Supporting Information (SI)

Aluminium-Biochar Composites as Sustainable Heterogeneous Catalysts for Glucose Isomerisation in a Biorefinery

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Table S1. Binding energies reported in the literature.

XPS	Components	Symbols	Binding energies (eV)	References
O 1s	Chemisorbed H_2O or O_2		535.3	[1]
	Anhydride, lactone, carboxylic acids	O-C=O	533.3	[1]
	Hydroxyl, ethers	C-OH, C-O-C	532.1	[1]
	Al-OH hydroxyl	Al-OH	531.4	[2, 3]
	Carbonyl, quinone	C=O	530.7	[1]
	Al oxide	Al-O	530.4	[2]
C 1s	Carboxylic groups, esters, and lactones	O-C=O	288.4	[4]
	Ketone, aldehyde	C=O	287	[5]
	Ether,epoxy	C-O-C	286.3	[5]
	Alcohol	C-OH	285.6	[5]
	Carbon-carbon	C-C	284.6	[6]
	Graphitic	C sp2	284.4	[5]
Al 2p	Tetrahedrally or octahedrally coordinated Al	Al[4], Al[6]	76.8	[7]
	Alumina	Al_2O_3	75.8-76	[7,8]
	Bayerite	β-$Al(OH)_3$	75	[3]
	Gibbsite, Al-O-C	γ-$Al(OH)_3$, Al-O-C	74.4	[3, 9]
	Boehmite	γ-AlO(OH)	73.9	[3]
	Metallic Al	Al	72.2-72.8	[7, 9]

References

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Table S2. XPS results of elemental composition of selected Al biochars.

	Atomic (%)		
Sample	**Al 2p**	**O 1s**	**C 1s**
0%Al-500N2	0.5	12	87.5
10%Al-500N2	10.6	31.7	57.7
10%Al-600N2	11.2	31.5	57.3
10%Al-700N2	10.6	27.4	62
20%Al-500N2	15.8	40.1	44
20%Al-500N2-Reused	18.3	27.1	54.7

