

Supplementary Material

S1 Material and methods

S1.1 Chemicals

Chemical reagents (analytical pure grade) including glucose, xylose, 5-hydroxymethylfurfural (HMF), furfural, hydrochloride acid, sodium hydroxide and sodium pyrophosphate were purchased from Aladdin (Shanghai, China).

S1.2 Physical-chemical analysis

The concentrations of 5-hydroxymethylfurfural (HMF) and furfural (FF) produced in each trial during hydrothermal reaction were determined by high pressure liquid chromatography (HPLC; Agilent Technologies 1260, USA) at 285 nm, equipped with an Agilent 5 TC-C18(2) column (250×4.6 mm). The mobile phase was made up of methanol and water mixed at a ratio of 1:9 (vol:vol), and the flow rate was set at 1 mL/min. The glucose, fructose and xylose were also detected by HPLC equipped with refractive index (RI) detector and Hi-Plex Ca column (300×7.7 mm); water at a temperature of 80°C was used as the mobile phase with flow rate set at 0.6 mL/min.

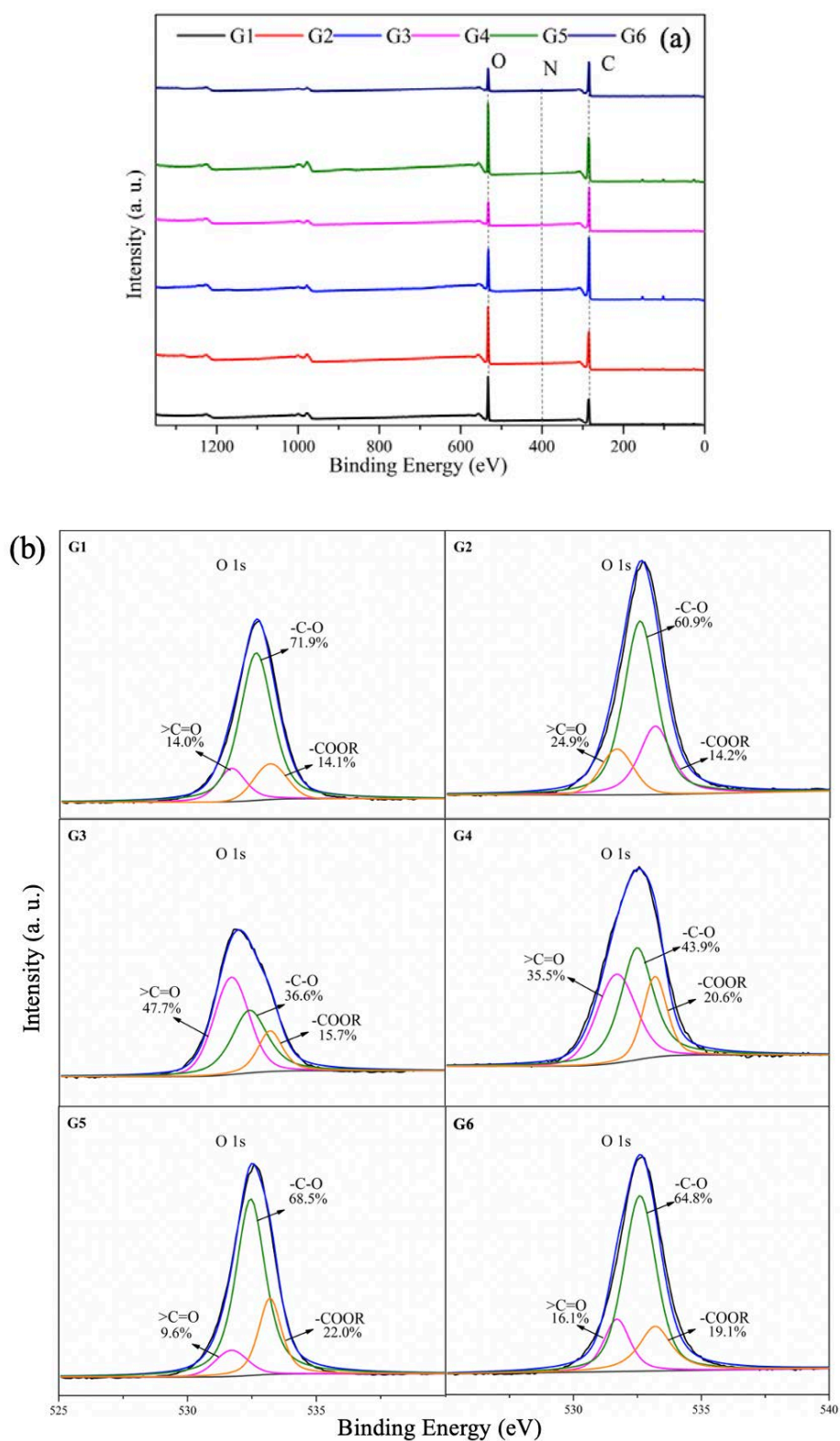


Fig. S1 (a) XPS full survey of each hydrochar; (b) high-resolution XPS scan of the O 1s for each hydrochar.

