

Table S1. A assignment of peaks in Fourier transform infrared (FTIR) analysis and their correlation to functional groups in lignin.

Frequency (cm ⁻¹)	Assignments
1030	C–O(H) + C–O(C) (first order aliphatic OH and ether
1270	C–O stretching vibration of secondary alcohol
1462	Lignin (C-H bending in CH ₂ and CH ₃)
1513	C–C stretching (aromatic skeleton
1590	Aromatic skeletal vibration
1660	Lignin (C=O stretching)

Table. S2. Yields of obtained lignin.

Biomass feedstock loading	Chemical composition			Solid recovery %	Lignin removal %	Lignin yield %
	Cellulose%	Hemicellulose%	Lignin %			
Raw Biomass (Tectona Grandis)	34	29.7	17.5	-	-	-
Batch 1	67.3	14.4	4.8	50.6	85.2	13.88
Batch 2	63.6	13.6	6.8	50.4	85.2	19.58
Bacth 3	58.4	17.4	5.9	55	80	18.54

Table S3. NMR assignments of major interlinks in 2D-HSQC NMR spectra of lignin.

Label	δc/δ _H (ppm)	Assignments
B _β	53.7/3.37	C _β -B _β in phenylcoumaran
C _β	54.2/3.06	C _β -B _β in B _β - B _β ' resinol
-OCH ₃	56.0/3.74	C-H in methoxyls
A _γ	60.9/3.38	C _γ -H _γ in γ-hydroxylated β-O-4'
B _γ	62.4/3.63	C _γ -H _γ in phenylcoumaran
A _γ	64.7/3.94	C _γ -H _γ γ-acetylated β-O-4'
C _γ	70.1/3.94	C _γ -H _γ in β- β' resinol
Aα	72.35/4.85	Cα-Hα in β-O-4 substructures (A)
A _β (H)	81.3/4.61	C _β -B _β in β-O-4' linked to a H-unit
A _β (G)	84.3/4.29	C _β -B _β in β-O-4' linked to a G-unit
Cα	85.7/4.62	Cα-Hα in β-β' resinol
A _β (H)	81.3/4.61	C _β -B _β in β-O-4' linked to a H-unit
A _β (G)	84.3/4.29	C _β -B _β in β-O-4' linked to a G-unit
Cα	85.7/4.62	Cα-Hα in β-β' resinol
A _β (S)	86.0/4.14	C _β -B _β in β-O-4' linked to a S-unit

S _{2,6}	104.4/6.71	C ₂ -H ₂ and C ₆ H ₆ in etherified syringyl units (S)
S' _{2,6}	104.7/7.36	C ₂ -H ₂ and C ₆ H ₆ in etherified syringyl units (S')
G ₂	112.0/7.68	C ₂ -H ₂ in guaiacyl units (G)
PCA _β and FA _β	116.7/6.39	C _β -B _β in p-coumarate (PCA)
G ₅	115.9/6.69	C ₅ -H ₅ in guaiacyl units (G)
G ₆	119.3/6.77	C ₆ -H ₆ in guaiacyl units (G)
PCA _{3,5}	115.4/6.68	C ₃ -H ₃ in C ₅ -H ₅ in p-coumarate (PCA)
H _{2,6}	128.6/7.04	C _{2,6} -H _{2,6} in p-hydroxyphenyl units (H)
PCA _{2,6}	130.7/7.49	C ₂ -B ₂ and C ₆ -H ₆ in p-coumarate (PCA)

Table S4. Lignin-PVDF with various concentrations and observations of nanofiber of different average diameters and standard deviation.

	PVDF (wt%)	Lignin (wt%)	Observations	Average Diameter (nm)	Standard Deviation
P10-L3	10	3	Uniform fibers	488.2	153.9244
P10-L5	10	5	Uniform fibers	505.3	175.4753
P10-L7	10	7	Beads on strings	586.7	276.7745
P10-L9	10	9	Beads on strings	2338.996	386.9155

Table S5. The Dielectric Constant and Dielectric Loss of PLNF-TENGs with different compositions.

	Dielectric Constant	Dielectric Loss
P10-L0	3.23	0.01
P10-L3	5.92	0.06
P10-L5	12.97	0.03
P10-L7	9.97	0.06
P10-L9	4.33	0.05

Table S6. The Comparison of the performance of TENGs from various materials, including biomaterials.

Materials	Fabrication method	Contact area	Conditions	Current	Voltage	Power Density	Sustainability	References
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						(mW/m ²)		
TiO ₂ NP	Electrospinning	10 cm × 10 cm	5–10 Hz	–1.61 µA	111 V	23.44 mW m ⁻²	Biocompatibility, Mechanical durability	²
chitosan-diatom	Casting	3 × 4 cm ²	3Hz, 5Hz, 7Hz, 10 Hz	1.02 µA	150 V	15.7 mW/m ²	skin-attachable	³
PCA PNFMTPU /CB BNFM	Electrospinning	4x4 cm ²			24.45 V	6 mW/m ²	Biocompatibility, human motion detection	⁴
PI/TPU-TPU	Electrospinning	-	4Hz/5kPa		0.92 V	-	Fingertip interaction force detection, pronunciation sensing, human motion and finger gesture recognition	⁵
CMCSCM C-Na	Electrospinning	9 cm ²	2Hz	20 nA	3V	120 mWm ⁻²	Water soluble	⁶
CANF	Electrospinning	1.27 cm ²	3 N, 4Hz	0.4 mA/m ²	25 V	16 mW/m ²	Tactile and proximity sensing	⁷
PEI-GO in CS	Casting	3 and 6 cm	1.0–6.0 Hz	6.6 µA	222 V	407 mW/m ²)	fully bioderived	⁸
Lignin/PVDF	Electrospinning	2x2 cm ²	1Hz,3Hz,5 Hz	0.74 µA	7.4 V	60 mW/m ²	Sustainable Material Innovation, Green filler, Excellent Durability, Cost-effective approach.	This work

Abbreviations: TiO₂-Titanium dioxide; PCA-homogeneous PLA/CS/aloin, PNFM-porous nanofiber membrane, TPU-Thermoplastic polyurethanes, CB-Carbon black, CMCS-Carboxymethyl chitosan, CMC-Na carboxymethyl cellulose sodium, CANF- Cellulose acetate nanofiber, PEI- Polyethylenimine, GO- Graphene Oxide, CS-Chitosan.