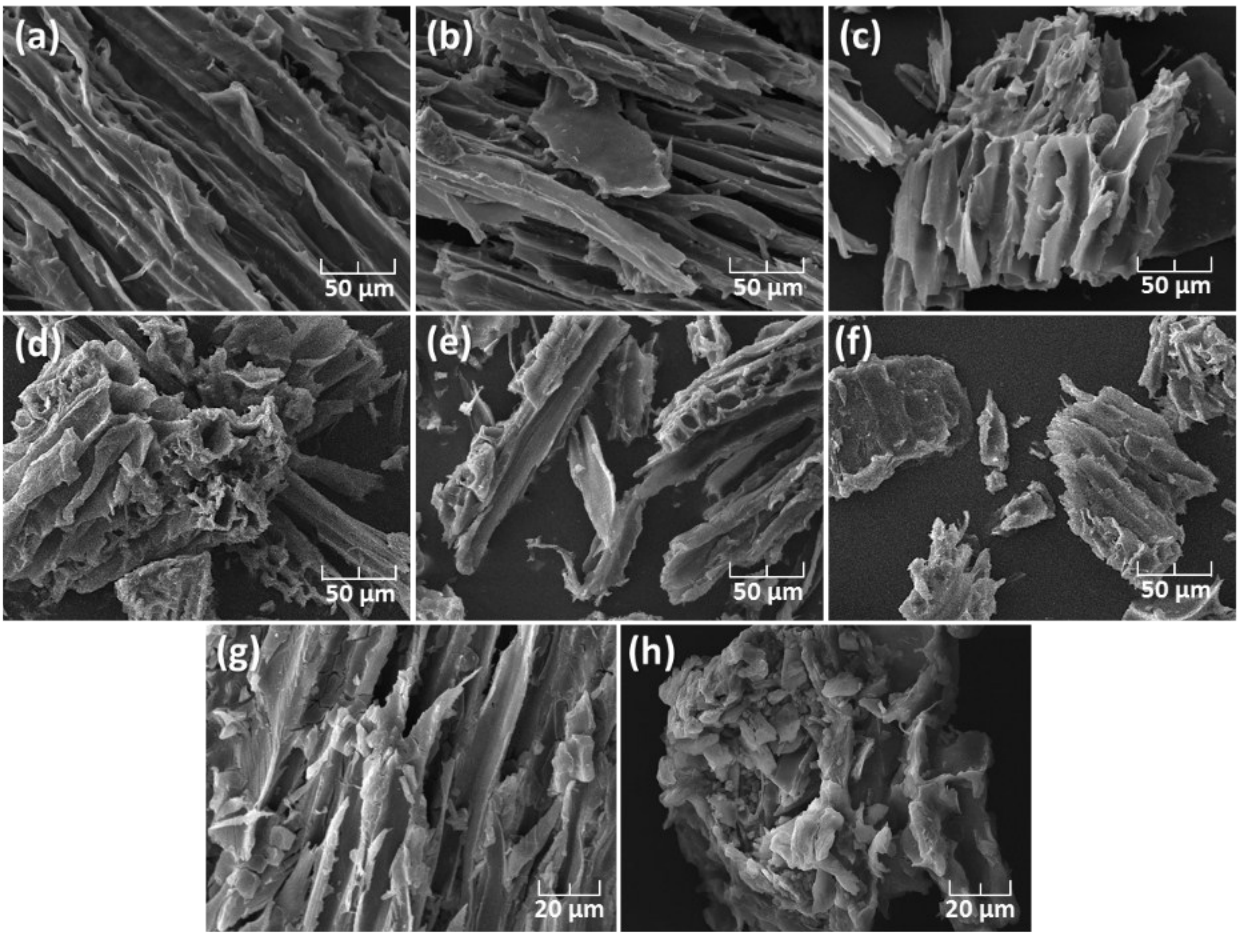

Figure S1. SEM images (1000 x) of (a) 10%Al-500N_2, (b) 10%Al-600N_2, (c) 10%Al-700N_2, (d) 10%Al-500CO_2, (e) 10%Al-600CO_2, (f) 10%Al-750CO_2, and SEM images (2000 x) of (g) 20%Al-500N_2 and (h) 20%Al-500N_2-Reused.

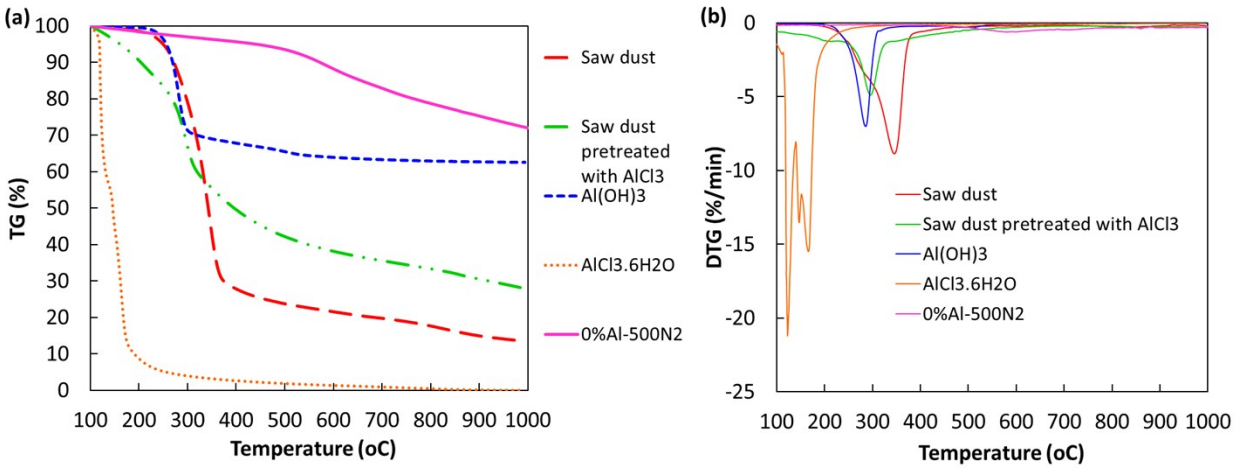

Figure S2. TG and DTG of 0%Al-500N_2, sawdust samples, and standard Al compounds.

