

## Supporting Information

# Heavy Metal-Free Tannin from Bark as Cathodes for Sustainable Energy Storage

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$$E = E^0 - \frac{RT}{zF} \ln\left(\frac{a_{red}}{a_{ox}}\right) \dots\dots\dots\text{Equation (S1)}$$

Where E is the electrode potential (in Volts), E<sub>0</sub> is the standard reduction potential of the redox couple of interest (in Volts), R is the gas constant (8.315 J K<sup>-1</sup> mol<sup>-1</sup>), T is the temperature (Kelvin), z is the number of moles of electrons transferred, and F is Faraday's constant (96,485 C mol<sup>-1</sup>), and a<sub>Red</sub> is the activity of the reduced form and a<sub>Ox</sub> is the activity of the oxidized form of the relevant species.

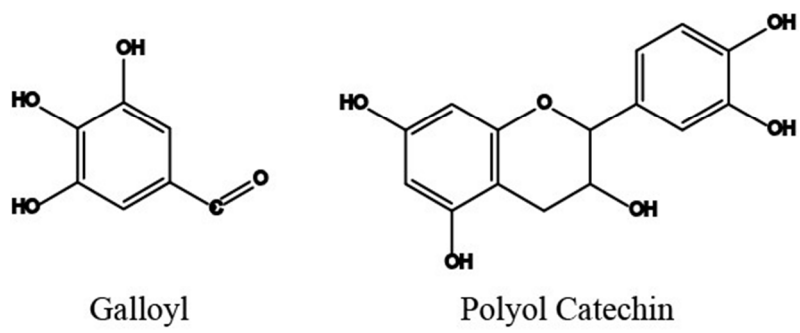


Figure S1: Structures of galloyl group and polyol catechin.

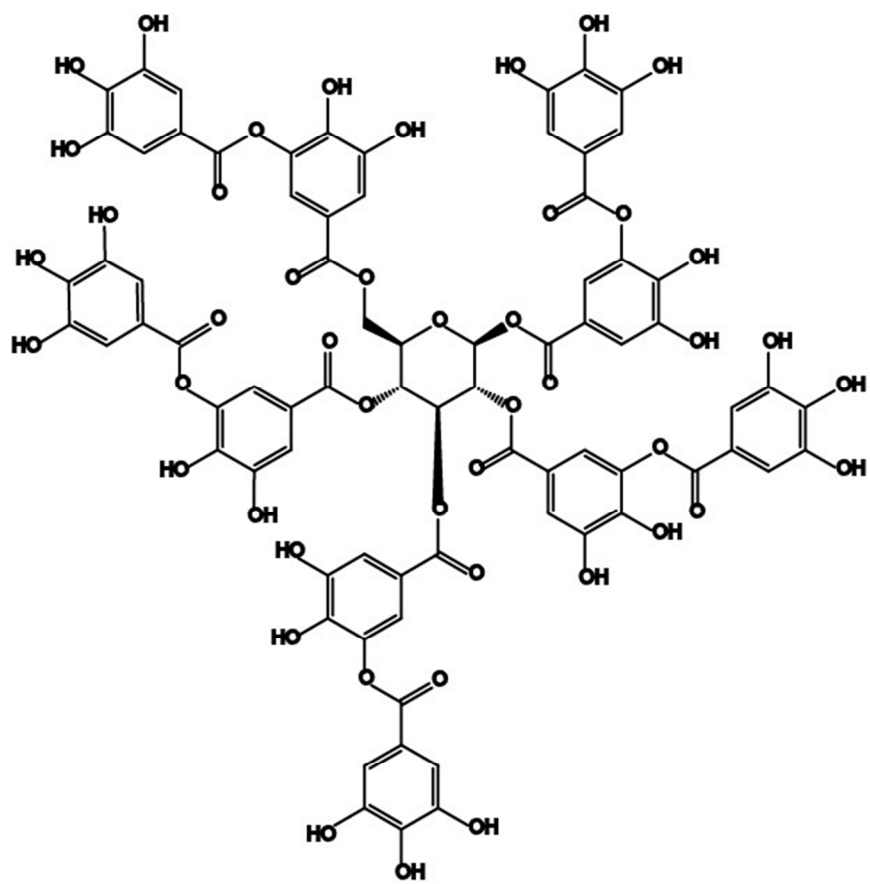


Figure S2: Model structure of Gallotannin.

