

## Ga/HZSM-5 catalysed acetic acid ketonisation for upgrading of biomass pyrolysis vapours

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Supplementary Materials

# Ga/HZSM-5 Catalysed Acetic Acid Ketonisation for Upgrading of Biomass Pyrolysis Vapours

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## Characterisation

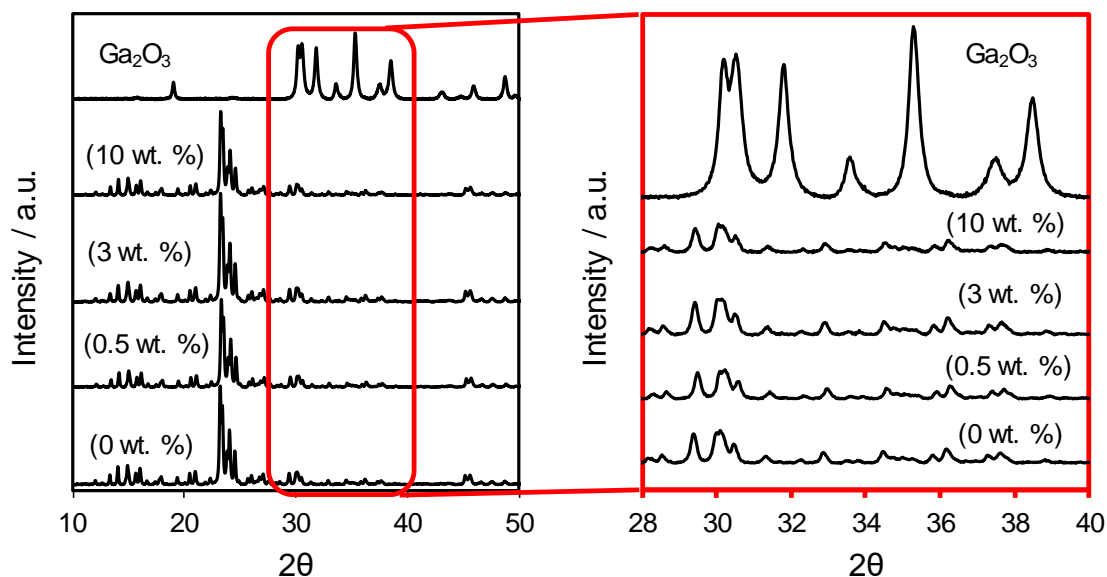


Figure S1. XRD patterns of xGa/HZSM-5 and bulk Ga<sub>2</sub>O<sub>3</sub>.

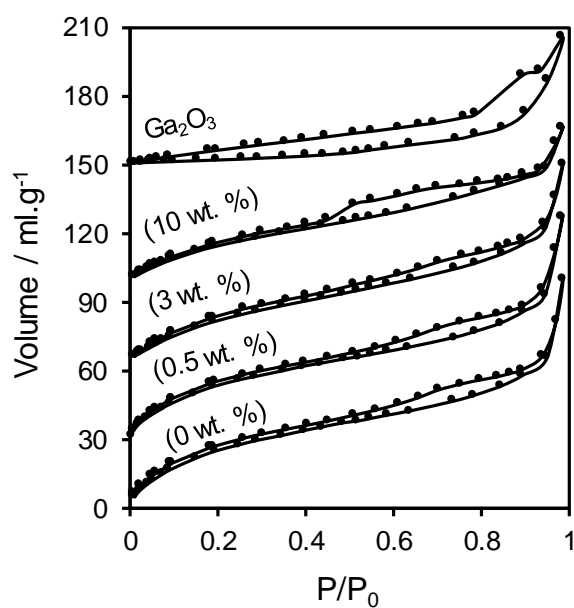


Figure S2. N<sub>2</sub> adsorption-desorption isotherms of xGa/HZSM-5 and Ga<sub>2</sub>O<sub>3</sub>.

Table S1. Surface and bulk compositions of xGa/HZSM-5 and Ga<sub>2</sub>O<sub>3</sub>.