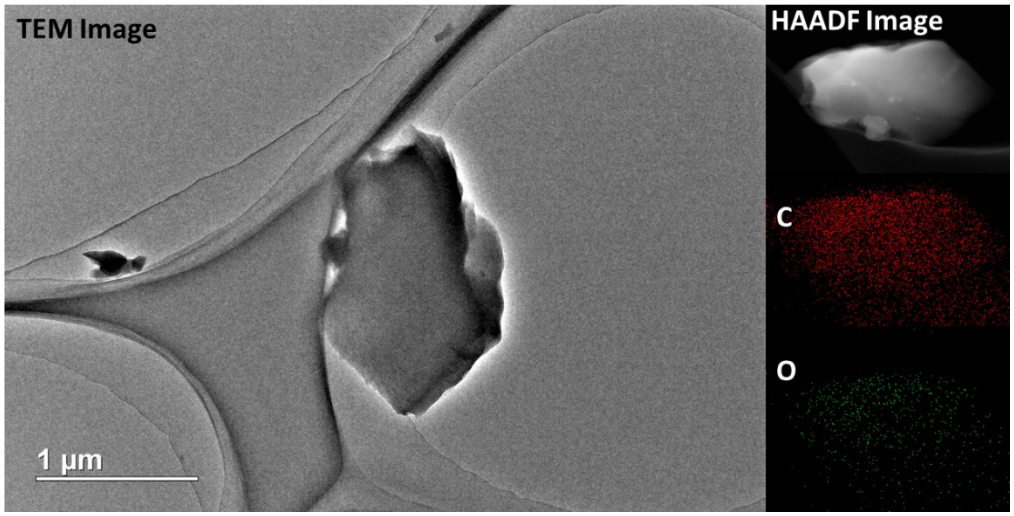

Figure S3. TEM-EDX mappings of 0%Al-500N_2.

