

## Supporting Information

# **Sheet-Like Lignin Particles as Multifunctional Fillers in Polypropylene**

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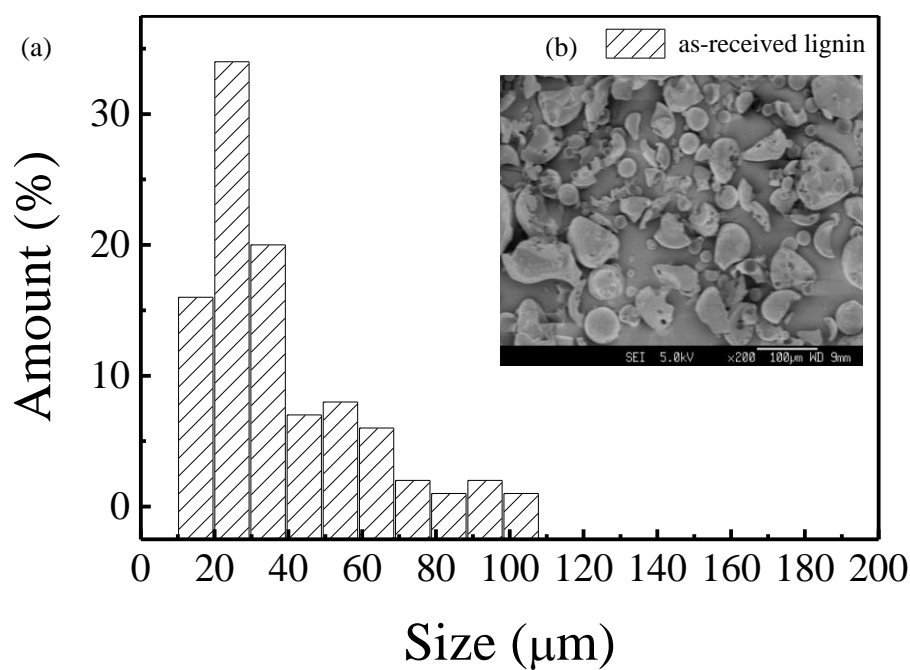
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6 pages, 2 tables, and 4 figures

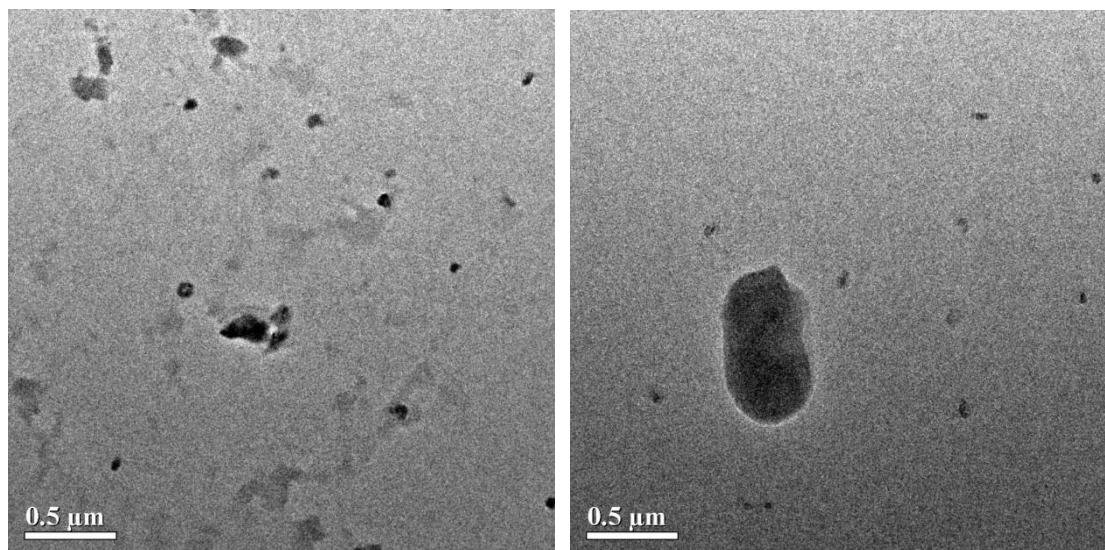


**Fig. S1** Size distribution of the as-received alkali lignin measured from the SEM images ( $\times 200$ ) using an image analyzer.