Catalysts	Surface composition (XPS)				Bulk composition (ICP)
	O / wt%	Si / wt%	Al / wt%	Ga / wt%	Ga / wt%
HZSM-5	46.9	50.1	3.0	0	0
0.5Ga/HZSM-5	47.1	50.2	2.5	0.2	0.3
3Ga/HZSM-5	47.5	49.5	2.7	0.3	3
10Ga/HZSM-5	40.3	50.6	3.0	6.1	9
Ga <sub>2</sub> O <sub>3</sub>	37.1	0	0	62.9	75

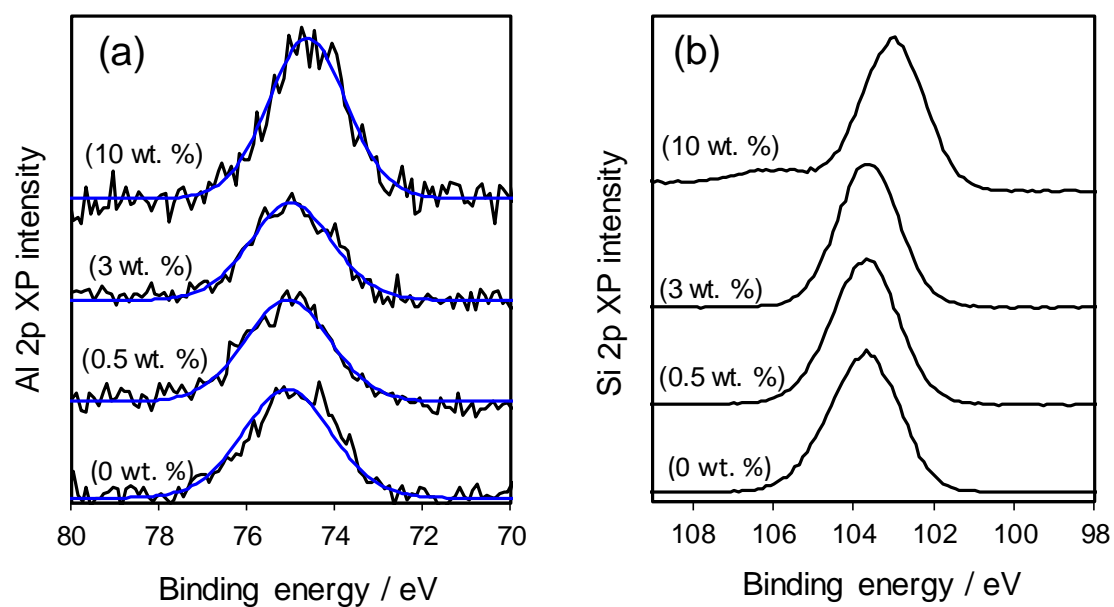


Figure S3. (a) Al and (b) Si 2p XP spectra of xGa/HZSM-5.