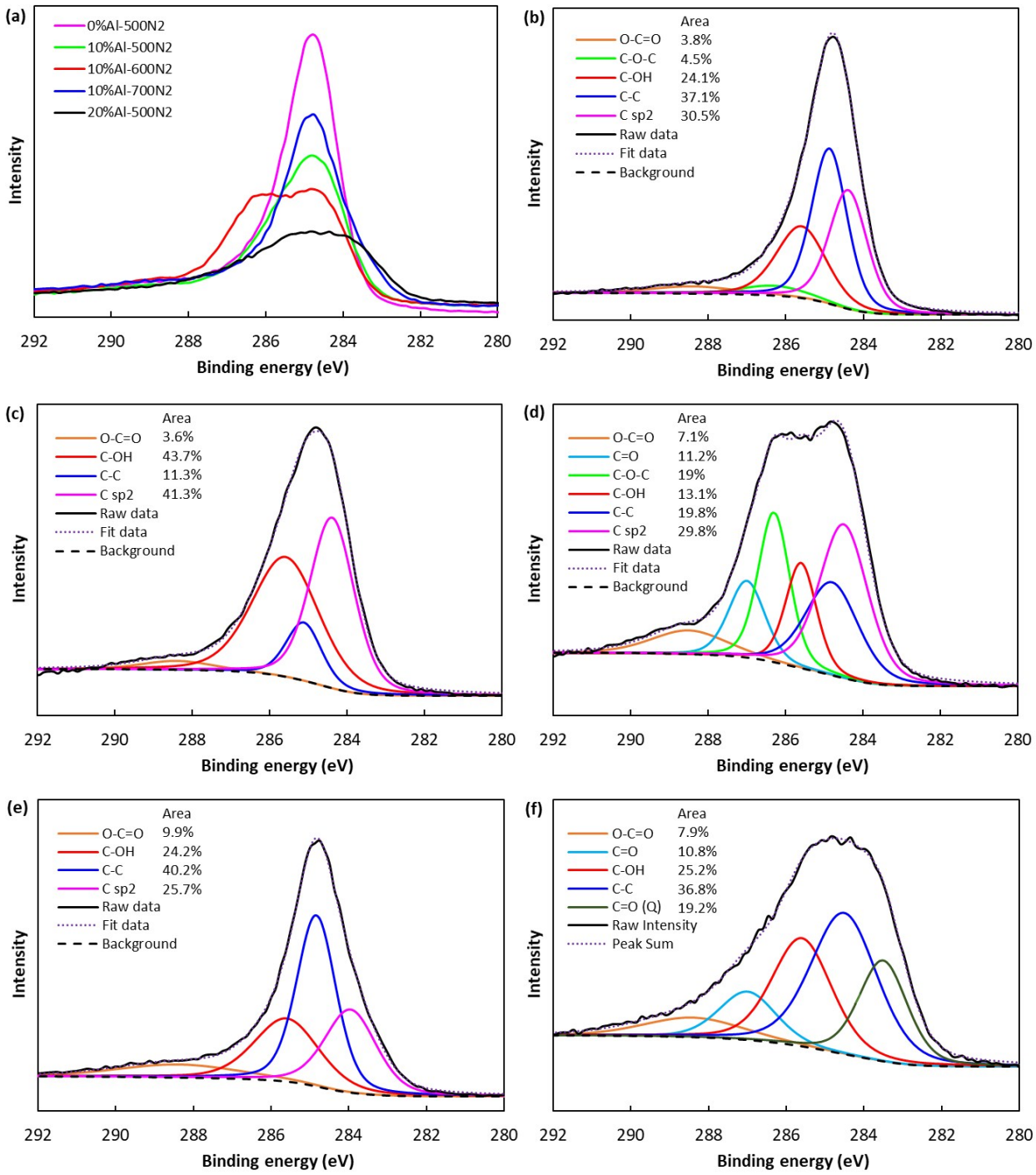

Figure S4. C 1s XPS spectra of (a) N_2 biochars as well as curve fitting for (b) 0%Al-500N_2, (c) 10%Al-500N_2, (d) 10%Al-600N_2, (e) 10%Al-700N_2, and (f) 20%Al-500N_2.

