

**Electronic supplementary information (ESI) for**

**Achieving high lignin content and mechanical enhancement in  
biobased thermosets via a high-molecular-weight soybean oil skeleton**

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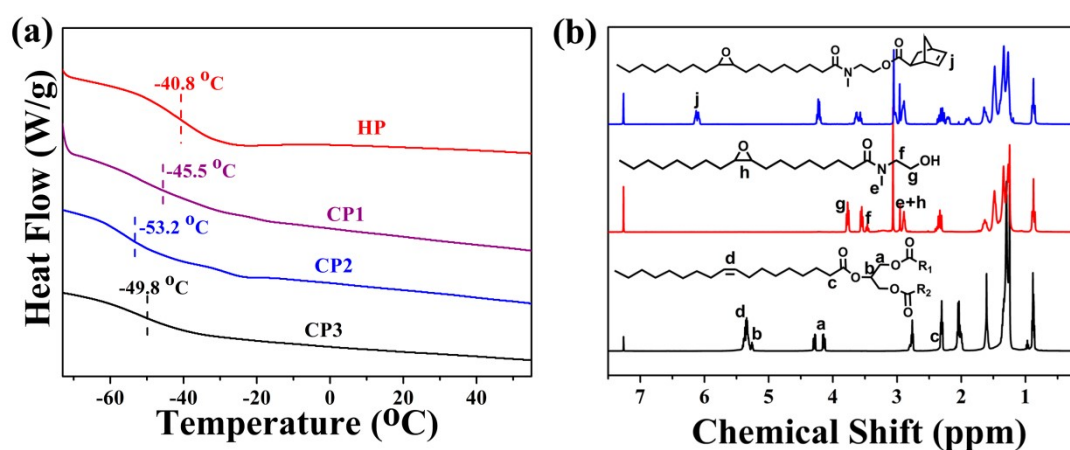
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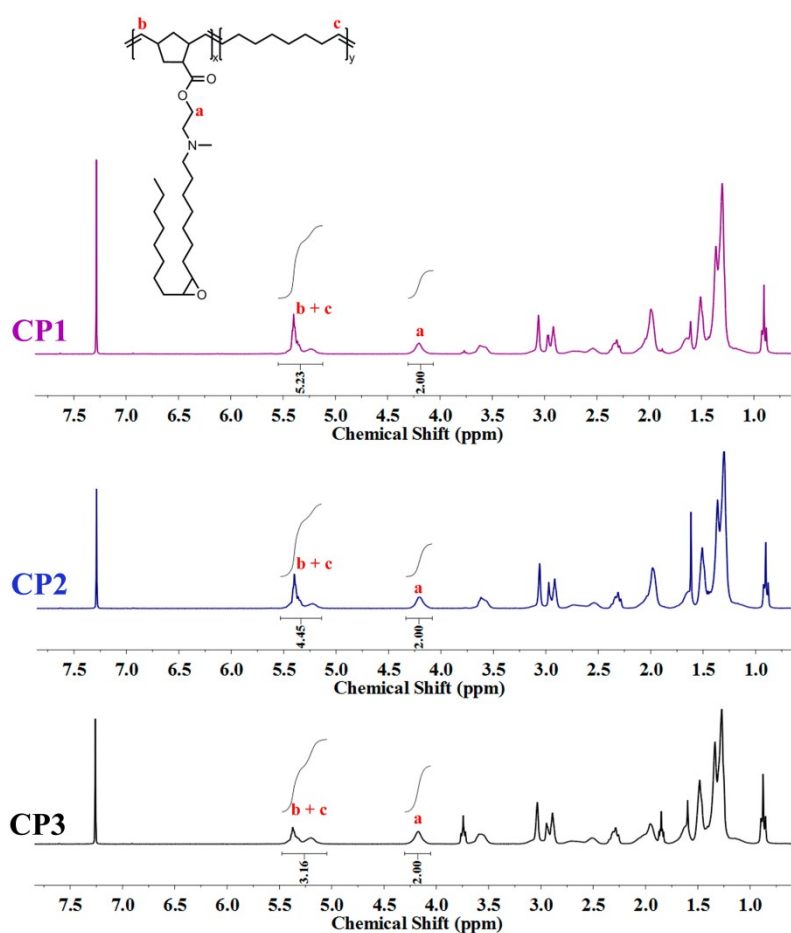
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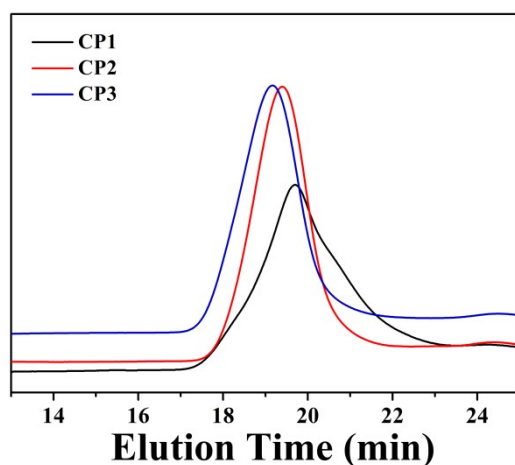
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**Figure S1.** (a) DSC curves of homopolymer (HP) and copolymers (CP1-CP3). (b)  $^1\text{H}$  NMR spectra of soybean oil, SBOH and NS monomer.



