SUPPLEMENTAL INFORMATION

Deep eutectic solvents regulates lignin: in situ synthesis of low curing temperature phenolic resin

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The PDF file includes: Figure S1 to S12; Table S1 to S2.

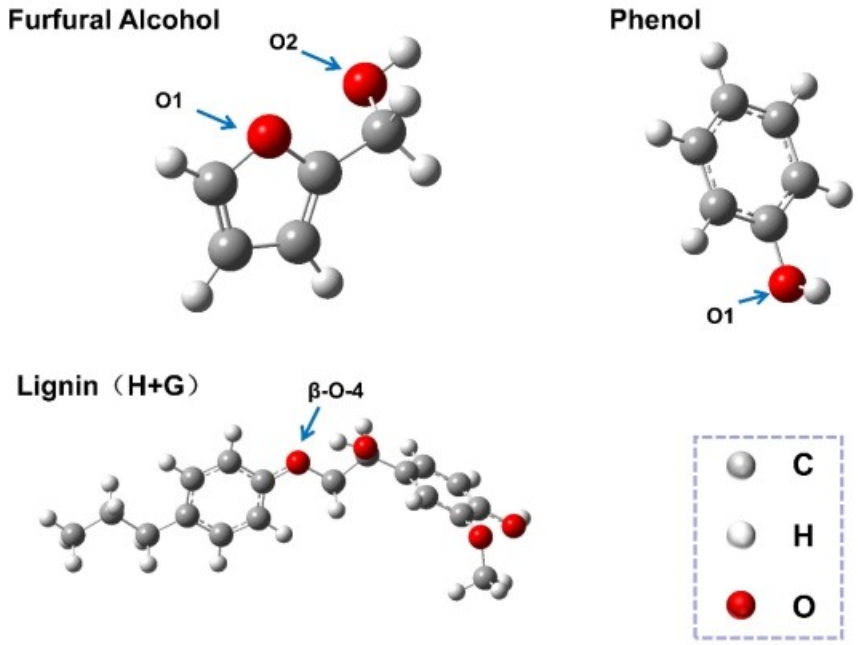

Figure S1. Optimized molecular structure and atomic positions of PFA-DES interacting with lignin models