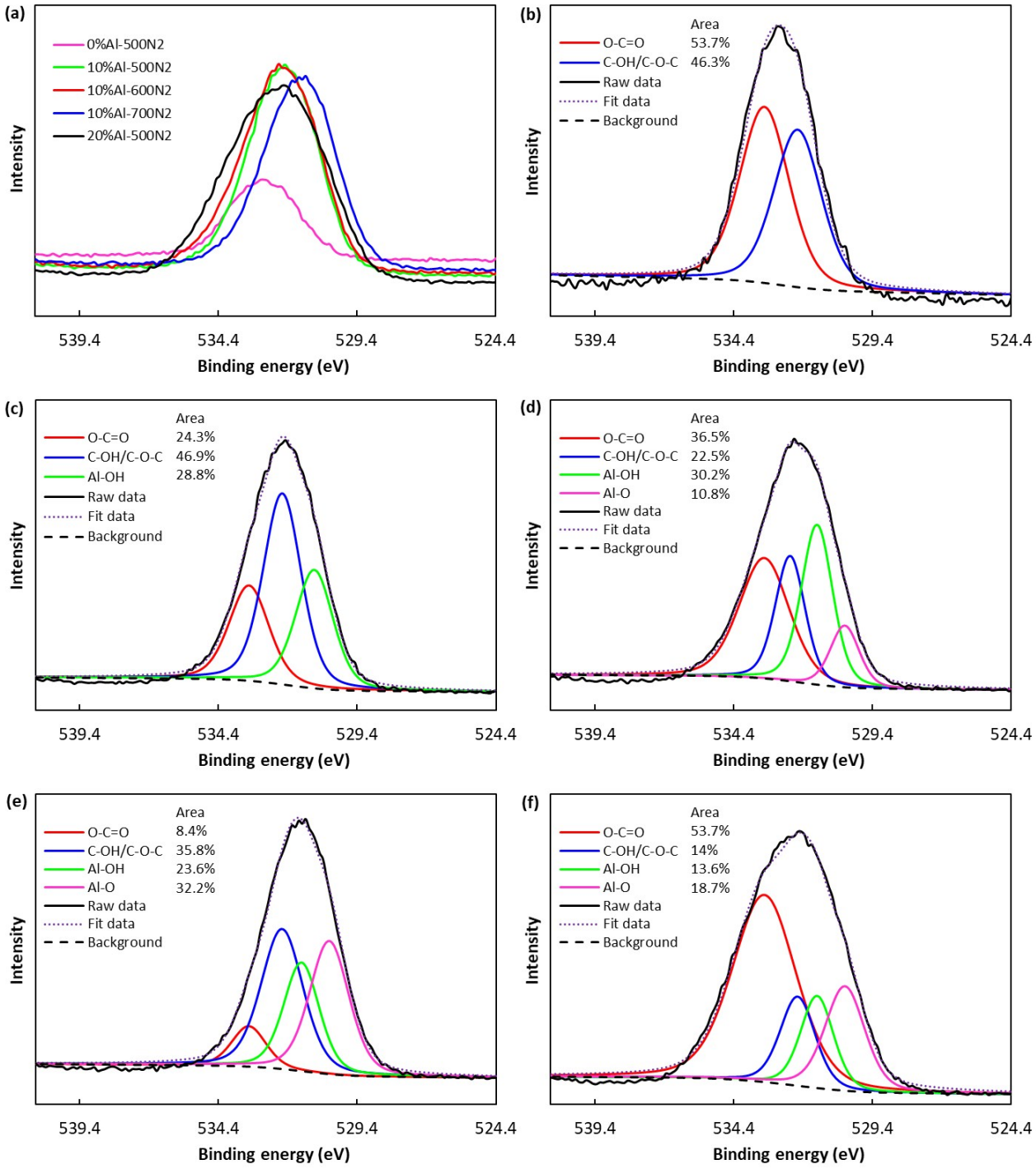

Figure S5. O 1s XPS spectra of (a) N_2 biochars as well as curve fitting for (b) 0%Al-500N_2, (c) 10%Al-500N_2, (d) 10%Al-600N_2, (e) 10%Al-700N_2, and (f) 20%Al-500N_2.

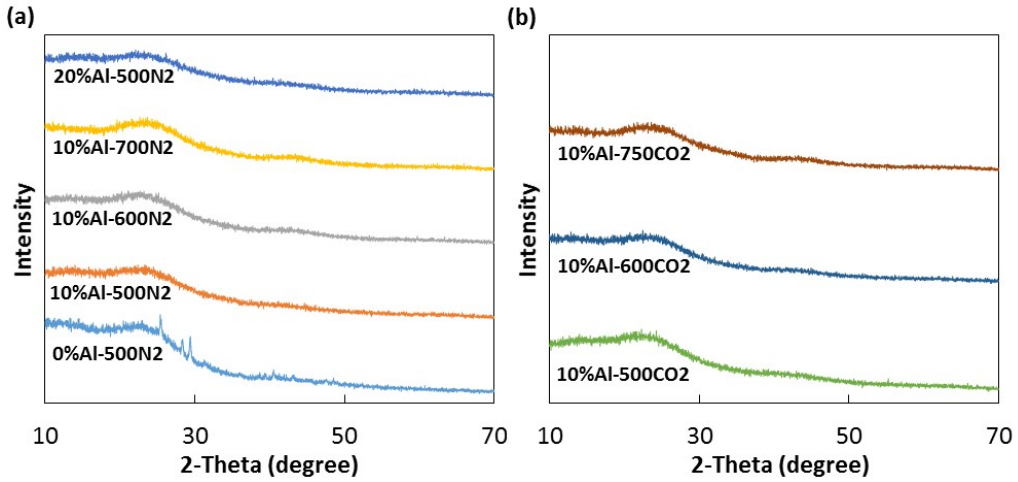

Figure S6. XRD patterns of Al biochars produced via pyrolysis in (a) N_2 and (b) CO_2.