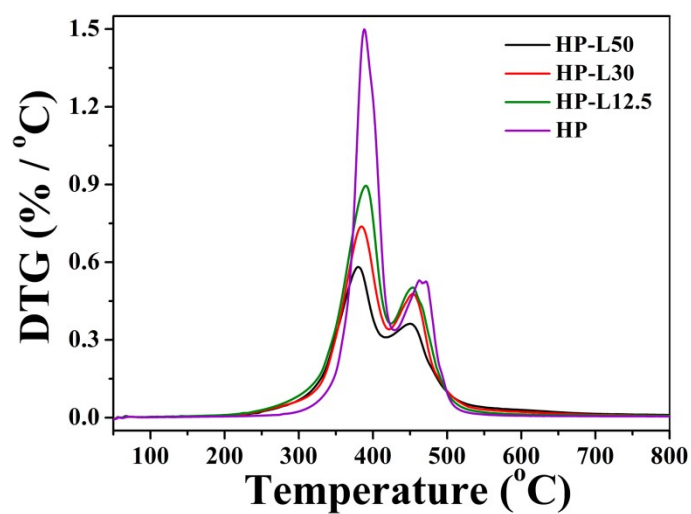
**Figure S2.**  $^1\text{H}$  NMR spectra of copolymers (CP1 - CP3) with different soybean oil unit contents.



**Figure S3.** GPC traces of copolymers.

**Table S1.** Degrees of curing of HP-LX thermosets with various weight fractions of lignin.

Sample code	Time (h)	$T_{\text{peak}}$ (°C)	$\Delta H_{\text{rxn}}$ (J/g)	$\Delta H_{\text{t}}$ (J/g)	Degree of curing
HP-L12.5	2	$199.9 \pm 1.4$	$34.6 \pm 1.5$	$1.49 \pm 0.4$	95.7 %
HP-L30	2	$194.9 \pm 0.14$	$45.2 \pm 4.9$	$3.88 \pm 0.3$	91.4 %
HP-L40	2	$192.4 \pm 2.5$	$41.7 \pm 2.3$	$1.88 \pm 0.6$	95.5 %
HP-L50	2	$204.4 \pm 1.6$	$52.1 \pm 3.4$	$6.88 \pm 0.3$	86.8 %