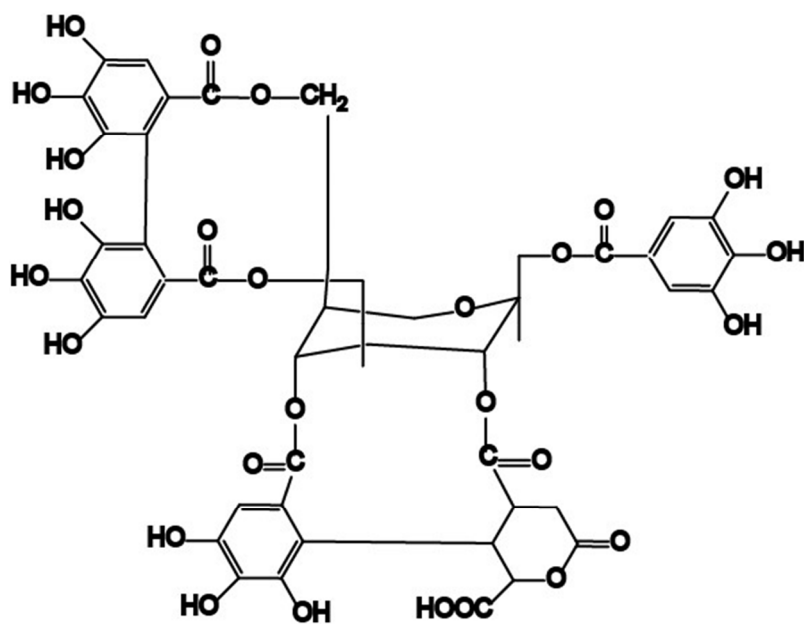


Figure S3: Representative structure of ellagi tannin.

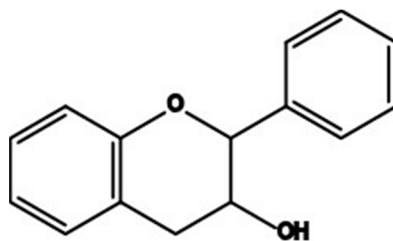


Figure S4: Structure of flavon-3-ol oligomer groups.