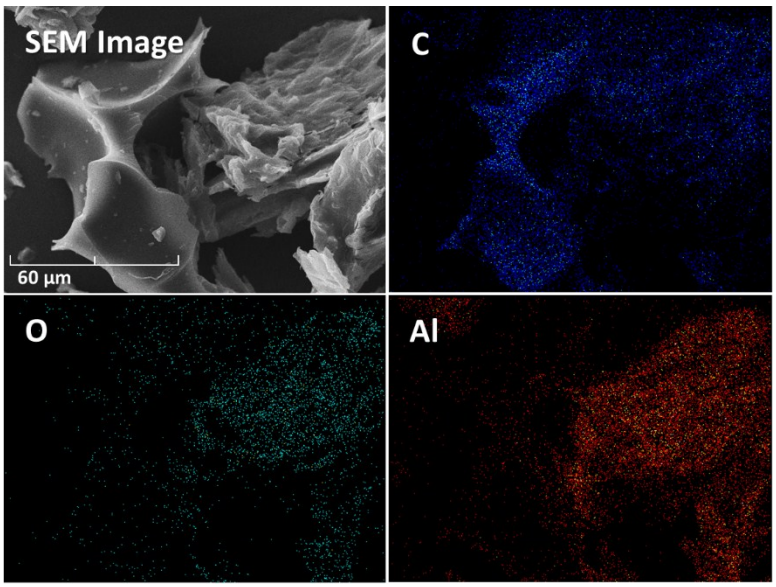

Figure S7. SEM-EDX mappings of 10%Al-750CO_2.