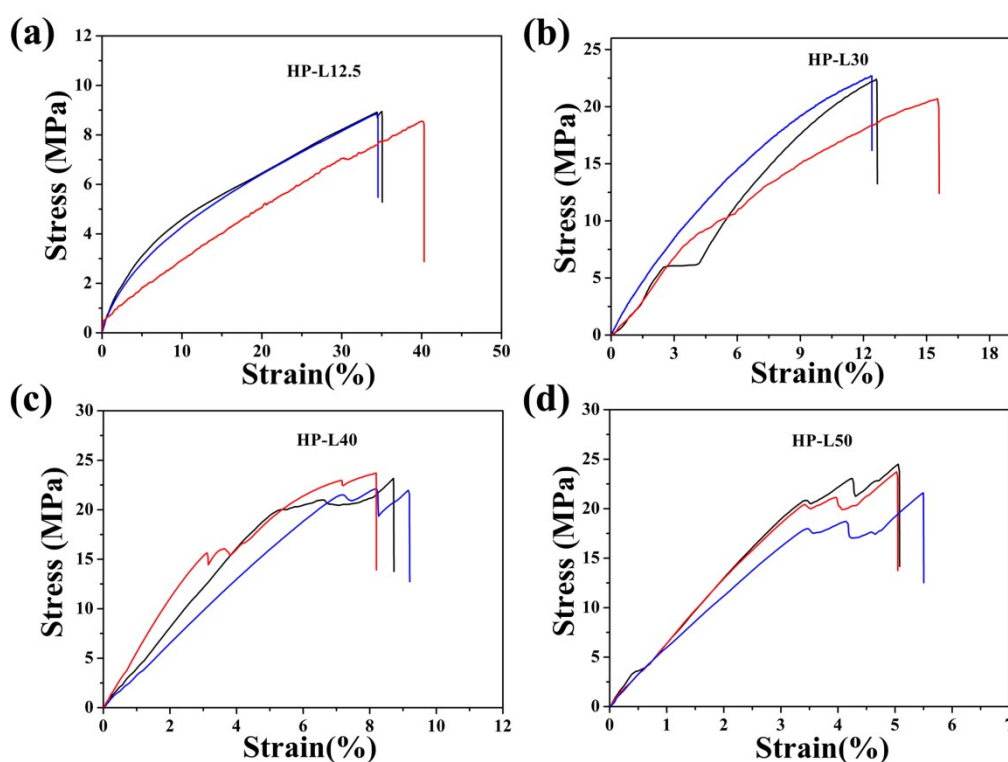


**Figure S4.** DTG curves of HP and HP-LX thermosets.

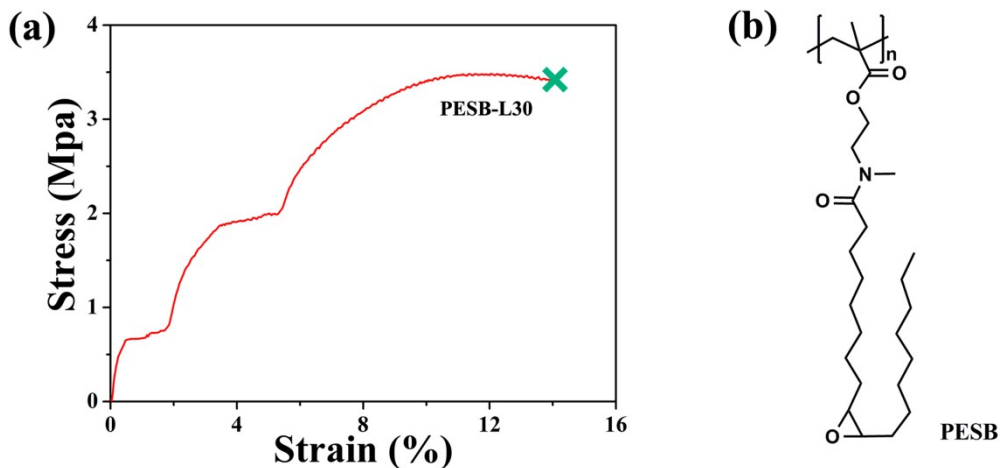
**Table S2.** Mechanical properties of HP-LX thermosets.