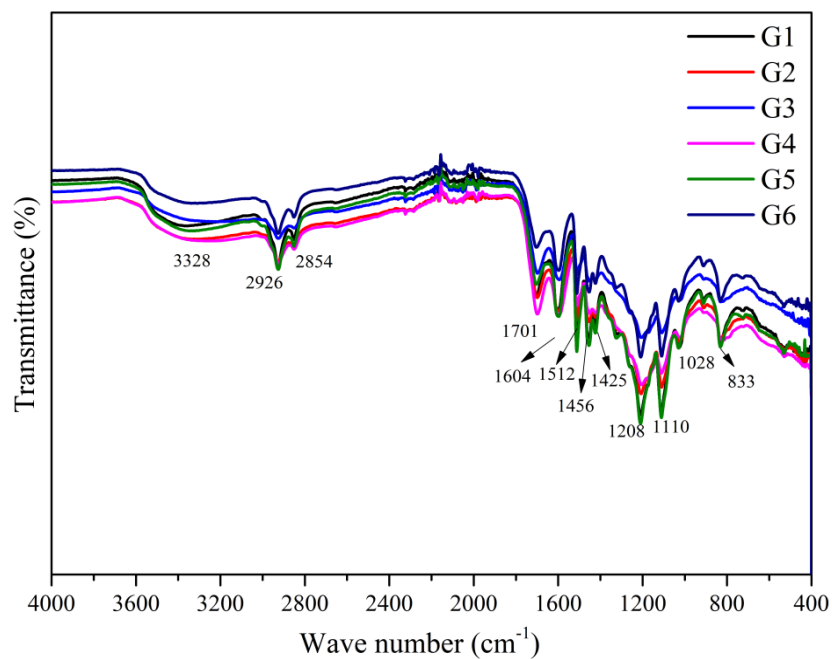


Fig. S2 The FT-IR spectra of each HHA_{alk} from different hydrochars under alkaline hydrothermal condition.

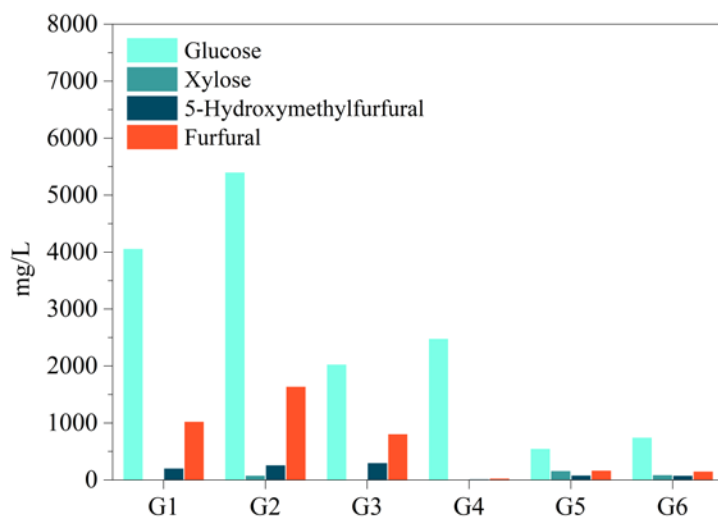


Fig. S3 The content of humic acid precursors including glucose, xylose, 5-hydroxymethylfurfural and furfural in each hydrothermal solution.

Table S1 The ultimate analysis of each hydrochar and hydrothermal humic acid (HHA) produced under different hydrothermal temperatures and pH.

Groups		N (wt%)	C (wt%)	H (wt%)	O (wt%)	H/C	O/C	Degree of unsaturation
Hydrochar	G1	0.16	56.14	6.08	37.62	1.30	0.50	2.64
	G2	0.44	61.45	5.36	32.76	1.05	0.40	3.44
	G3	0.57	69.95	5.21	24.27	0.89	0.26	4.23
	G4	0.29	66.97	5.08	27.67	0.91	0.31	4.04
	G5	0.37	53.26	6.18	40.19	1.39	0.57	2.35
	G6	0.38	54.51	6.15	38.97	1.35	0.54	2.47
HHA	G1	0.40	69.23	5.99	24.38	1.04	0.26	3.77
	G2	0.45	68.60	5.44	25.51	0.95	0.28	4.00
	G3	0.52	69.77	5.06	24.65	0.87	0.26	4.28
	G4	2.07	75.29	5.13	17.52	0.82	0.17	4.71
	G5	1.10	68.23	6.11	24.55	1.07	0.27	3.63
	G6	1.13	68.18	5.97	24.72	1.05	0.27	3.69

Notes: The element content was calculated based on weight of hydrochar and hydrothermal humic acid (dry basis).