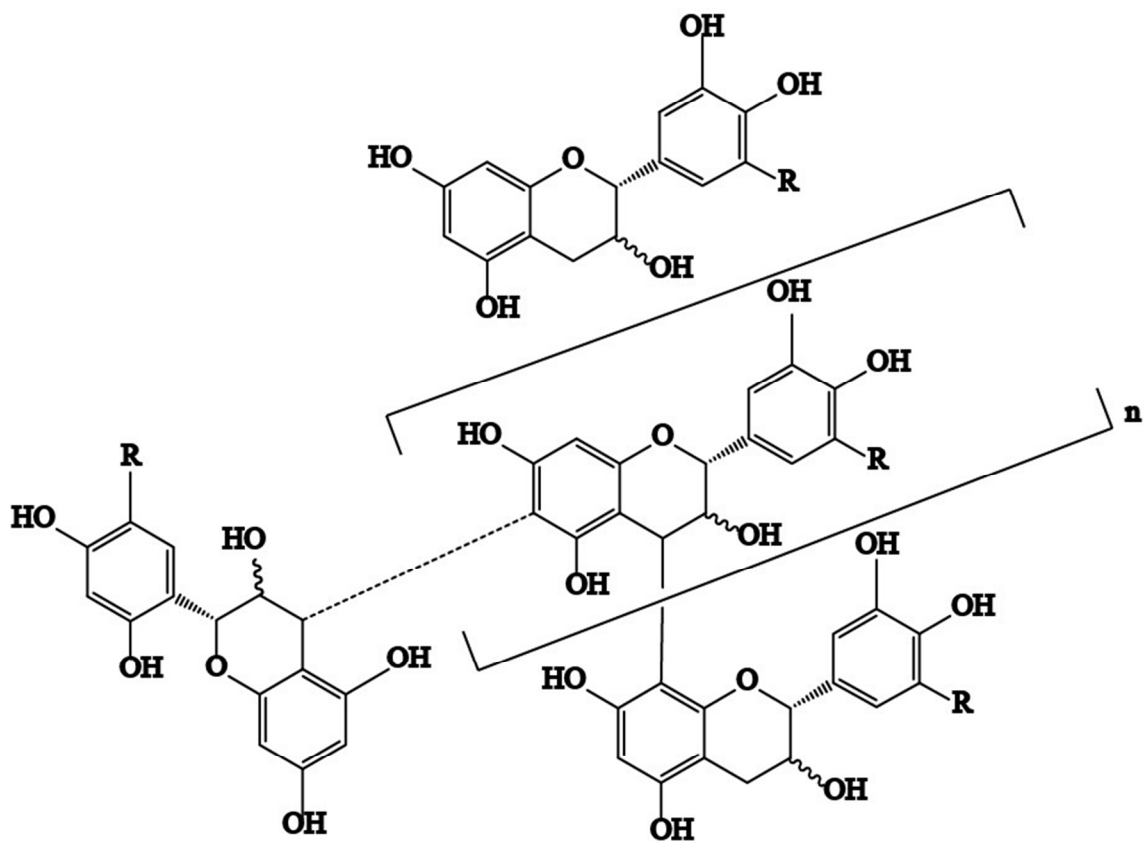


Figure S5: A model structure of condensed tannin.

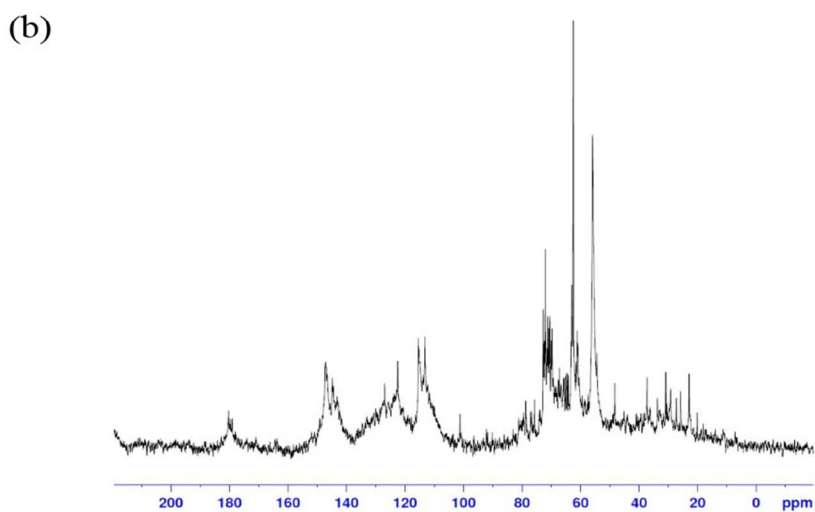
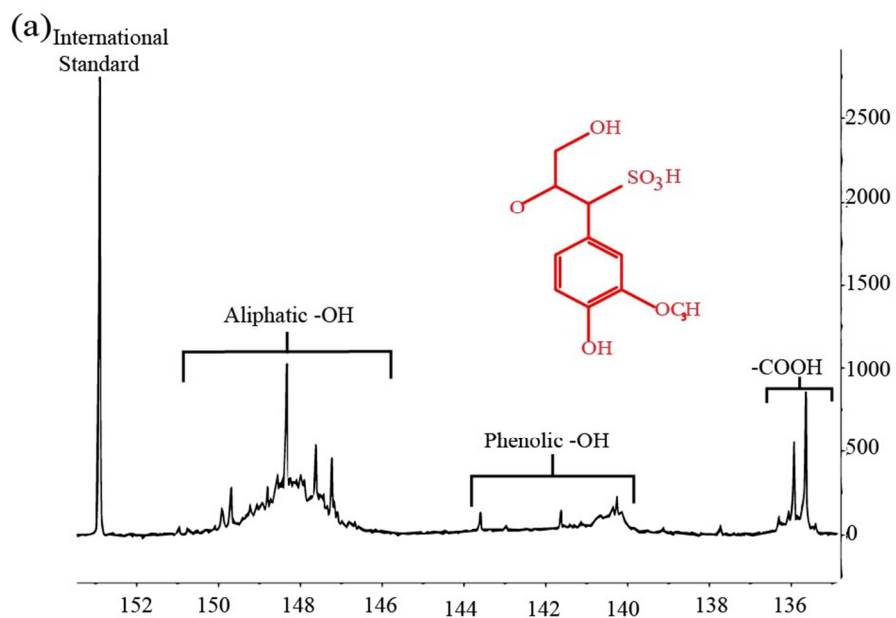


