Supporting Information

A novel functional lignin-based filler for pyrolysis and feedstock recycling of poly(L-lactide)

Lin Dai,* Rui Liu and Chuanling Si

College of Papermaking Science and Technology, Tianjin Key Laboratory of Pulp and Paper, Tianjin University of Science and Technology, Tianjin 300457, People's Republic of China.

*Corresponding author.

E-mail addresses: dailin@tust.edu.cn

Alkaline lignin materials

Alkaline lignin was supplied by Shandong Longlive Bio-technology Co., Ltd. (Jinan, China). The manufacturing process for alkaline lignin used in this work was as follows: first, the corn cob was treated hydrothermally to remove the hemicelluloses. After further treated with alkaline, the effluent was separated and adjusted to acidic condition to precipitate the alkaline lignin, then dried at 50 °C vacuum for 24 h prior to use. The number-average (M_n), weight-average (M_w) molecular weights, and polydispersity (M_w/M_n) of the alkaline lignin were listed in **Table S1**.

Table S1. The chemical composition, molecular weight, and content of the different hydroxyl groups of alkaline lignin quantified by ^{31}P-NMR.

Composition	Weight content (%)	Composition	Weight content (%)	–OH groups	Concentration (mmol/g)
Total lignin	94.78	Mannose	0.04	Total S	0.65
Klason lignin	90.83	Glucuronic acid	ND[a]	Total G	0.64
Acid-soluble lignin	3.62	Galacturonic acid	ND	Non-ph[b] S	0.55
Carbohydrate	0.62	Ash	2.15	Non-ph G	0.42
Arabinose	0.14	Others	2.78	Non-ph H	0.65
Galactose	0.03	M_w (g/mol)	3262	Total –COOH	1.09
Glucose	0.33	M_n (g/mol)	2265	Total aliphatic	1.77
Xylose	0.14	M_w/M_n	1.44		

[a] ND means not detected. [b] Non-ph means the noncondensed phenolic –OH.

Flynn-Wall-Ozawa method

Flynn-Wall-Ozawa method was used in evaluating activation energy (E_a) and preexponential factor (A) in this study, which was easy to obtain values for E_a and A over a wide range of decomposition by plotting logβ against $1/T$ at any certain conversion rate (**Figure S1 and S2**). The slope and intercept of each line is -0.4567 E_a/RT and log[$AE_a/Rg(w)$]-2.315. The equivalent can be described as follows:

$$\log \beta = \log \left[\frac{AE_a}{Rg(w)}\right] - 2.315 - \frac{0.4567E_a}{RT}$$

where β is heating rate in K/min, w is conversion rate, T is temperature in K, A is preexponential factor in s^{-1}, E_a is activation energy in kJ/mol, R is universal gas constant 8.314 J/(mol·K).[1,2]