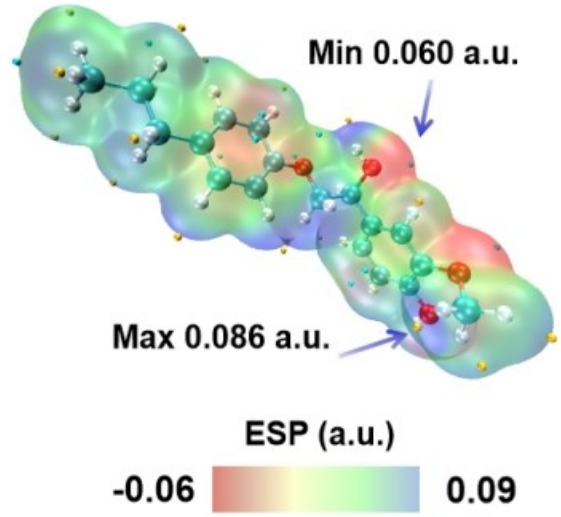

Figure S2. ESP image of lignin

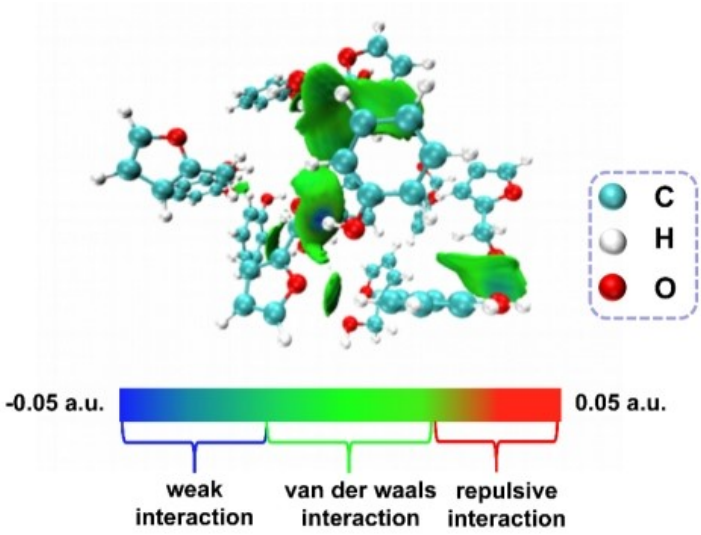

Figure S3. IGMH diagram

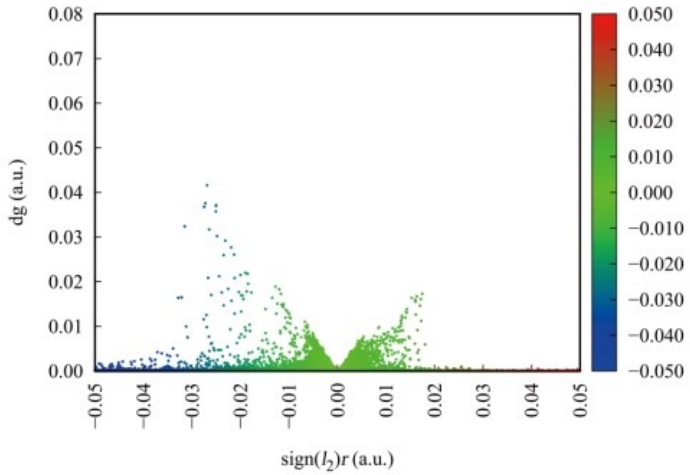

Figure S4. Scatter plot of IGMH data

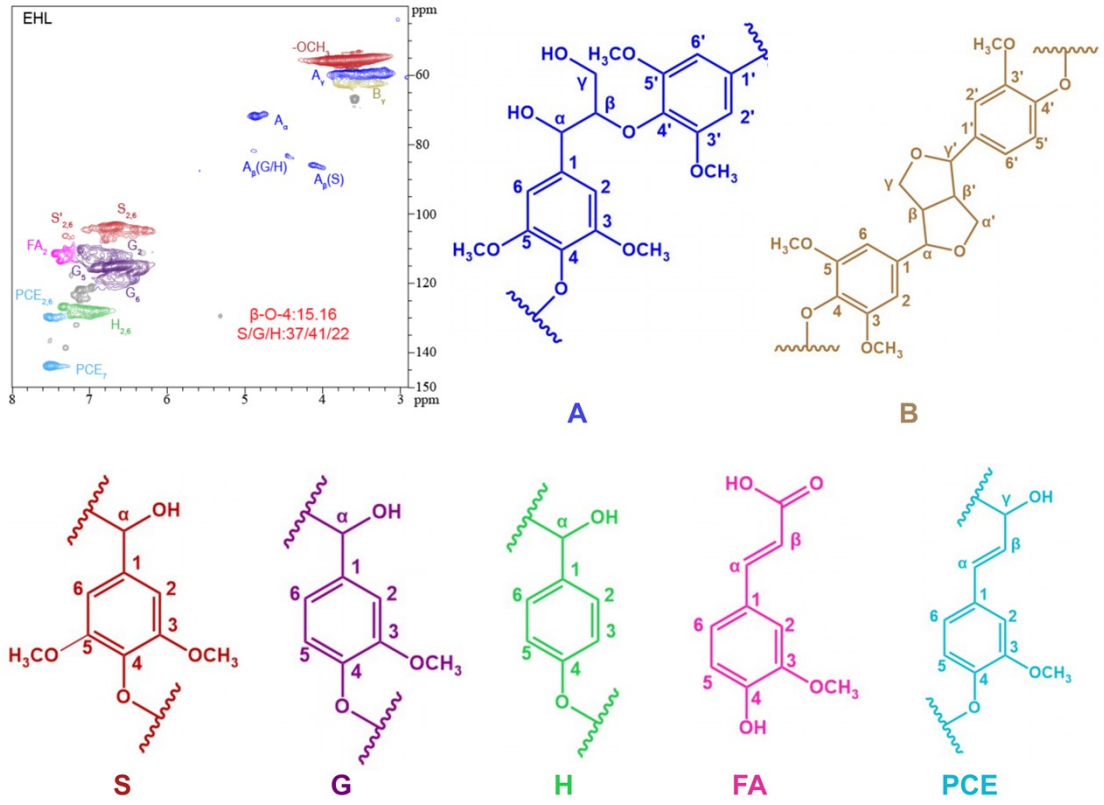

Figure S5. 2D-HSQC NMR spectra of lignins (aliphatic area and aromatic area) and main linkages and structural units: A (β-O-4), B (β-β), G (guaiacyl), S (eugenyl), H (p-hydroxyphenyl), FA (ferulic acid), and PCE (p-coumaric acid).