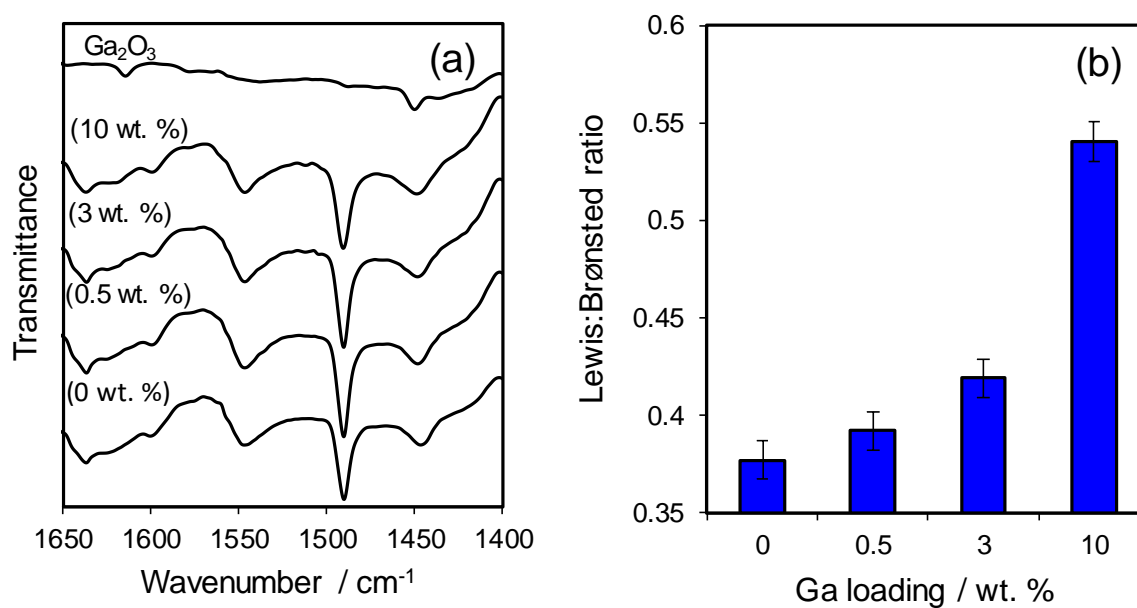


Figure S1. (a) DRIFT spectra of pyridine-saturated xGa/HZSM-5 and Ga<sub>2</sub>O<sub>3</sub> and (b) corresponding Lewis:Brønsted acid site ratio (1444 cm<sup>-1</sup>:1545 cm<sup>-1</sup> bands) for xGa/HZSM-5.

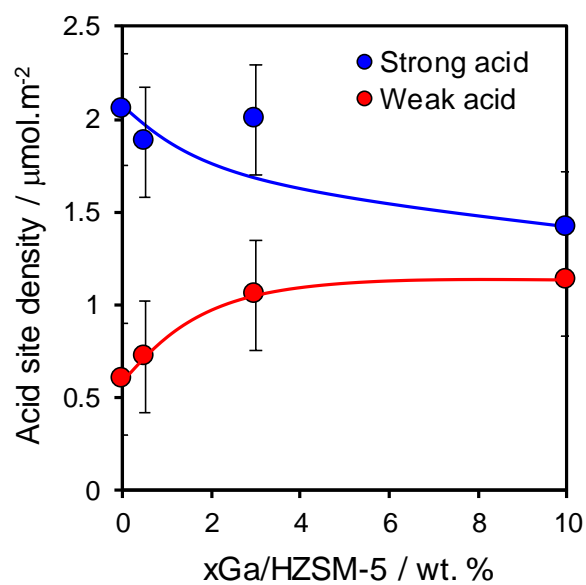


Figure S5. Density of strong and weak acid sites for xGa/HZSM-5 from propylamine TPRS.

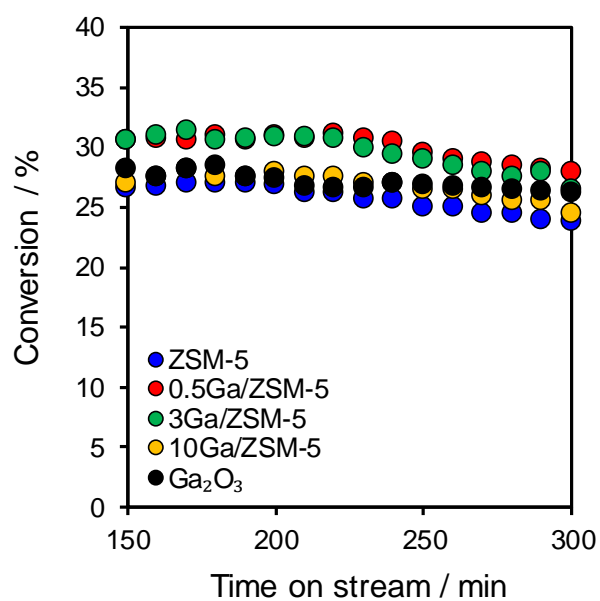
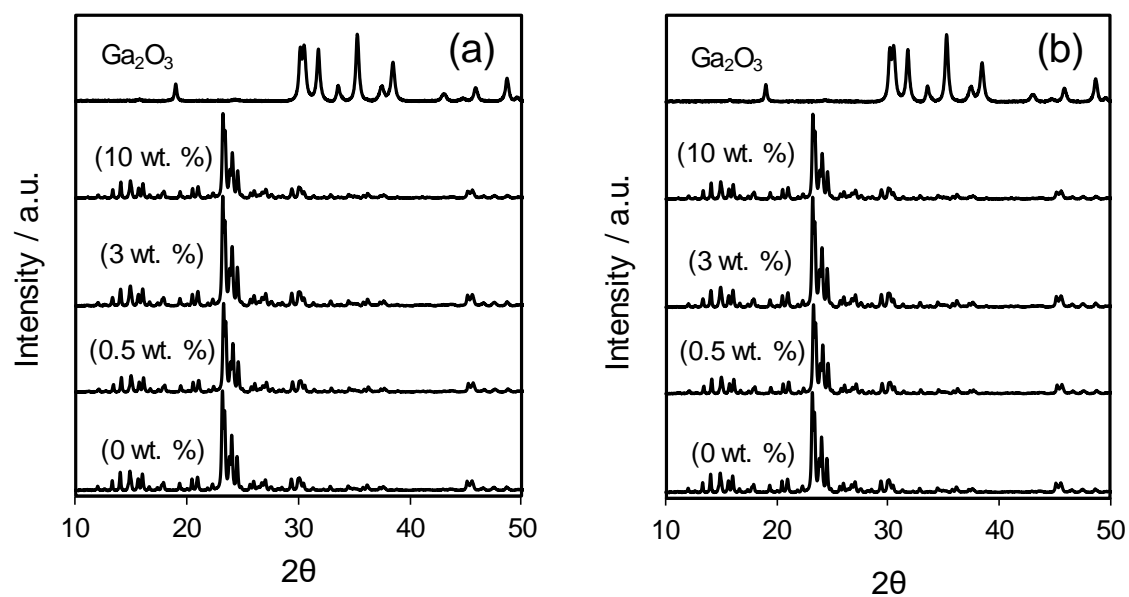


