

# Greener transformation of lignin into ultralight multifunctional materials

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Supplementary movie 1. Outstanding shape-recovery and compressibility of lignin based heat treated material

Supplementary movie 2. Hydrophobicity of lignin based biopolymer material and formation a beaded water droplet that would not roll off the surface

Supplementary movie 3. Heat treated lignin based “spongy-gel” soaked with silicon oil

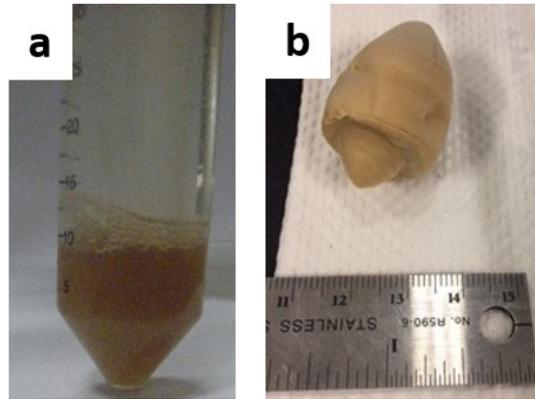


Fig. S1. (a) Suspended lignin electrospun nanofibers in water after 2 min vortexing, (b) freeze dried nanofibrous material



Fig. S2. Photographs of an as lyophilized lignin based sample with no shape recovery functions

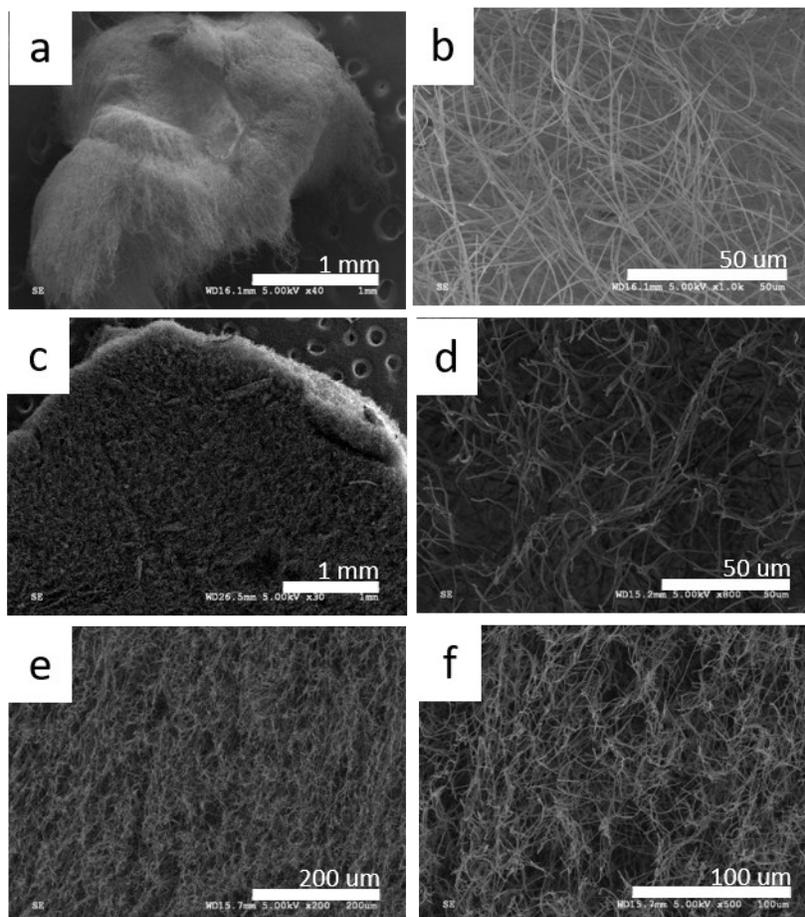


Fig. S3. SEM images showing the cross sectional views of (a,b) as freeze-dried sample (c,d) thermally treated sample, and (e,f) carbonized sample.

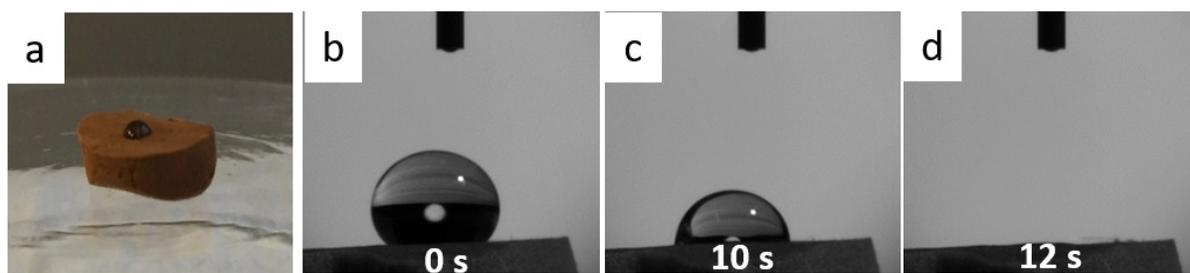


Fig. S4. Contact angle measurements at the cross section of lignin based heat treated sample (a) a water droplet on the cross section of the sample. Images of water droplet during measurement at (b) 0 sec, (c) 10 sec and (d) 12 sec.

Table S1. Contact angle measurements recorded on the surface (S), and on the cross section (CS) of lignin based biopolymer and carbon foams

Time (s)	Heat treated Lignin-S	Heat treated Lignin-CS	Carbonized lignin-S	Carbonized lignin-CS
<b>Initial</b>	132 °	139 °	137 °	132 °
<b>300</b>	129 °	N/A	135°	129 °
<b>600</b>	127 °	N/A	132 °	128 °

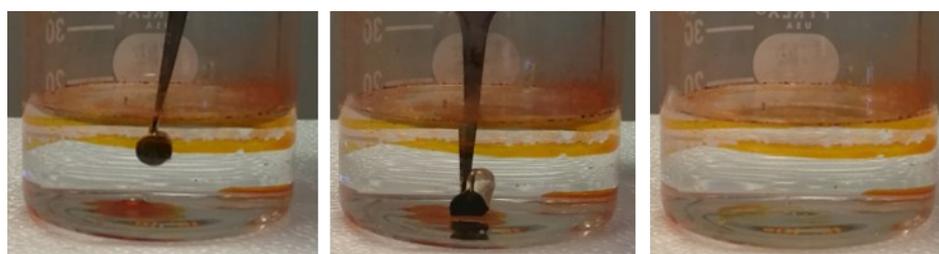


Fig. S5. Chloroform (orange dyed) absorption test with a lignin based carbon sample

Table S2. Silicon oil absorption test of heat treated foam samples

	<b>1</b>	<b>2</b>	<b>3</b>
<b>Before (mg)</b>	0.8	1.2	0.6
<b>After 10 min (mg)</b>	97.5	142.5	87.4
<b>mg/mg</b>	121.9	118.8	174.8