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

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ACS Sustainable Chemistry & Engineering

DOI:
10.1021/acssuschemeng.6b02396

Published: 01/01/2017

Peer reviewed version

Supporting information

Chemosynthesis and structural characterization of a novel lignin-based 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:

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

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

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:

$$\ln\left(Q_e - Q_t\right) = \ln Q_e - \frac{k_t}{2.303} \quad \textbf{(S3)}$$

$$\frac{t}{Q_t} = \frac{1}{k_2 Q_e^2} + \frac{t}{Q_e} \quad \textbf{(S4)}$$

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 : CS_2;

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

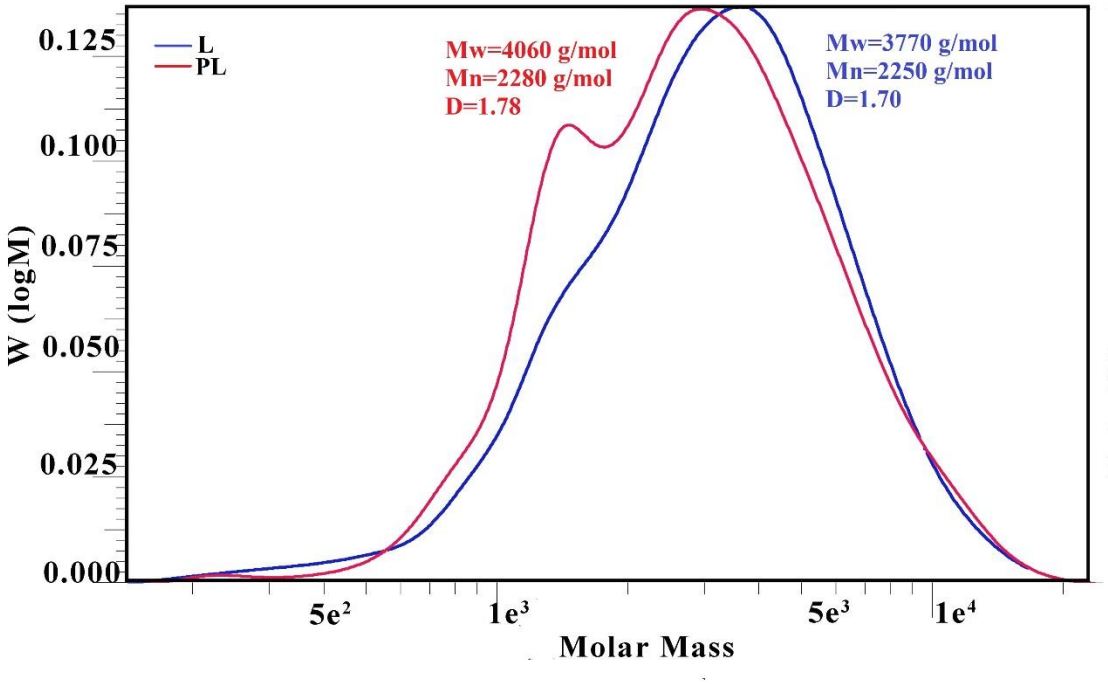

Fig. S1. Molecular weight distribution curves of L and PL.