Figure S2. Acetic acid conversion over xGa/HZSM-5, and Ga<sub>2</sub>O<sub>3</sub> vs time on stream. Reaction conditions: 200 mg catalyst, at 400 °C, 0.2 mL.min<sup>-1</sup> acetic acid, 50 mL.min<sup>-1</sup> N<sub>2</sub>, 1 bar.

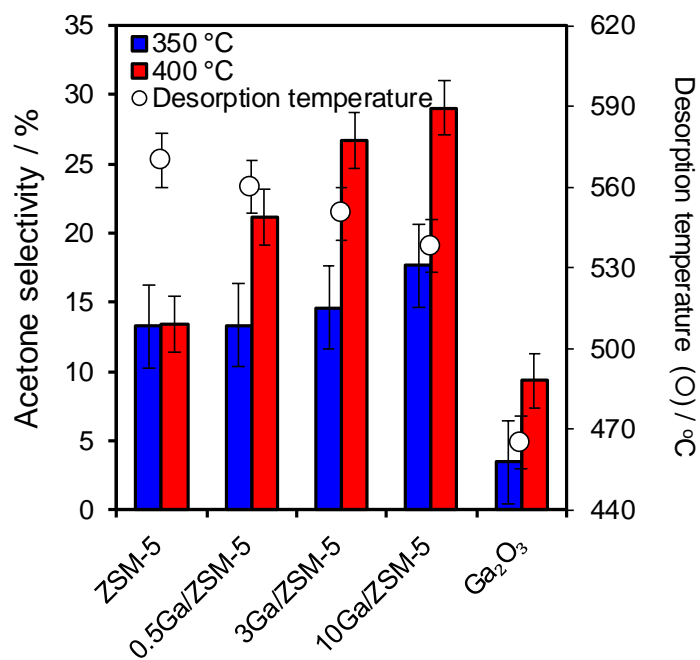


**Figure S7.** XRD patterns of (a) fresh and (b) post-reaction xGa/HZSM-5 and Ga<sub>2</sub>O<sub>3</sub>.

**Table S2.** Post-reaction carbon content of xGa/HZSM-5 and Ga<sub>2</sub>O<sub>3</sub> after 5 h acetic acid ketonisation at 400 °C.

Catalyst	Carbon content <sup>a</sup> / wt%
HZSM-5	12.0
0.5Ga/HZSM-5	11.8
3Ga/HZSM-5	12.1
10Ga/HZSM-5	11.9
Ga <sub>2</sub> O <sub>3</sub>	1

<sup>a</sup> CHNS analysis.



**Figure S8.** Correlation between acetone selectivity from acetic acid ketonisation at iso-conversion (23 % and 29 % at 350 °C and 400 °C, respectively) and acid strength from propylamine temperature-programmed reaction spectroscopy over xGa/HZSM-5, and Ga<sub>2</sub>O<sub>3</sub>. Higher temperatures indicate weaker acidity; the maximum propene desorption temperature from weak acid sites in Figure 4 is shown.