Cell Reports Physical Science, Volume *3*

Supplemental information

A low-corrosivity structural timber

Sicen Yu, Yu Liu, Chaoji Chen, Shijie Feng, Amanda Pia Siciliano, Liangbing Hu, and Ping Liu

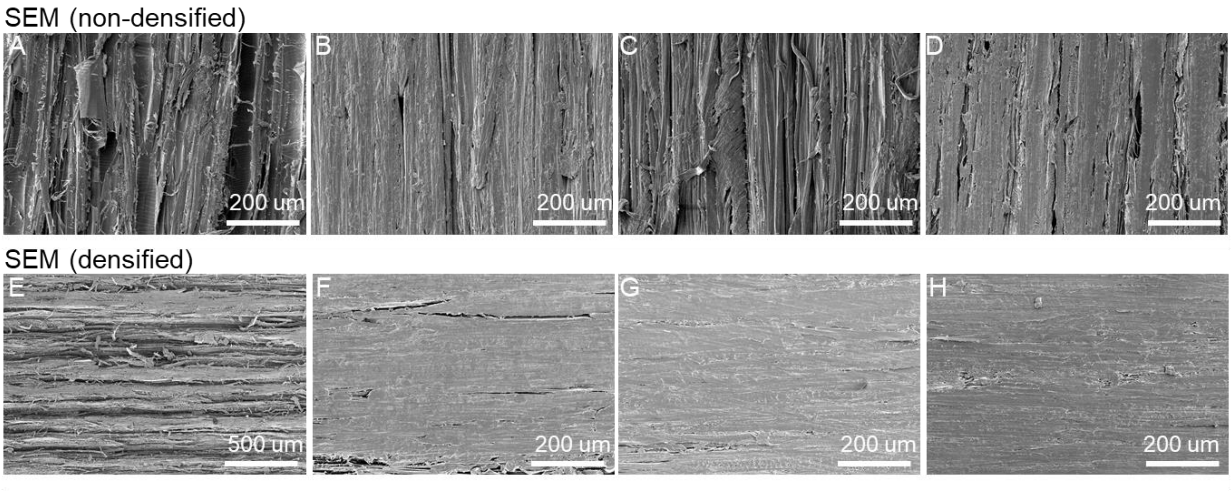

Figure S1. Cross-sectional morphology of basswood samples. (A) Natural basswood, (B) 4h-delignified wood, (C) 8h-delignified wood, (D) 12h-delignified wood, (E) Densified natural wood, (F) Densified 4h-delignified wood, (G) Densified 8h-delignified wood, and (H) Densified 12h-delignified wood.

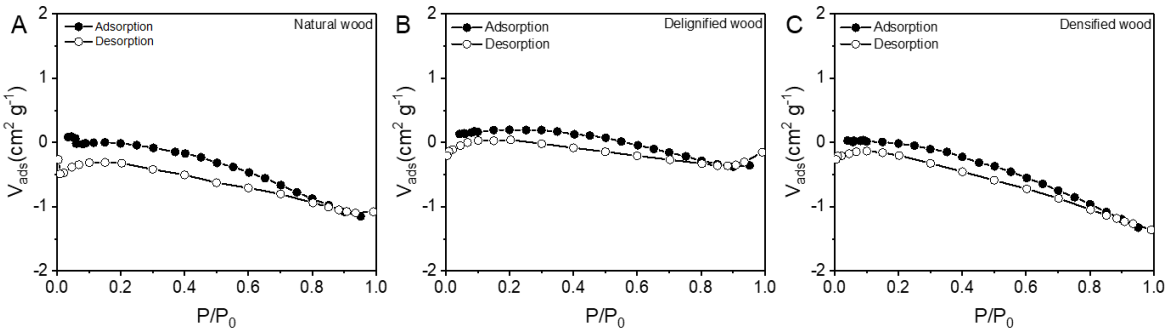

Figure S2. BET results of wood samples. (A) Natural wood, (B) delignified wood, and (C) densified wood. N_2 sorption at 77K.