Figure S6: NMR Spectrum of ultra-filtered Sodium Lignosulfonate (a) Acylation induced quantitative  $^{13}\text{C}$ -NMR Spectra of lignosulfonate (b) Solid State  $^{13}\text{C}$  CP/MAS NMR spectrum of lignosulfonate

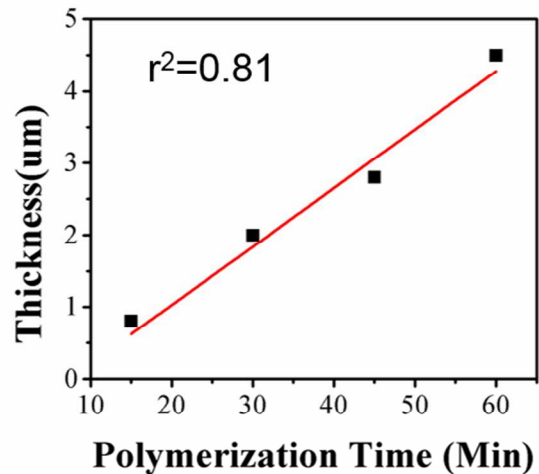
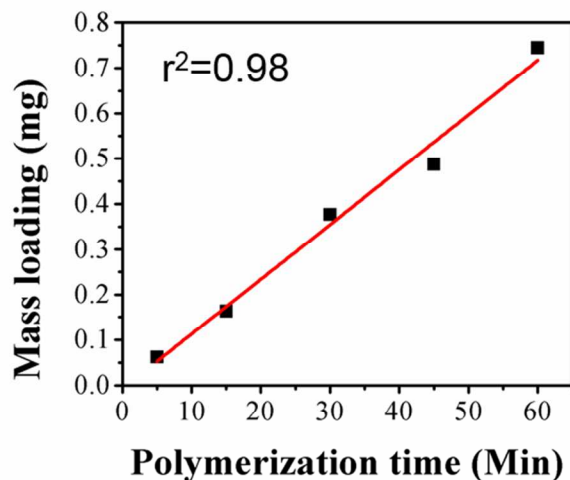


Figure S7: Effect of different electropolymerization time. The trend of mass loading correlating a linear relationship with increasing electropolymerization time with a  $r^2$  value of 0.98 and Change in thickness of the Tn/Ppy layer correlating a linear relationship with increasing electropolymerization time with a  $r^2$  value of 0.81

