# **Electronic Supplementary Information**

## Reduction of lignin color via one-step UV irradiation

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### 1 Calculation of the contents of lignin's functional groups

#### 1.1 Phenolic hydroxyl groups

The content of phenolic hydroxyl group was measured by Folin-Ciocalteu (FC) method. Calibration experiment was conducted with vanillin solutions. A vanillin-free sample was used as the reference. A standard calibration curve was obtained:

$$A = 11.38889c + 0.02754$$

(1)

(2)

where A represents the absorbance of sample at 760 nm; c represents the concentration of phenolic hydroxyl group (mmol/L). The regression coefficient  $R^2 = 0.997$ .

Content of phenolic hydroxyl group was calculated by equation (1) and (2):

$$C_{PhOH} = c \times 25 / (1000 \times m_s)$$

where m<sub>s</sub> represents the mass of sample, and C<sub>PhOH</sub> represents the content of phenolic hydroxyl.

Samples	А	c (mmol/L)	$m_{s}\left(g ight)$	C <sub>PhOH</sub> (mmol/g)
LCAL 1	0.4757	0.03935	0.0005968	1.648
LCAL 2	0.4953	0.04107	0.0005968	1.720
LCAL 3	0.4811	0.03982	0.0005968	1.668
Average of LCAL	/	/	/	$1.679\pm0.037$
AL 1	0.7642	0.06468	0.0005924	2.730
AL 2	0.8296	0.07042	0.0005924	2.972
AL 3	0.7896	0.06691	0.0005924	2.824
Average of AL	/	/	/	$2.842\pm0.154$

Table S1. The related data of content calculation of phenolic hydroxyl group.

### 1.2 Methoxyl group

The content of the methoxyl group of lignin was determined by headspace gas chromatographic. According to the HS-GC measurement on pure methyl iodide, a standard calibration curve was obtained:

$$S = 320184V + 79154$$
(1)

where V represents the volume of methyl iodide and S represents the GC signal count of methyl iodide. The regression coefficient  $R^2 = 0.999$ .

Content of methoxyl was calculated by equation (1) and (2):

$$C_{OMe} = V \times \rho / (M \times m_s)$$
<sup>(2)</sup>

where  $\rho$  and M are the density and the molar mass of iodine methane, respectively;  $m_s$  represents

the mass o	f lignin s	sample and	Come represents	the content	of methoxyl.
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Samples	S	V (uL)	$m_{s}\left(g ight)$	C (mmol/g)
LCAL 1	746710	2.08491	0.01078	3.105
LCAL 2	704607	1.95341	0.01026	3.057
LCAL 3	788782	2.21631	0.01006	3.537
Average of LCAL	/	/	/	$3.081\pm0.024$
AL 1	1330053	3.90681	0.01031	6.084
AL 2	1069702	3.09368	001006	4.938
AL 3	1084840	3.14096	0.01004	5.023
Average of AL	/	/	/	$4.980\pm0.043$

Table S2. The related data of content calculation of methoxyl.

#### 1.3 Carboxyl group

The content of the carboxyl group of lignin was determined by aqueous titration. Typical diagrammatic curve of lignin by aqueous titration is shown as following:



Fig. S1 Diagrammatic curve of sample by aqueous titration.

The content of the carboxyl group can be calculated according to following equation:

$$C_{COOH} = \frac{\left[\left(V_{3}^{'} - V_{2}^{'}\right) - \left(V_{3} - V_{2}\right)\right]C_{HCl}}{m_{s}}$$

where  $V_2$  and  $V_3$  represent the corresponding HCI volumes of endpoint 2 and 3 in control titration; V'<sub>2</sub>, and V'<sub>3</sub> represent the corresponding HCI volumes of endpoint 2 and 3 in sample titration; C<sub>HCl</sub> and m<sub>s</sub> are the concentration of HCl aqueous solution and the mass of lignin respectively. C<sub>COOH</sub> represents the content of carboxyl.

Samples	V <sub>2</sub> /V <sub>2</sub> ' (mL)	V <sub>3</sub> /V <sub>3</sub> '(mL)	$m_{s}\left(g ight)$	C (mmol/g)
Blank 1	4.7536	8.1139	/	/
Blank 2	4.7669	8.0982	/	/
Blank 3	4.7700	8.1249	/	/
Average of blank	4.7635	8.1123	/	/
LCAL 1	4.1584	7.9344	0.01480	3.210
LCAL 2	4.0036	7.8763	0.01467	3.971
LCAL 3	4.0044	7.9472	0.01467	4.502
Average of LCAL samples	/	/	/	$3.895 \pm 0.650$
AL 1	4.3826	8.0612	0.01440	2.547
AL 2	4.3940	8.0510	0.01427	2.402
Average of AL	/	/	/	$2.475 \pm 0.103$

Table S3. The related data of content calculation of carboxyl.



Fig. S2 Photos of AL/DMF solution before (right) and after (left) UV irradiation, the concentration of AL in DMF was 0.5 g/L.



Fig. S3 AFM images of AL and LCAL.