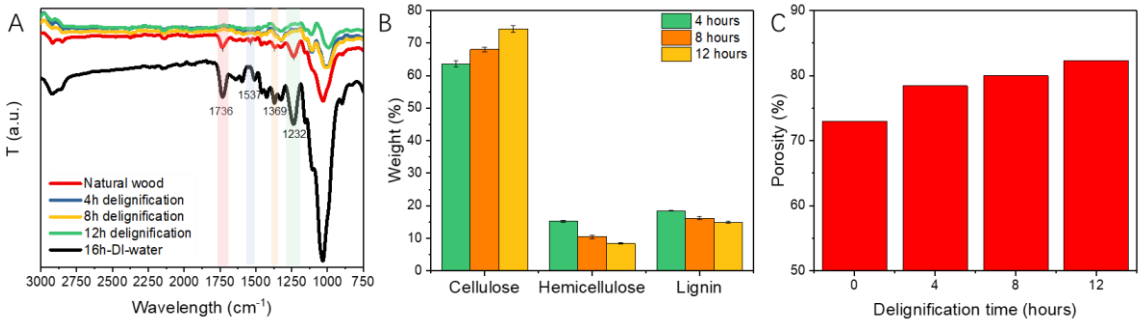

Figure S3. Wood characterizations. (A) IR spectra of natural basswood, delignified wood (delignification time: 4, 8, and 12 h) and basswood boiled with deionized water (DI-water) over 16 h. (B) Wood compositions and (C) porosities of delignified wood (delignification time: 4, 8, and 12 h). The error bars describe the ranges of three repeated data points.

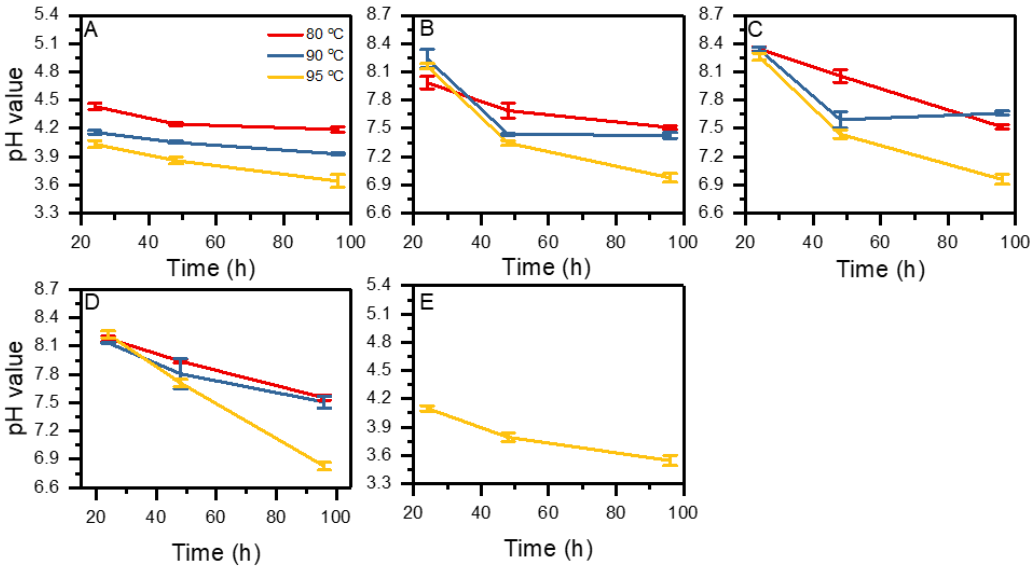

Figure S4. pH evaluation of basswood samples soaked in water. (A) Natural basswood, (B) 4h-delignified wood, (C) 8h-delignified wood, and (D) 12h-delignified wood at 80°C, 90°C, and 95°C, respectively. (E) Basswood (boiled in DI-water over 16 hours) evaluated at 95°C. The error bars describe the ranges of three repeated data points.