Sample code	Tensile strength (MPa)	Strain at break (%)	Young's modulus (MPa)*	Toughness (MJ/m <sup>3</sup> )
HP-L12.5	8.95 ± 0.2	35.1 ± 3.2	53.1 ± 1.61	2.01 ± 0.2
HP-L30	22.4 ± 1.1	12.6 ± 1.8	268.7 ± 4.75	1.51 ± 0.1
HP-L40	23.1 ± 0.8	8.7 ± 0.5	389.3 ± 3.85	1.28 ± 0.2
HP-L50	24.4 ± 1.5	5.1 ± 0.3	664.3 ± 6.71	0.74 ± 0.08

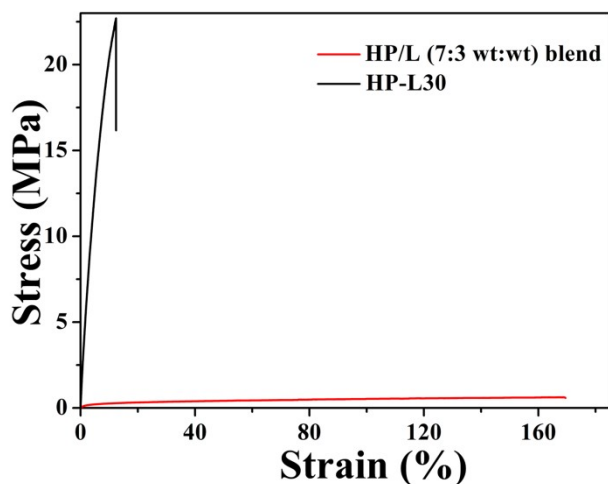
\*Young's Modulus calculated for the linear response until 2% elongation.



**Figure S5.** (a) Stress-strain curves of HP-LX thermosets. (a) HP-L12.5, (b) HP-L30, (c) HP-L40, (d) HP-L50. Different colored curves represent different specimens of the same sample.



**Figure S6.** (a) Stress-strain curve of PESB-L30 thermoset. (b) Chemical structure of PESB with low molecular weight.



**Figure S7.** Stress-strain curves of HP-L30 thermoset and HP/L blend at identical feeding ratios.

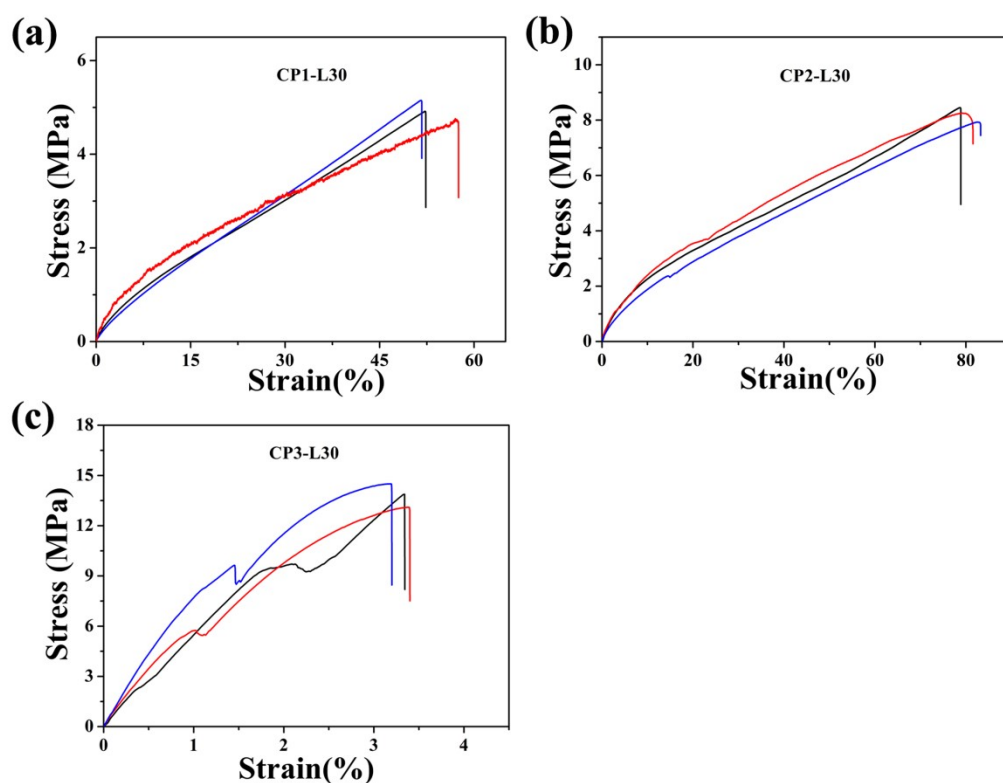
**Table S3.** Dynamic mechanical properties and cross-linking density ( $\nu_e$ ) of HP-LX thermosets.