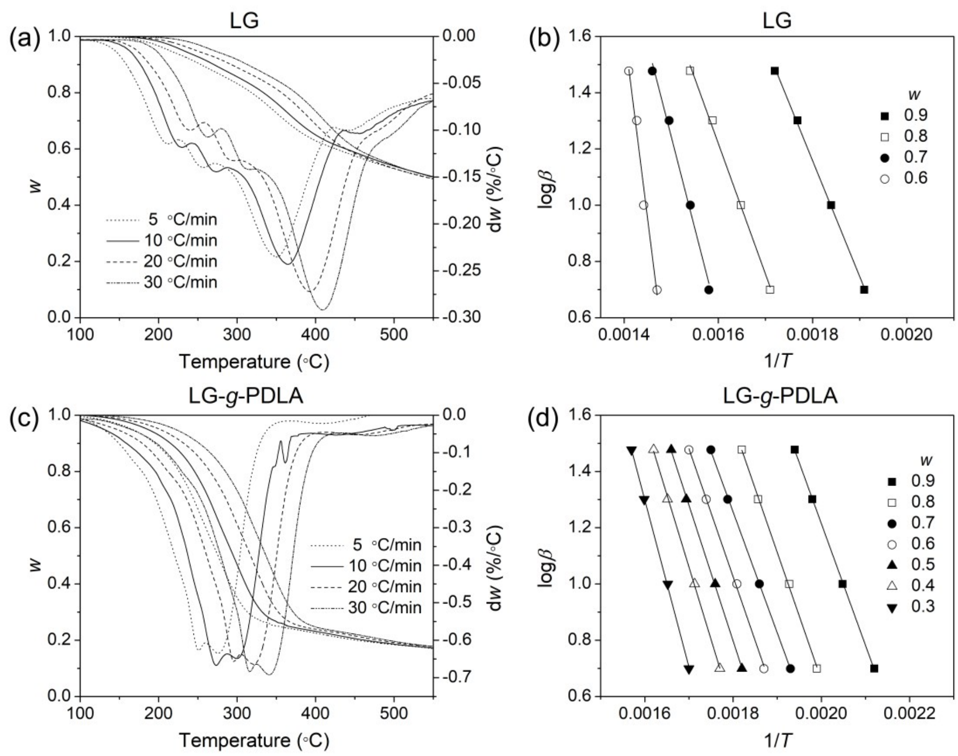

Figure S1. TGA and DTG curves of (a) LG and (b) LG-*g*-PDLA at different heating rates. Flynne-Walle-Ozawa plots for different degrees of conversion w=0.9-0.1 of (c) LG and (d) LG-*g*-PDLA.

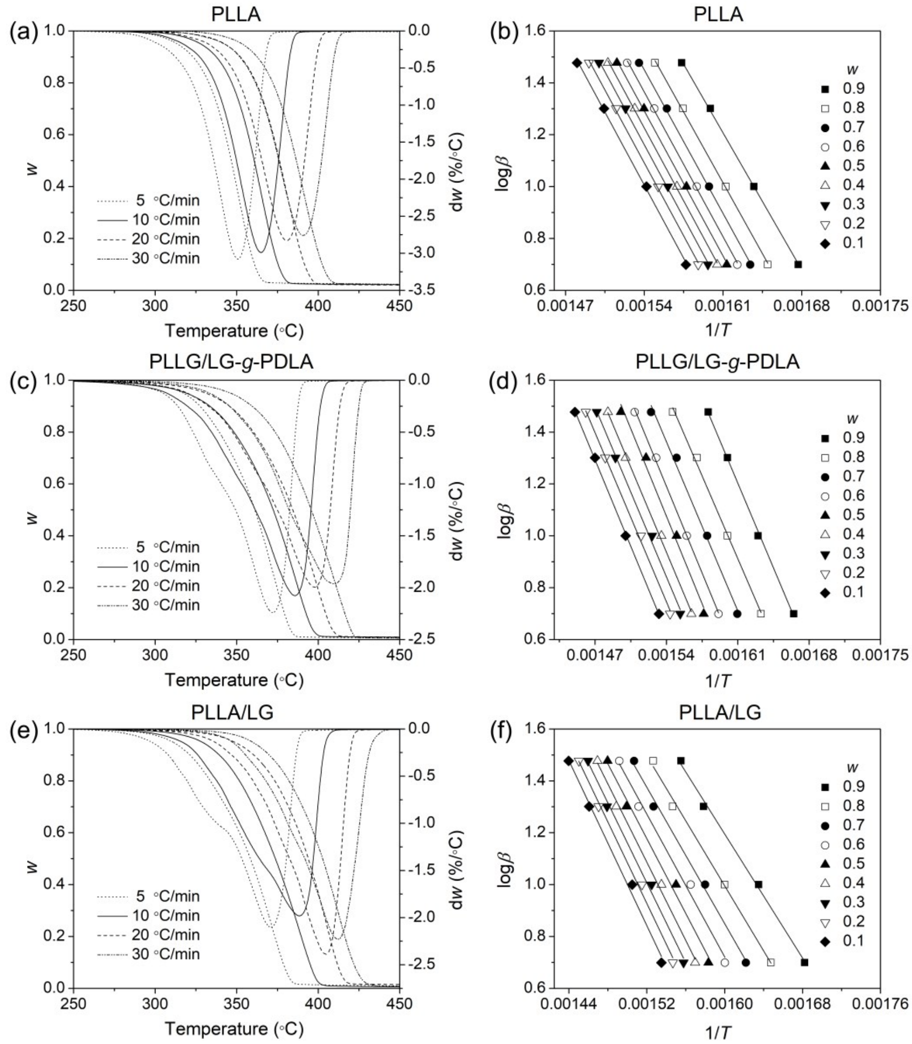

Figure S2. TGA and DTG curves of (a) PLLA, (c) PLLA/LG composite, and (e) PLLA/LG-*g*-PDLA blend film at different heating rates. Flynn-Wall-Ozawa plots for different degrees of conversion *w*=0.9-0.1 of (b) PLLA, (d) PLLA/LG composite, and (f) PLLA/LG-*g*-PDLA blend film.

References

1. J. H. Flynn and L. A. Wall, *Journal of Research of the National Bureau of Standards–a Physics & Chemistrya*, 1966, 70A.
2. Ozawa T. A new method of analyzing thermogravimetric data. *Bulletin of the chemical society of Japan*, 1965, 38(11): 1881-1886.