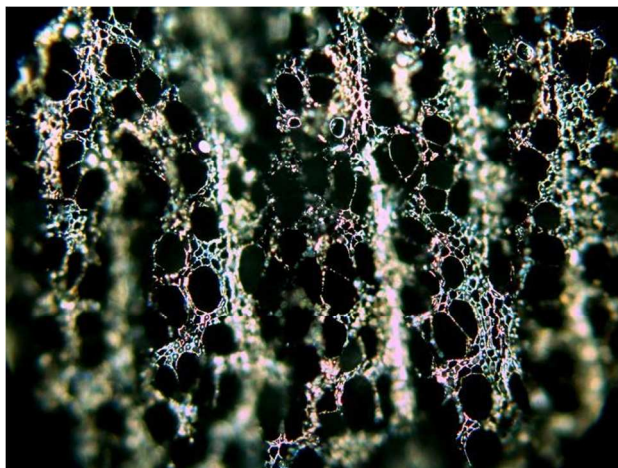


Figure S8: Optical microscope image of tannin/ppy composite on CW electrode

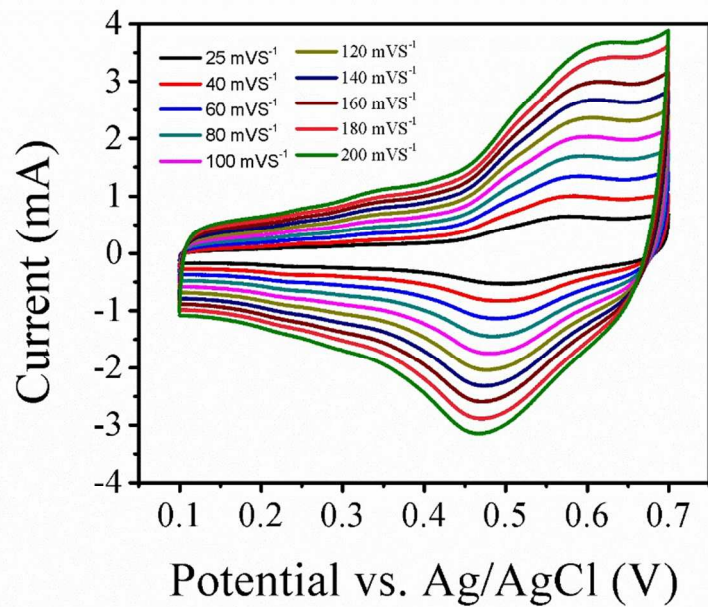


Figure S9: Cyclic Voltammetry of tannin loaded in carbon paper in 0.1M perchloric acid at different scan rate ranging from 25  $\text{mVS}^{-1}$  to 200 $\text{mVS}^{-1}$