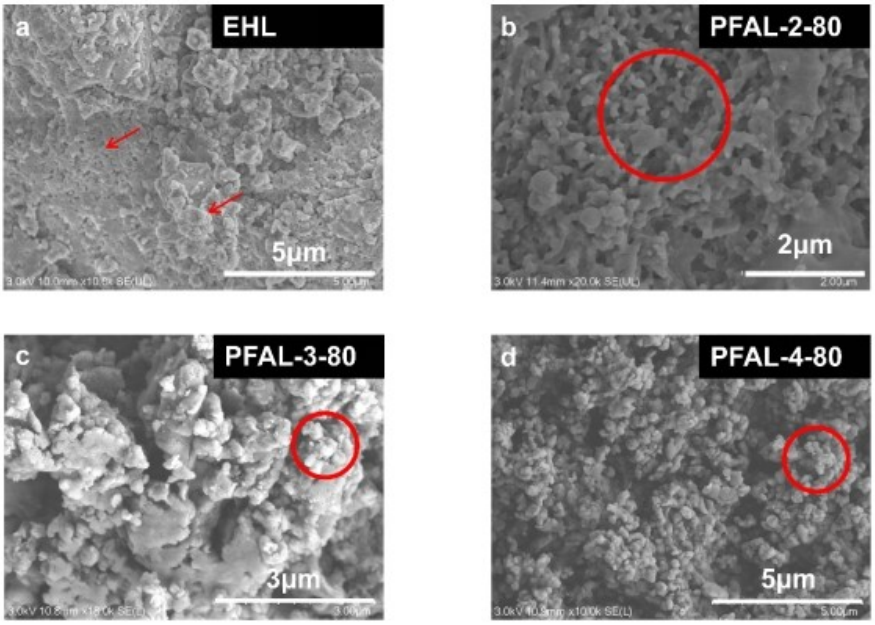

Figure S6. SEM spectra of EHL and modified lignin in 80 ℃

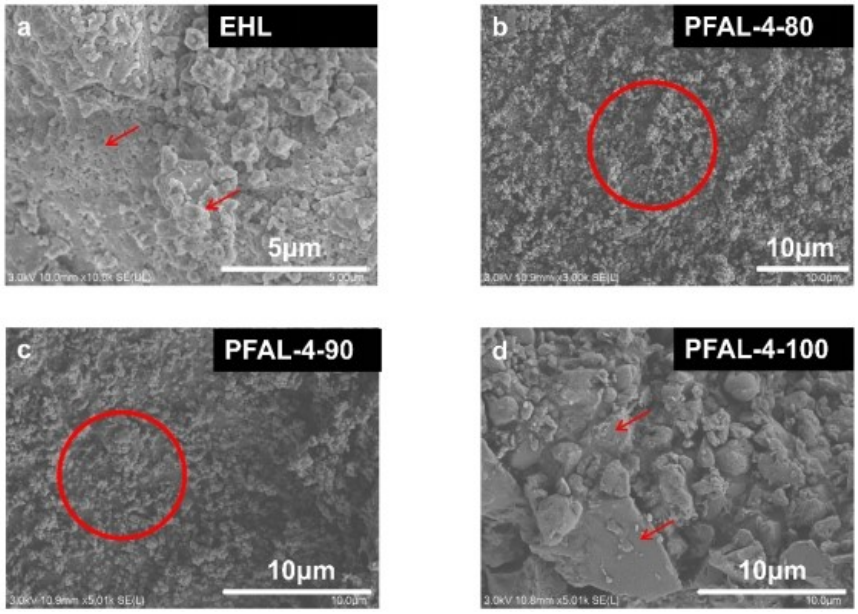

Figure S7. SEM spectra of EHL and modified lignin in 4h