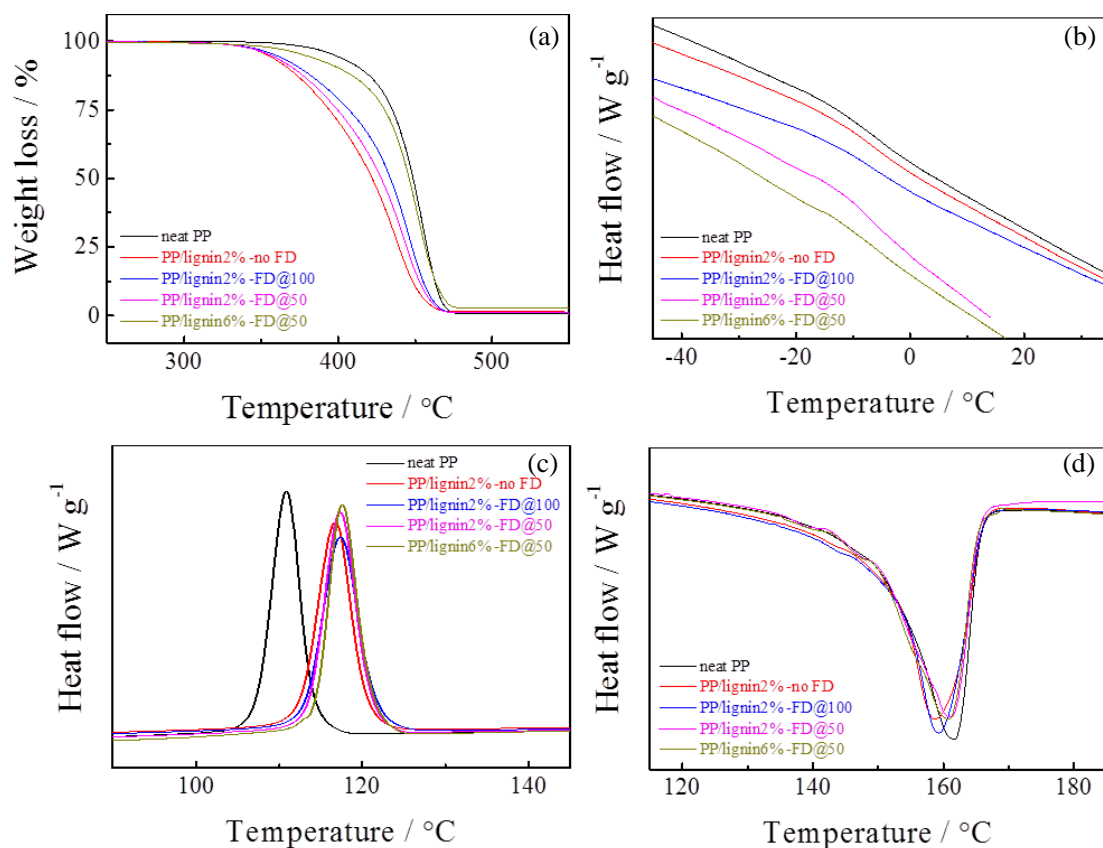
**Table S1.** BET specific surface area (SSA) and BJH pore volume of lignin particles. Freeze-dried samples were prepared from 50 mg/mL lignin aqueous solutions.

Sample	Freezing temperature ( $^{\circ}\text{C}$ )	Specific surface area ( $\text{m}^2/\text{g}$ )	Total pore volume ( $\text{cm}^3/\text{g}$ )	Average pore size (nm)
As received lignin	-	$\sim 0.03$	$\sim 0$	<sup>a</sup>
Lignin-FD@50	-196	9.50	$\sim 0.01$	<sup>a</sup>

