Electronic Supplementary Information

Processing of lignin in urea/zinc chloride deep-eutectic solvent and its use as filler in a phenol-formaldehyde resin

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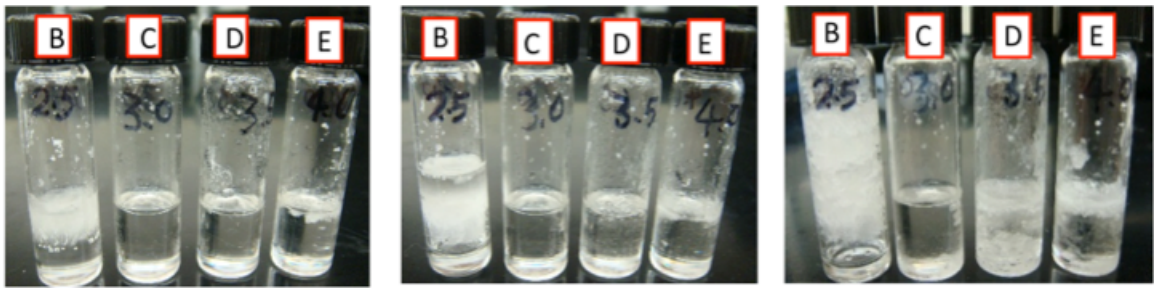

Figure S1. Storage of DES prepared under oil bath after (left) the second day, (center) the 10th day (right) after the 30th day.

Table S1. DSC results for different DESs.

Molar Ratio ($ZnCl_2$/urea)	2.5:10	3:10	3.5:10	4:10
Onset Temperature	-30.2	-29.6	-28.6	-28.3
T_g(at inflexion point)	-27.0	-26.3	-24.2	-24.2
Offset Temperature	-24.4	-22.6	-19.7	-21.1

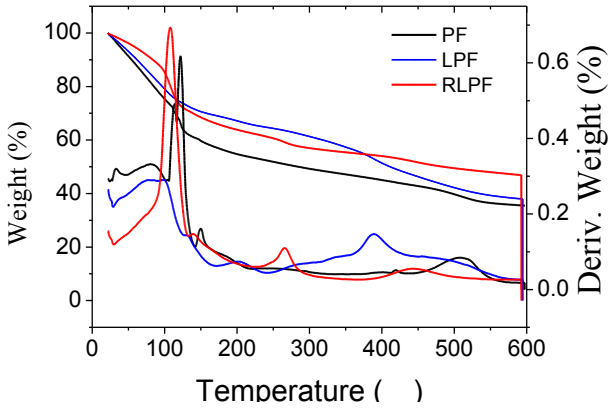

Figure S2. TG and DTG curves of PF, LPF and RLPF resin.

Lignin digestion

A 6.0 mg sample of lignin or relignin was digested with 2.0 mL of 3:1 sulfuric acid and 30% hydrogen peroxide. 1.46 ml of nitric acid was added to the solution and diluted to 10 mL, lightly heated for 2 hours until digestion was completed and the mixture was clear with no solids. Samples were then diluted to 50 mL to achieve a 2% nitric acid solution.

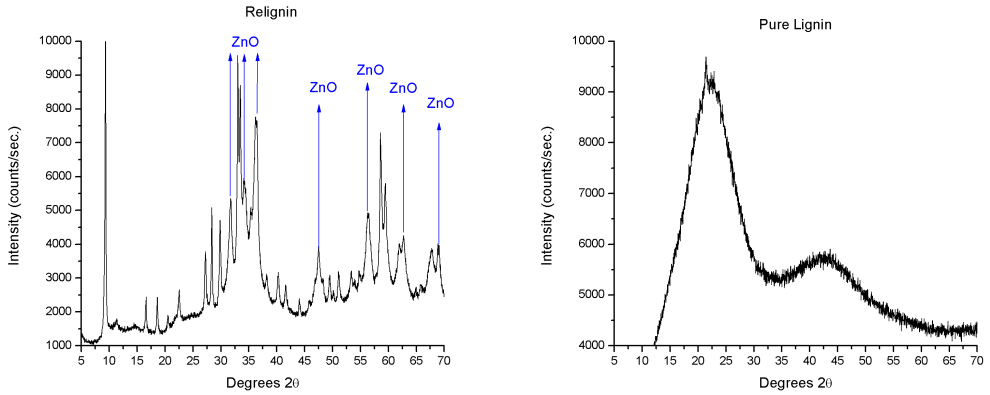

Figure S3. XRD diffractograms of relignin and bare lignin.

2θ (Degrees)			
Lignin	Relignin	ZnO[1]	$ZnCl_2$[2]
	16.57	-	16.61
22.17	-	-	-
	31.72	31.70	-
	34.24	34.38	-
	36.34	36.18	-
	38.21	-	38.21
42.10	-	-	-
	47.51	47.45	-
	56.27	56.46	56.25
	58.58	-	58.58
	62.63	62.76	-
	67.81	-	67.80
	69.01	69.01	-

*Bold Denotes Major peaks

Table S1. Diffraction peaks matching crystalline structures of ZnO and $ZnCl_2$ for both relignin and lignin.

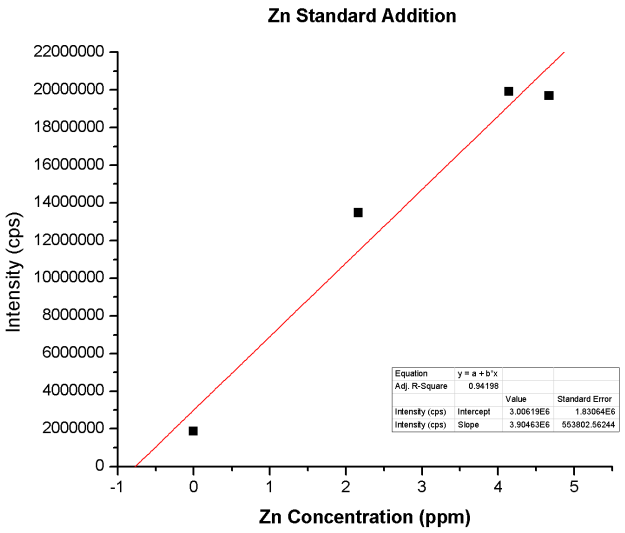

Figure S4. Calculation of Zn via standard addition by ICP-MS.
*RSD Error bars are < 00.2%

References

1. **Albertsson J., Abrahams S.C., Kvick A., Acta Crystallogr., Sec. B: Struct. Sci., 45, 34, (1989).**
2. **Brehler., Z. Kristallogr., Kristallgeom., Kristallphys., Kristallchem., 115, 373, (1961)**