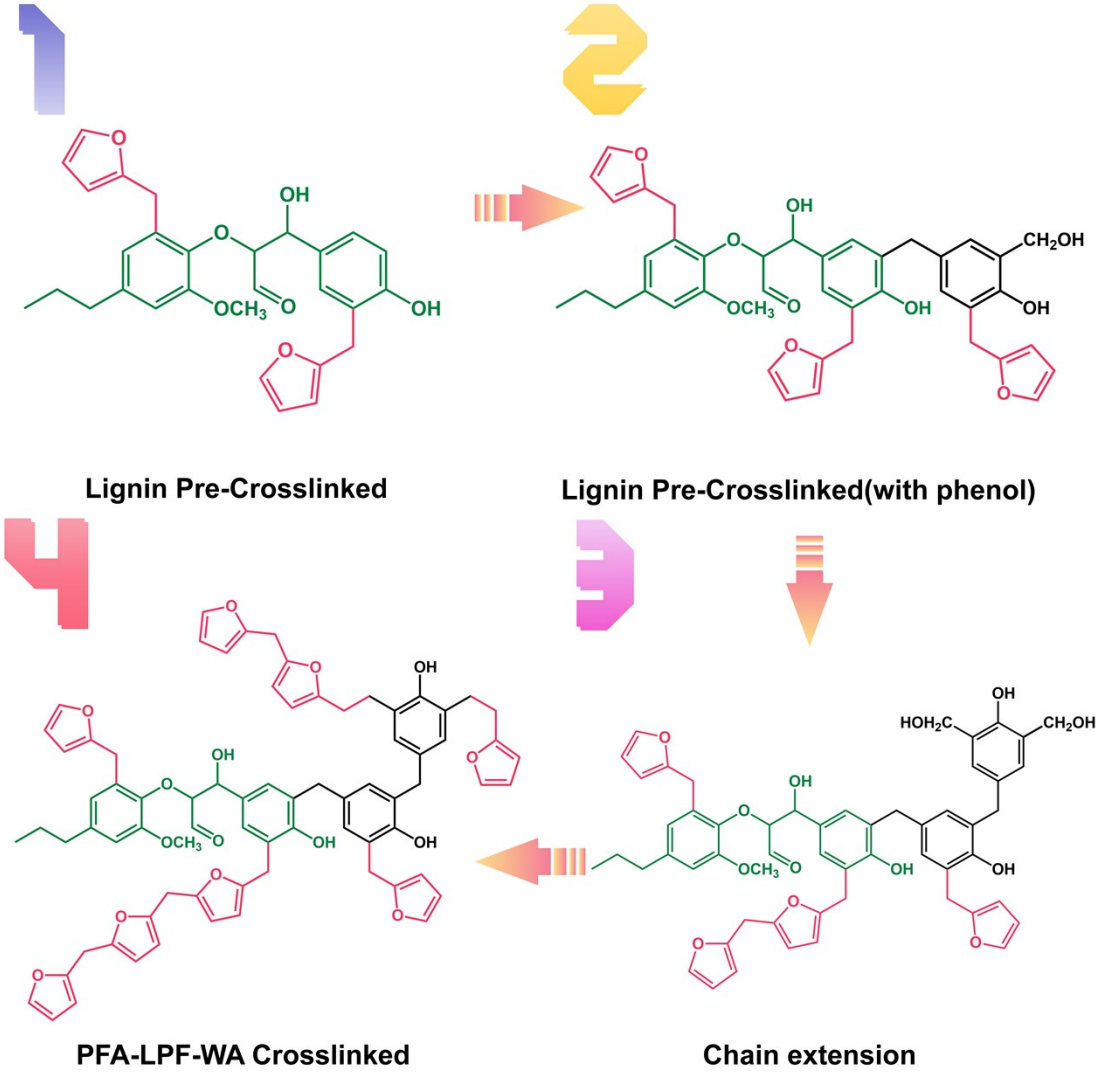

Figure S8. Schematic diagram of the synthesis of the PFA-LPF-WA main structure

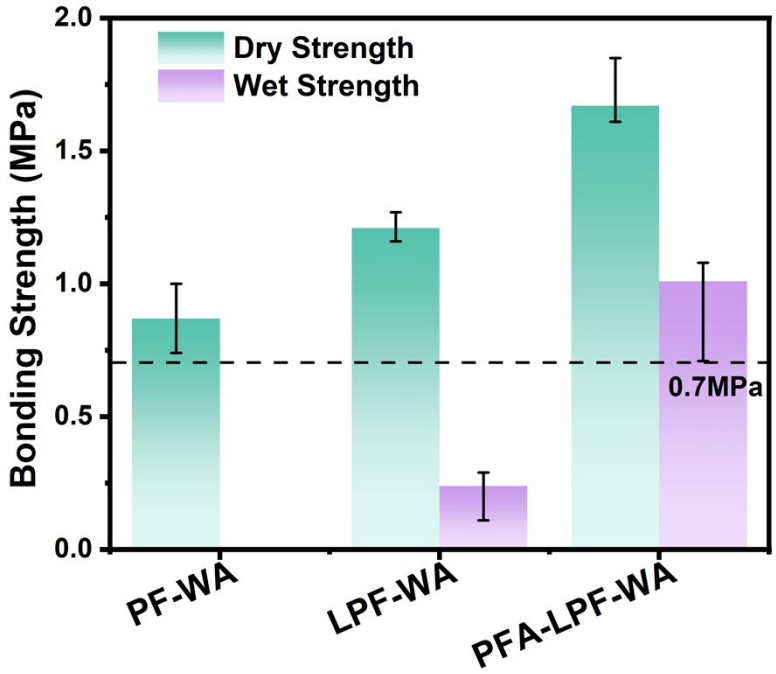

Figure S9. Bonding strength of adhesives with oxalic acid.