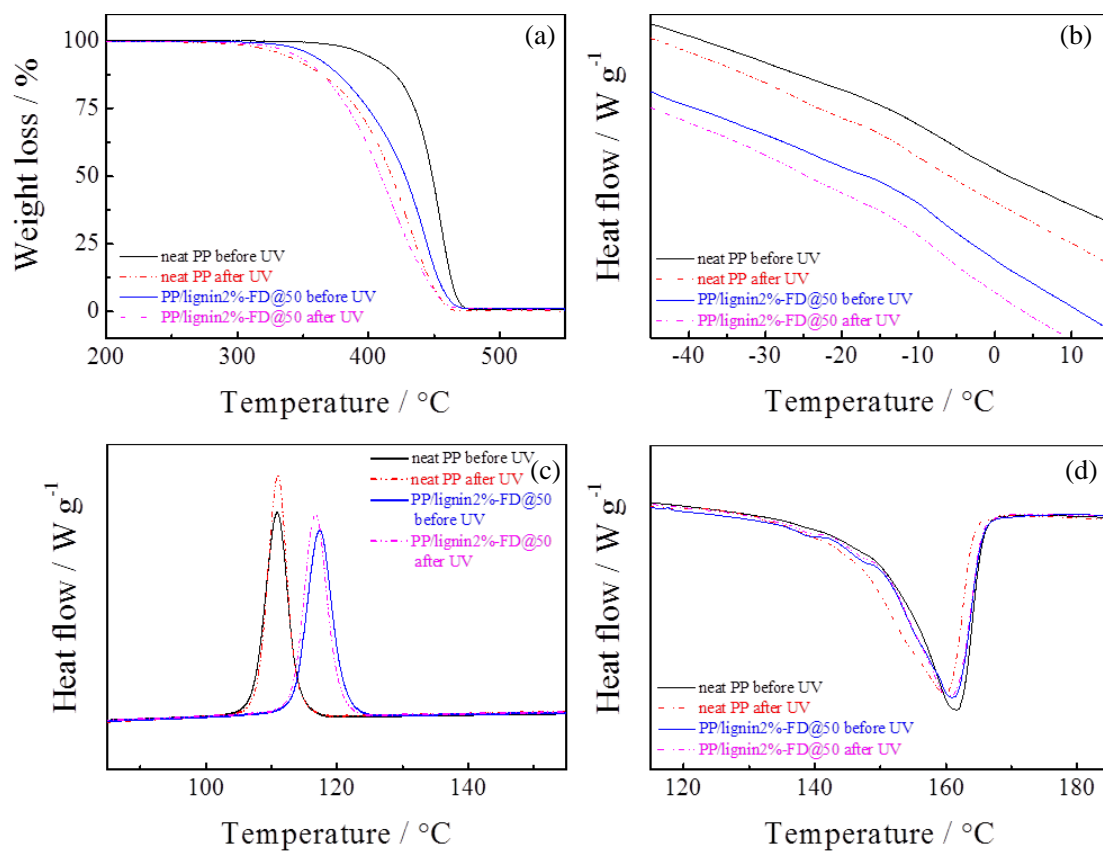
<sup>a</sup> not measured as pore volume is too small.



**Fig. S2** Typical TEM images of PP/lignin composites containing 2 wt% freeze-dried lignin from the solution with conc. of 50 mg/mL. The smaller dark particles are likely to be lignin sheets that are somewhat perpendicular to the cutting plane while the larger dark particles are likely to be lignin sheets that are more or less parallel to the cutting plane.



**Fig. S3** Thermal properties of neat PP, and the PP/lignin composites containing 2 wt% as-received lignin, 2 wt% freeze-dried lignin from the solution with lignin conc. of 100 mg/mL, 2wt% freeze-dried lignin from the solution with conc. of 50 mg/mL, and 6% freeze-dried lignin from the solution with lignin conc. of 50 mg/mL. DSC was conducted at a heating rate of 10°C/min in N<sub>2</sub> atmosphere.



**Fig. S4** Thermal properties of neat PP and PP/2%lignin-FD@50 before and after UV irradiation.

**Table S2** Mechanical properties of neat PP and lignin blended PP composites tested with tensile speed of 50 mm/min.

<i>Sample</i>	<i>Lignin Type</i> (mg/mL)	<i>Composites</i>		<i>E-modulus</i> (MPa)	<i>Yield stress</i> (MPa)	<i>Yield strain</i> (mm/mm)	<i>Elongation at break</i> (%)
		<i>Content<sup>a</sup></i> (wt)	<i>UV</i> (h)				
neat PP	--	0	0	616±16	39.1±0.8	0.177±0.008	54.0±5.0
	--	0	336	650±18	30.4±2.6	0.065±0.006	6.8±0.8
No FD-2%	no FD	2%	0	628±9	38.8±0.6	0.145±0.006	35.3±7.2
	no FD	2%	336	640±26	37.5±3.3	0.110±0.024	12.2±3.3
FD@100-2%	100	2%	0	637±13	38.3±0.8	0.137±0.003	57.8±15.5
	100	2%	336	625±29	38.7±0.7	0.140±0.007	48.0±11.0
FD@50-2%	50	2%	0	641±6	38.6±1.0	0.136±0.004	95.5±34.9
	50	2%	336	645±26	39.6±1.0	0.134±0.008	68.0±18.0
FD@50-6%	50	6%	0	655±17	37.4±1.0	0.123±0.003	55.0±7.3
	50	6%	336	653±17	37.9±1.1	0.122±0.005	38.5±7.0

<sup>a</sup> lignin content in the PP/lignin composites