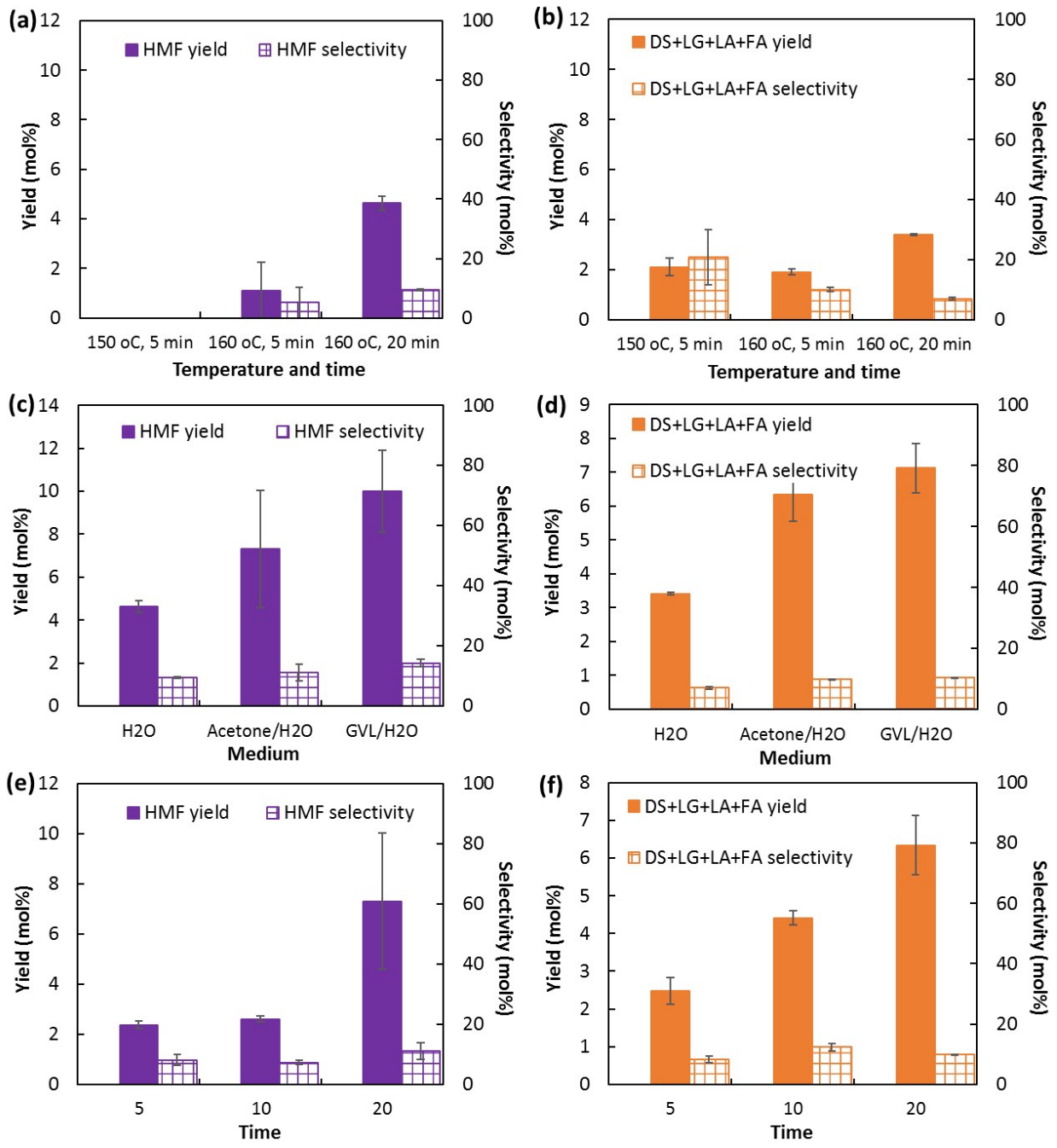

Figure S8. Yield and selectivity of (a, c, e) HMF and (b, d, f) other products (i.e., disaccharide (DS), levoglucosan (LG), levulinic acid (LA), and formic acid (FA)) resulted from the catalytic conversion of glucose over 20%Al-500N_2 (conditions: 0.5 g glucose and 0.25 g Al biochar in 10 ml (a&b) water at 160 ^oC, (c&d) in different media at 160 ^oC for 20 min, and (e&f) in acetone/H_2O at 160 ^oC for different reaction time; yield = $product_{Cmol}/glucose_{Cmol} \times 100\%$; selectivity = $product_{Cmol}/(initial\ glucose_{Cmol} - final\ glucose_{Cmol}) \times 100\%$).

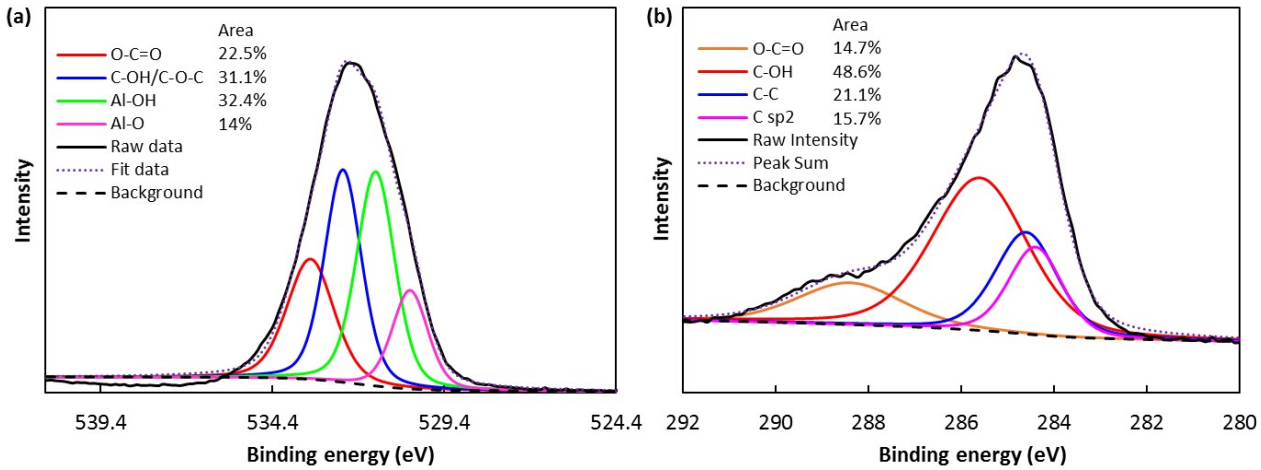

Figure S9. (a) O 1s and (b) C 1s XPS spectra and curve fitting for 20%Al-500N_2-reused.