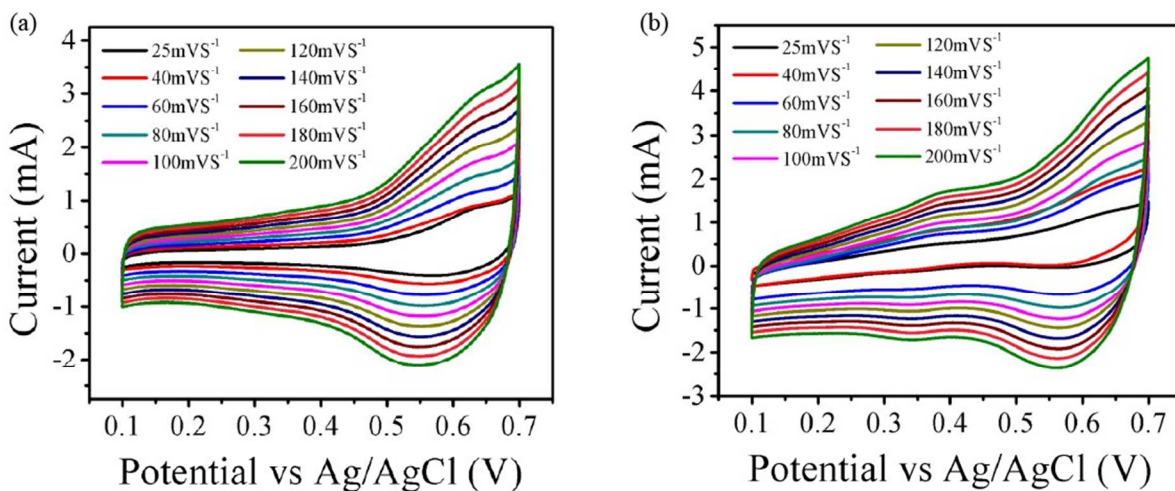


Figure S10: Cyclic Voltammetry of tannin loaded in carbon paper at different scan rate ranging from 25  $\text{mVS}^{-1}$  to 200 $\text{mVS}^{-1}$  (a) in 0.5M sulfuric acid as an electrolyte. (b) in 1M hydrochloric acid as an electrolyte

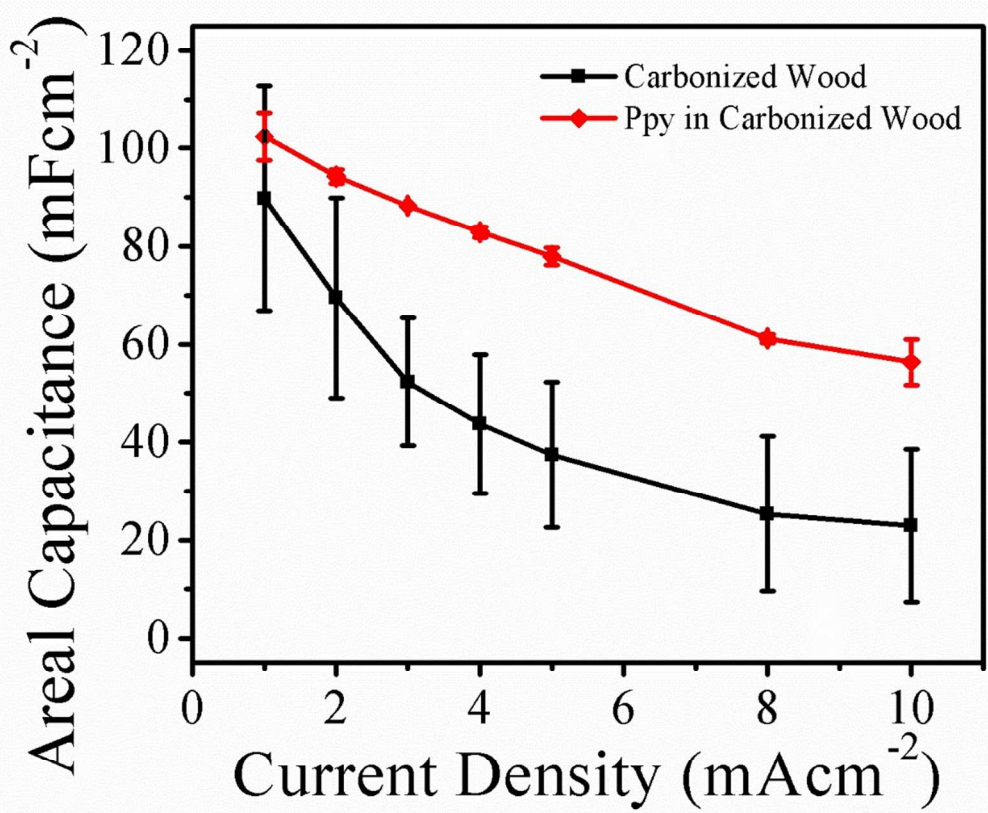


Figure S11: Areal Capacitance of carbonized wood at different current density