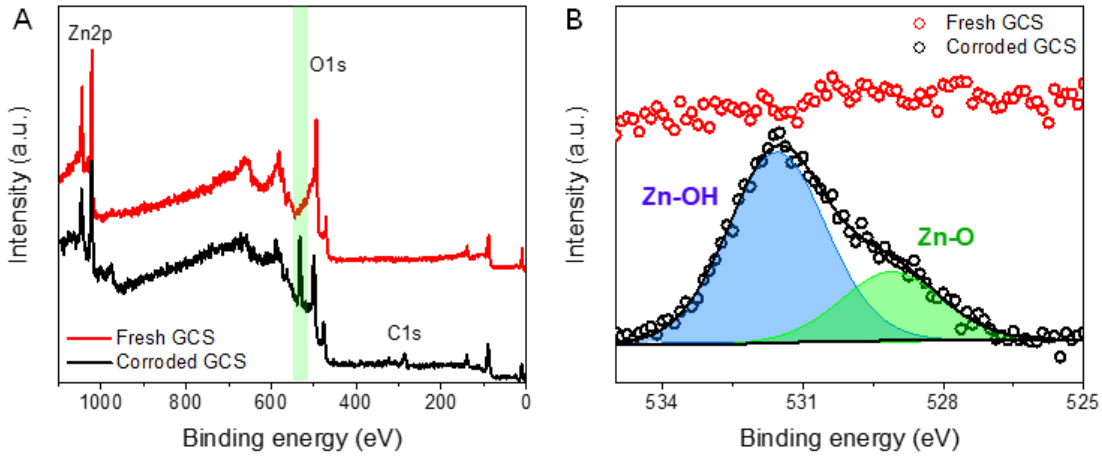

Figure S5. XPS analysis of corrosion products. (A) Survey and (B) O1s of fresh GCS and corroded GCS in densified wood. The O1s peaks of the corroded GCS represent the signals of Zn-OH and Zn-O.

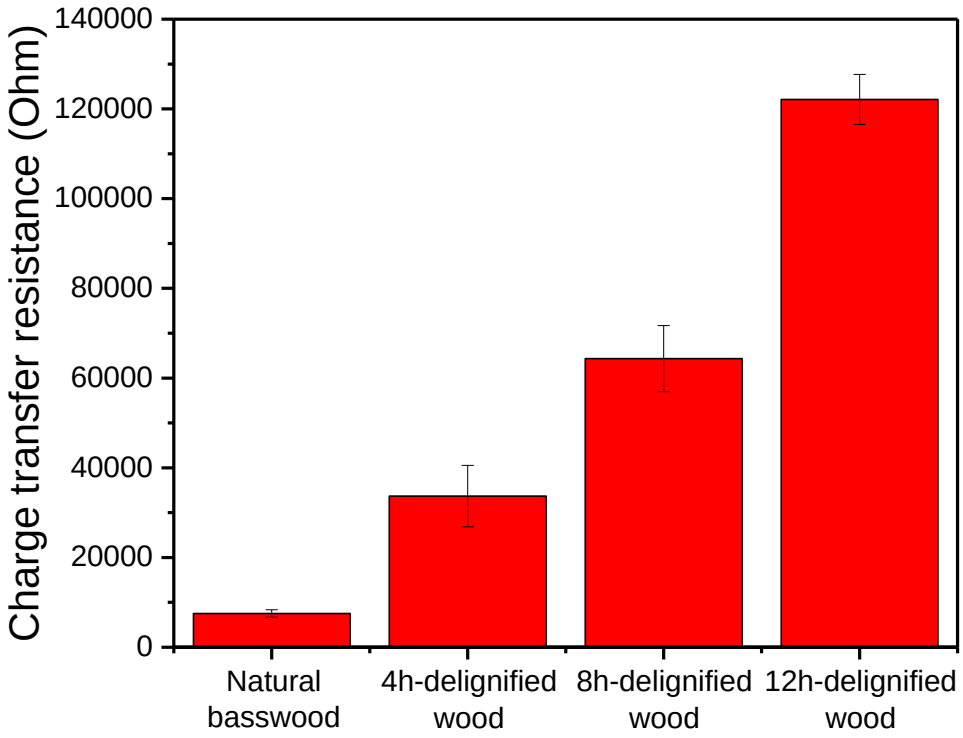

Figure S6. Charge transfer resistance evaluation. Charge transfer resistance of two galvanized low-carbon steel electrodes in natural basswood, 4h-delignified wood, 8h-delignified wood, and 12h-delignified wood extracts were obtained by EIS tests. The error bars describe the ranges of three repeated data points.