Sample code	$E'$ at 25 °C (MPa)	$E'$ at $T_g+30$ °C (MPa)	$T_g$ (°C)	$\nu_e$ (mol/m <sup>3</sup> )
HP-L12.5	161.8	12.02	35.08	1430
HP-L30	1721.2	41.27	74.6	4382
HP-L40	1672.7	38.9	85.68	4013
HP-L50	2032.5	56.98	121.56	5381

**Table S4.** Mechanical properties of HP-L30 and CP-L30 thermosets.

Sample code	Tensile strength (MPa)	Strain at break (%)	Young's modulus (MPa)*	Toughness (MJ/m <sup>3</sup> )
HP-L30	22.4 ± 1.1	12.6 ± 1.8	268.7 ± 4.75	1.51 ± 0.1
CP1-L30	4.9 ± 0.2	52.3 ± 3.2	21.6 ± 0.28	1.40 ± 0.2
CP2-L30	8.5 ± 0.3	78.9 ± 2.1	44.1 ± 0.34	3.83 ± 0.3
CP3-L30	13.9 ± 0.7	3.3 ± 0.1	531.1 ± 1.69	0.26 ± 0.05

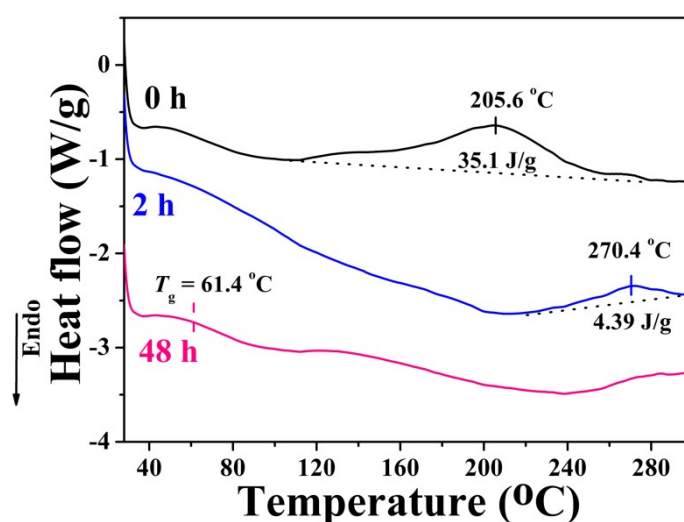
\*Young's Modulus calculated for the linear response until 2% elongation.



**Figure S8.** (a) Stress-strain curves of CP-L30 thermosets. (a) CP1-L30, (b) CP2-L30, (c) CP3-L30. Different colored curves represent different specimens of the same sample.