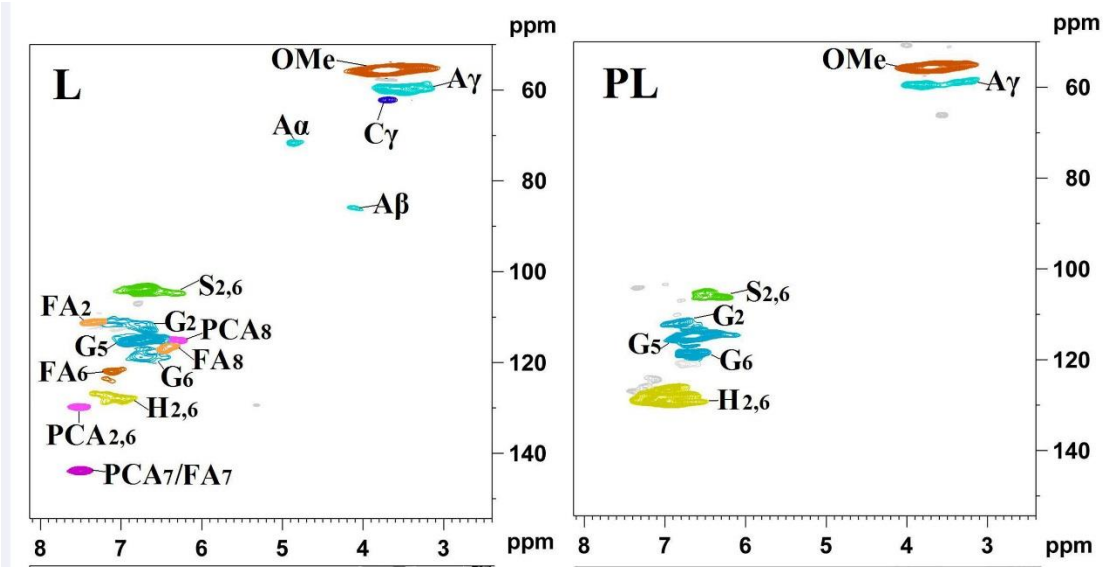

Fig. S2. 2D HSQC NMR spectra of the lignin (L) and phenolated lignin (PL).

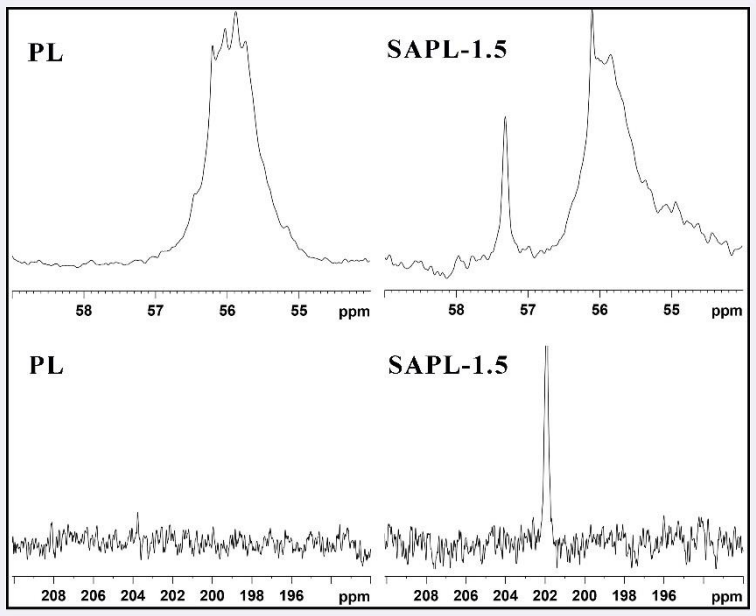

Fig. S3. The ^{13}C NMR spectra of the lignins.

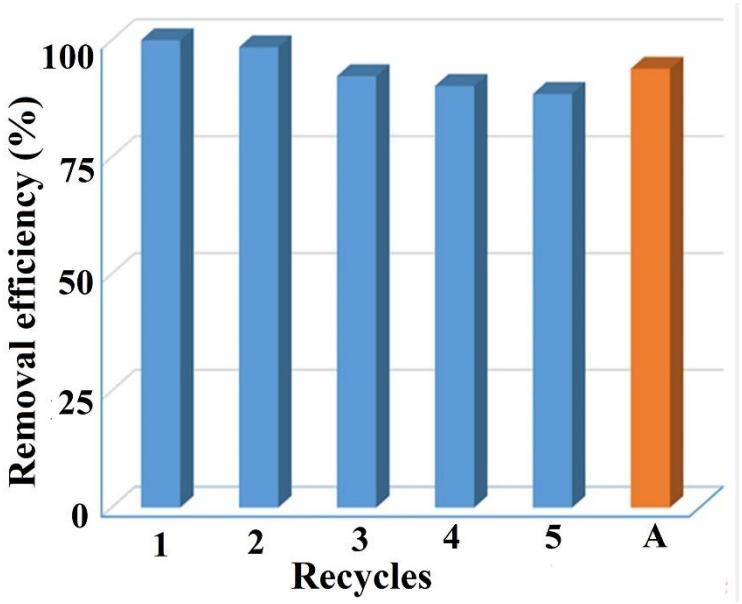

Fig. S4. The removal efficiency of SAPL-1.5 during 5 regeneration cycles.