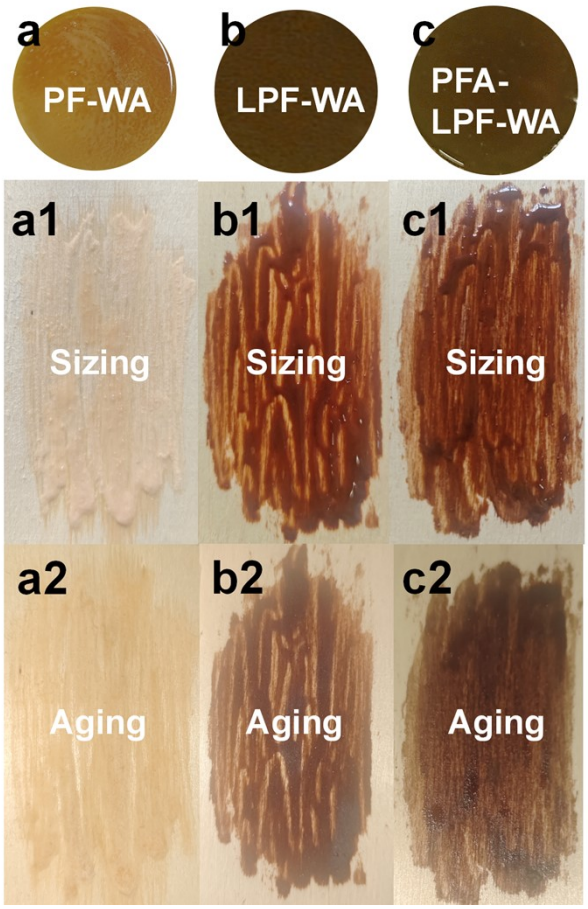

Figure S10. Appearance of oxalic-acid-containing adhesives (a-c), their spreading behavior on veneer (a1-c1), and their appearance after aging (a2-c2)..