**Table S5.** Dynamic mechanical properties and cross-linking density ( $\nu_e$ ) of CP-L30 thermosets.

Sample code	$E'$ at 25 °C (MPa)	$E'$ at $T_g+30$ °C (MPa)	$T_g$ (°C)	$\nu_e$ (mol/m <sup>3</sup> )
CP1-L30	197.0	8.89	44.2	1027
CP2-L30	188.1	15.3	49.2	1742
CP3-L30	566.2	18.83	59.8	2081



**Figure S9.** CP2-L30 system after curing at 110 °C for 0, 2 and 48 h.

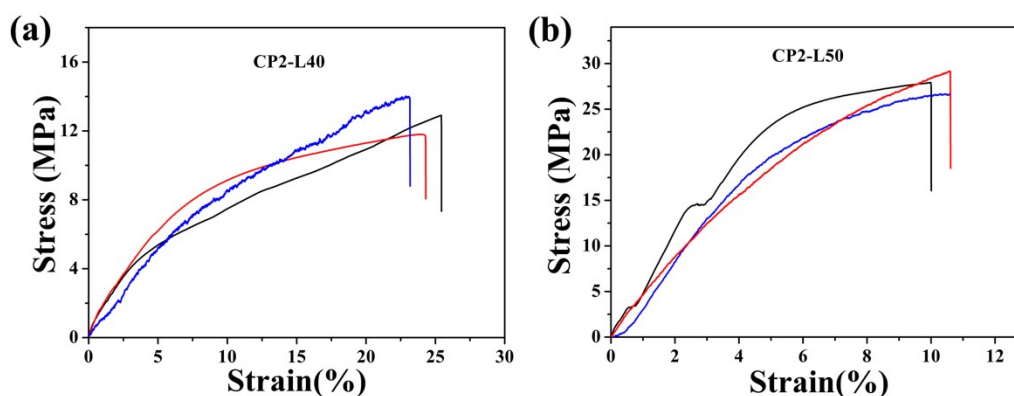
**Table S6.** Degrees of curing of CP2-LX thermosets with various weight fractions of lignin.

Sample code	Time (h)	$T_{peak}$ (°C)	$\Delta H_{rxn}$ (J/g)	$\Delta H_t$ (J/g)	Degree of curing
CP2-L30	2	205.6 ± 0.3	35.1 ± 2.7	4.39 ± 2.1	87.5%
CP2-L40	2	205.7 ± 0.6	38.1 ± 3.9	3.87 ± 1.6	89.8%
CP2-L50	2	208.8 ± 4.4	42.2 ± 1.7	6.77 ± 3.3	83.9%

**Table S7.** Mechanical properties of CP2-LX thermosets.

Sample code	Tensile strength (MPa)	Strain at break (%)	Young's modulus (MPa)*	Toughness (MJ/m <sup>3</sup> )
CP2-L30	8.5 ± 0.3	78.9 ± 2.1	44.1 ± 0.34	3.83 ± 0.3
CP2-L40	12.9 ± 1.1	25.4 ± 1.0	144.2 ± 2.32	2.06 ± 0.1
CP2-L50	27.9 ± 1.3	10 ± 0.2	489.5 ± 9.0	1.95 ± 0.1

\*Young's Modulus calculated for the linear response until 2% elongation.

**Figure S10.** (a) Stress-strain curves of CP2-LX thermosets. (a) CP2-L40, (b) CP2-L50. Different colored curves represent different specimens of the same sample.**Table S8.** Dynamic mechanical properties and cross-linking density ( $\nu_e$ ) of CP2-LX thermosets.

Sample code	$E'$ at 25 °C (MPa)	$E'$ at $T_g$ +30 °C (MPa)	$T_g$ (°C)	$\nu_e$ (mol/m <sup>3</sup> )
CP2-L30	188.1	15.3	49.2	1742
CP2-L40	519.0	38.3	50.8	4340
CP2-L50	1274.3	93.58	70.6	10043