

Structural Variation of Lignin and Lignin–Carbohydrate Complex in Eucalyptus grandis × E. urophylla during Its Growth Process

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Supporting information

Chemosynthesis and structural characterization of a novel ligninbased bio-sorbent and its strong adsorption for Pb (II)

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The Langmuir isotherm assumes that adsorption occurs through monolayer sorption onto a surface, and the Freundlich isotherm is a model of multilayer adsorption onto heterogeneous surfaces with undefined sites. The two isotherm models can be described as follows:

$$\frac{C_e}{Q_e} = \frac{C_e}{Q_m} + \frac{1}{K_L Q_m}$$
(S1)

$$\log Q_e = \log K_F + \frac{1}{n} \log C_e$$
 (S2)

where C_e is the final equilibrium concentration (mg/L), Q_e is the adsorption capacity at equilibrium (mg/g), Q_m is the maximum adsorption capacity (mg/g), K_L is the Langmuir constant (L/mg). K_F is a constant related to the adsorption capacity, and n is an empirical parameter related to the adsorption intensity.

The pseudo-first-order and pseudo-second-order model is described in the following:

$$\ln(Q_{e}-Q_{t}) = \ln Q_{e} - \frac{k_{t}}{2.303}$$
(S3)
$$\frac{t}{Q_{t}} = \frac{1}{k_{2}Q_{e}^{2}} + \frac{t}{Q_{e}}$$
(S4)

where Q_e and Q_t is the amount (mg/g) of adsorption at equilibrium and at time t (min), respectively, k_1 (1/min) is the pseudo-first-order rate constant; k_2 [g (mg·min)] is the pseudo-second-order kinetic rate constant. The pseudo second-order model assumes that the chemisorption in this system is the rate determining step of adsorption.

Table S1.

The molar ratio of different lignin samples

| sample | SAPL-1.0 ^a | SAPL-1.5 | SAPL-2.0 | SAL-1.5 |
|-------------|-----------------------|---------------|----------|---------------|
| molar ratio | 1:1:1:1 | 1:1.5:1.5:1.5 | 1:2:2:2 | 1:1.5:1.5:1.5 |

^a molar ratio means AS^b : HCHO : HD : CS₂;

AS^b means the amount of active sites in lignin or phenolation lignin determined by ³¹P-NMR.

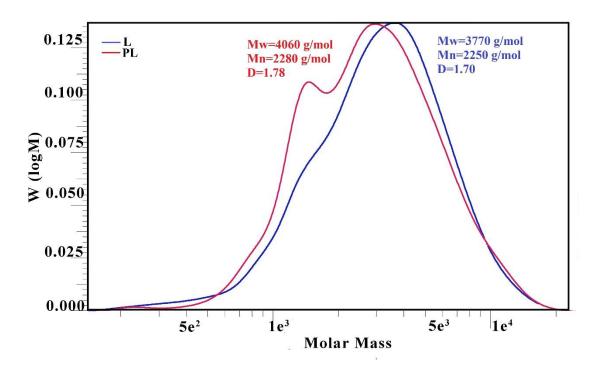


Fig. S1. Molecular weight distribution curves of L and PL.

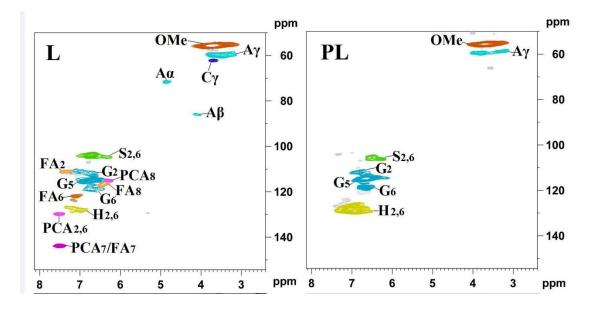


Fig. S2. 2D HSQC NMR spectra of the lignin (L) and phenolated lignin (PL).

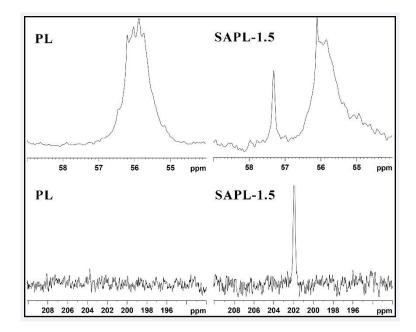


Fig. S3. The ¹³C NMR spectra of the lignins.

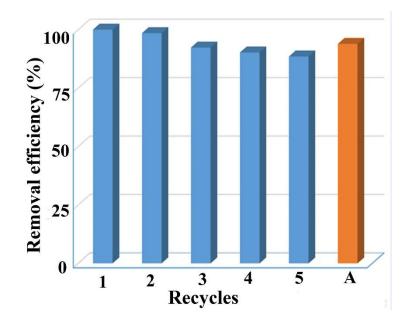


Fig. S4. The removal efficiency of SAPL-1.5 during 5 regeneration cycles.