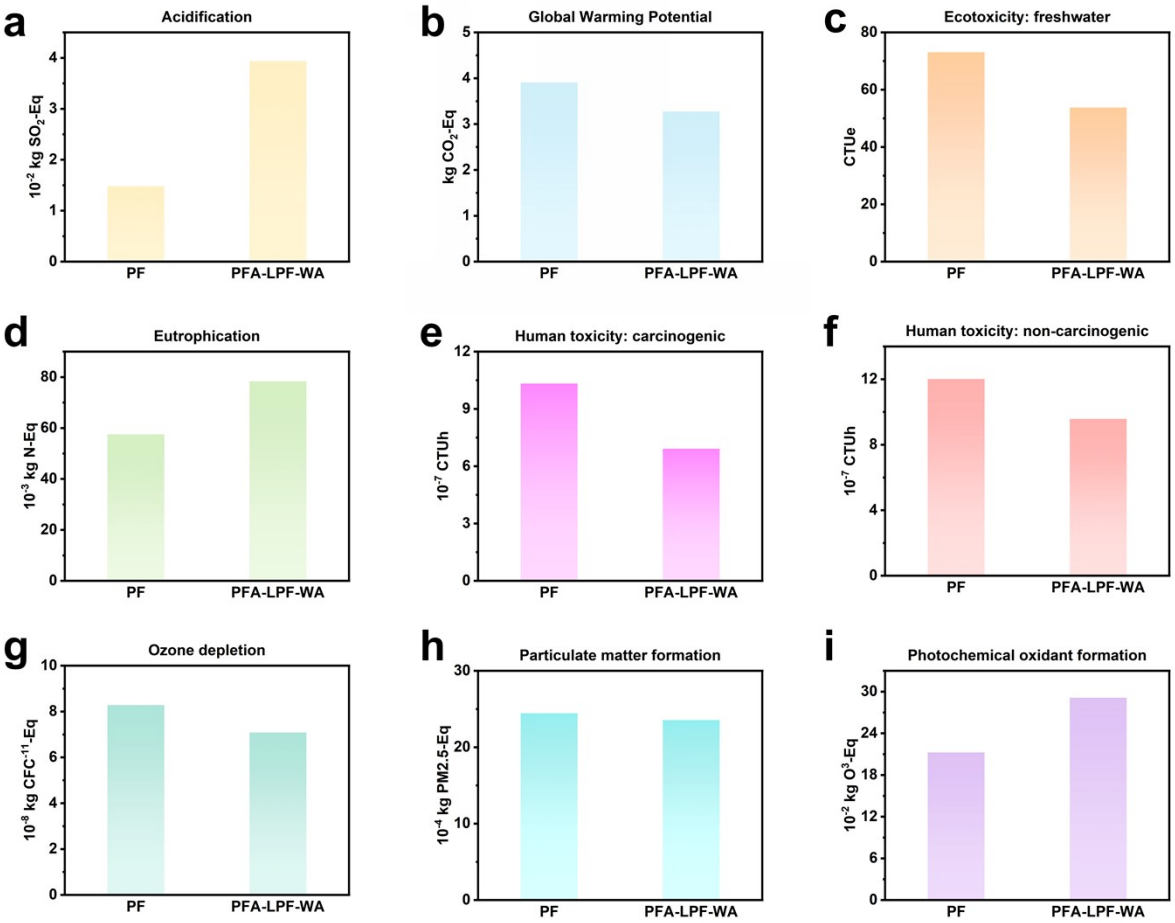

Figure S11. The specific values of the LCA for PF and PFA-LPF-WA.

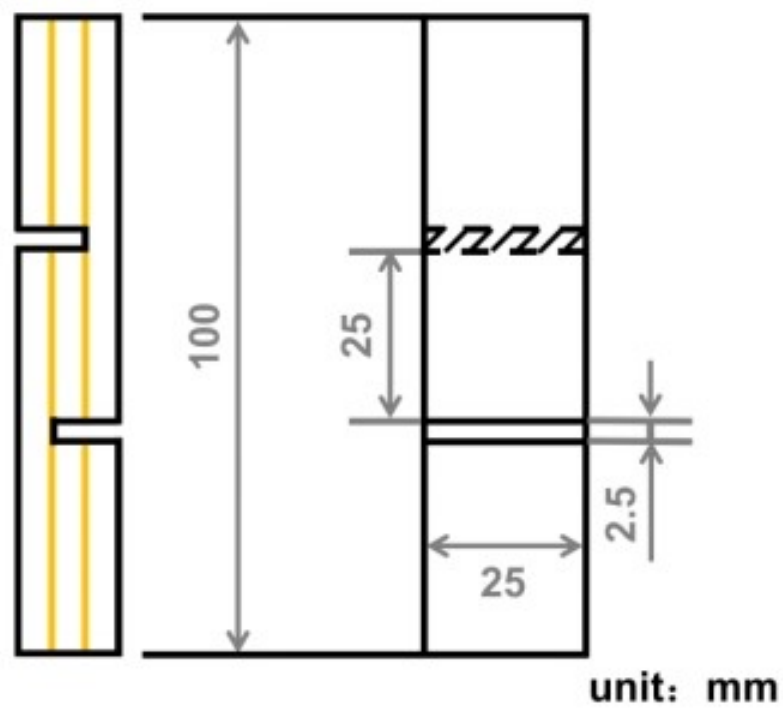

Figure S12. Schematic diagram of the cutting of bonded specimens

Table S1. Lignin phenol hydroxyl content and molecular weight

Sample	Phenolic hydroxyl（mmol/g）	M_w	M_n	PDI（M_w/M_n）
EHL	3.95	2608	1345	1.94
PFAL-2-80	2.91	3808	1636	2.33
PFAL-3-80	1.98	5736	2090	2.75
PFAL-4-80	0.81	-	-	-
PFAL-2-90	1.79	3814	1304	2.92
PFAL-3-90	1.03	4125	1417	2.91
PFAL-4-90	1.28	5176	1633	3.17
PFAL-2-100	1.88	5964	1873	3.18
PFAL-3-100	0.40	5288	1976	2.68
PFAL-4-100	0.72	9840	2755	3.57

Table S2. Cost of PFA-LPF-WA per Tonne

Components/Energy	Consumption (t or kW·h)	Prices (¥/ t or kW·h)	Cost (¥)
Water	0.379	3 ~ 5	1~2
Electricity	15.4	0.3 ~ 0.5	5~6
EHL	0.05	800 ~ 1000	40~50
Furfuryl alcohol	0.32	8000~9500	2560~3040
formaldehyde solution (37 wt%)	0.334	1000 ~ 1100	334~368
Oxalic acid	0.08	2000 ~ 2500	160~200
Phenol	0.2	6000~6300	1200~1260
Total		4300~4926	