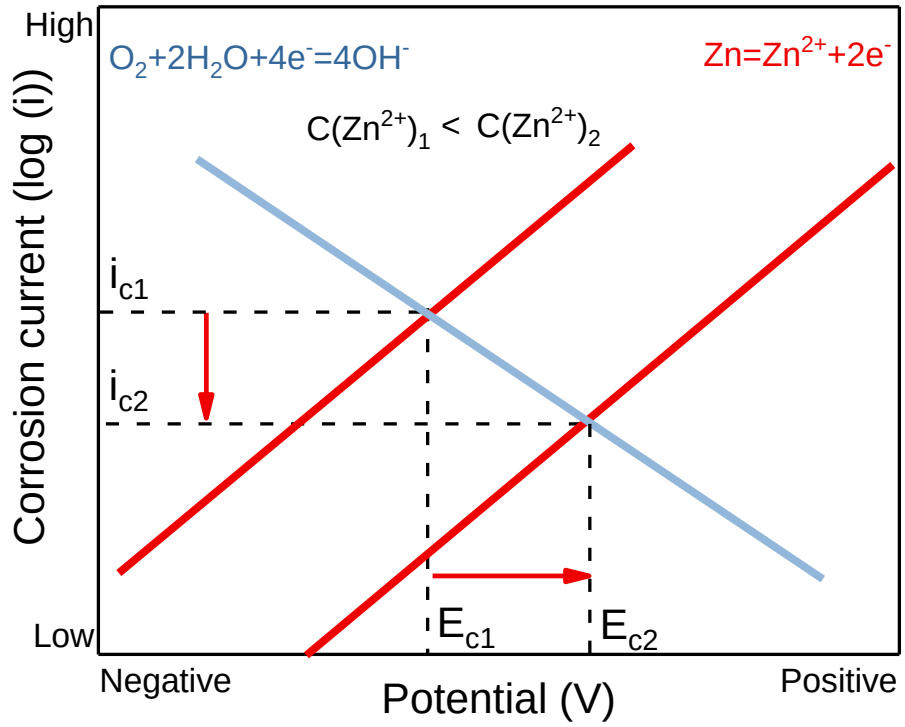

Figure S7. Evan's diagram. Blue line is the cathodic reaction (oxygen reduction) and red lines are the anodic reactions (zinc oxidation). The intersection of the blue and red line determines the corrosion rate i_c and the corrosion potential E_c. The reversible potential ($E^{rev}_{Zn/Zn^{2+}}$) of the red line can be described by the Nernst equation: $E^{rev}_{Zn/Zn^{2+}} = E^{o}_{Zn/Zn^{2+}} + \frac{RT}{2F} In(c(Zn^{2+}))$. Here, $E^{o}_{Zn/Zn^{2+}}$ is the standard potential. The dense wood structure impedes the mass transfer leading to a higher $c(Zn^{2+})$ at the Zn/wood interface. Hence, the reversible potential of Zn shifts to a more positive value leading to a more positive E_c and a lower corrosion rate (i_c) of GCS.

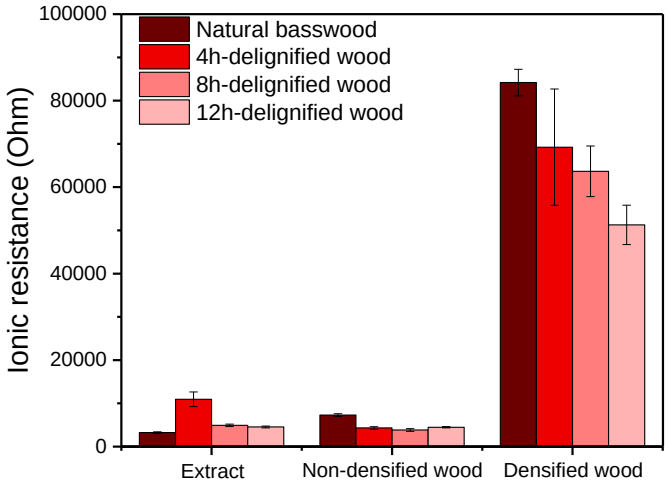

Figure S8. Ionic resistance evaluation. The ionic resistance values of natural basswood and delignified wood (4, 8, and 12 h) as well as their extract= solutions. For the test in wood extract, two electrodes were immersed in the solution that are one inch apart and parallel to each other. The error bars describe the ranges of three repeated data points.

