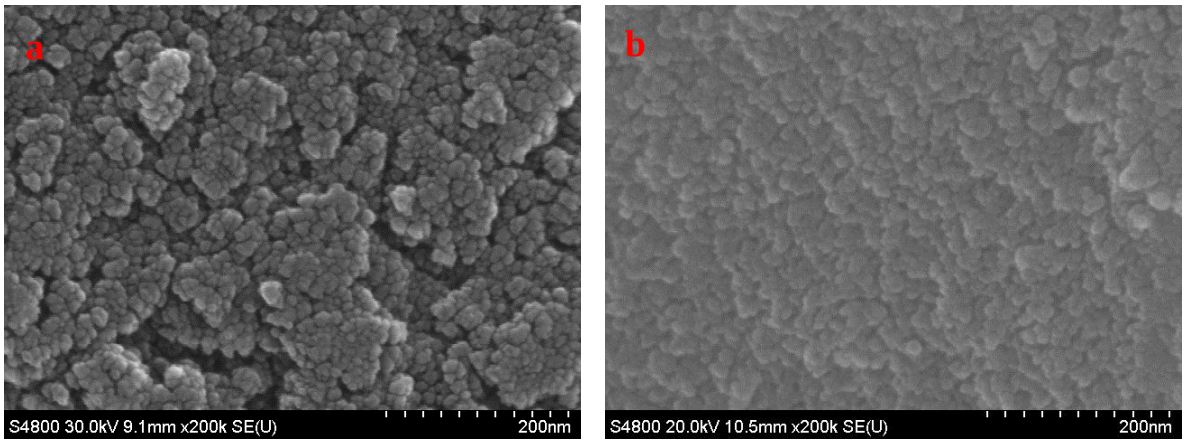
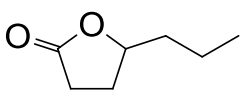
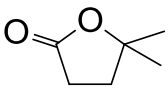


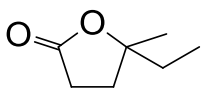
Fig. S4 SEM images for ZrO_2-573 after cycle 4 (a) and regeneration (b).



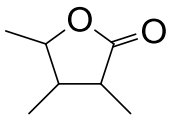
5-propyldihydrofuran-2(3*H*)-one



5,5-dimethyldihydrofuran-2(3*H*)-one



5-ethyl-5-methyldihydrofuran-2(3*H*)-one



3,4,5-trimethyldihydrofuran-2(3*H*)-one

Scheme S1 By-products derived from GVL were detected by GC-MS analysis.