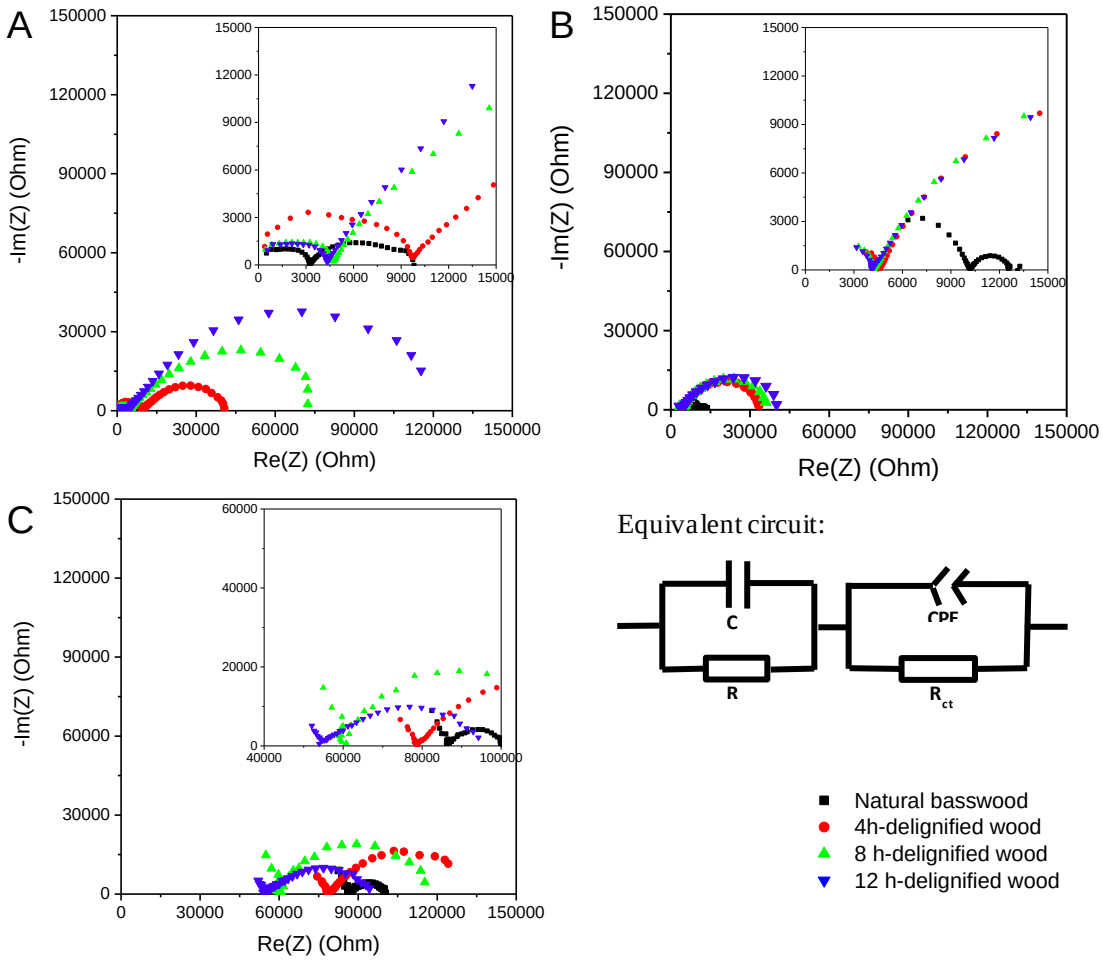

Figure S9. EIS test to measure charge transfer resistance and ionic conductivity. The EIS of natural basswood and delignified wood (4 h, 8 h, and 12 h) when sandwiched between two GCS sheets: (A) In the extract solution, (B) Non-densified wood and (C) Densified wood. EIS measurements were carried out in the frequency range of 7 MHz–0.1 Hz.

Figure S10. Long-term corrosion evaluation of GCS in wood. The long-term corrosion evaluation of GCS in natural wood and densified wood was evaluated by storing the metal-wood couple in a box with a relative humidity of 100% over one year. The unit is converted from mg $cm^{-2}day^{-1}$ to μA cm^{-2}. The error bars describe the ranges of three repeated data points.

Table S1. Experimental data for mathematical model. The density of wood samples was obtained by at least three repeated measurements. The corrosion rate measured with the wood extract can be regarded as the value for a wood sample with a porosity approaching 1. For extract, non-densified wood, and densified wood, the corrosion rate of each condition contains three repeats. For partially densified wood, the corrosion rate of each condition contains one repeat.

	Delignification time	Density	Porosity	Average corrosion rate	Relative standard deviations
	hour	g cm^{-3}		μA cm^{-2}	μA cm^{-2}
Extract	0	-	1	9.130	4.600
	4	-	1	0.981	0.723
	8	-	1	0.520	0.190
	12	-	1	0.611	0.345
Non-densified wood	0	0.400	0.733	1.310	0.594
	4	0.320	0.787	0.788	0.473
	8	0.300	0.800	0.776	0.435
	12	0.280	0.813	0.441	0.172
Partially densified wood (0.12 inch thick)	4	0.932	0.379	0.225	-
	8	0.767	0.489	0.260	-
	12	0.818	0.455	0.392	-
Partially densified wood (0.1 inch thick)	4	1.218	0.188	0.076	-
	8	1.046	0.303	0.109	-
	12	1.126	0.249	0.115	-
Densified wood (0.08 inch thick)	4	1.357	0.095	0.050	0.024
	8	1.354	0.097	0.090	0.034
	12	1.345	0.104	0.062	0.019