Supplementary information

Biohybrid plants with electronic roots via *in-vivo* polymerization of conjugated oligomers

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UV-VIS spectroscopy on roots

16 mg of freeze-dried root material, treated with ETE-S for 72 h and without treatment (control roots) were placed in a mortar with 3 mL of DMSO. The samples were mechanically crushed for 10 min until the root samples were homogenized in DMSO. Treated root extract exhibits a pale rose color while the control root shows no specific coloration after the extraction. The solutions were then left to settle for 6 h and the supernatant was collected for UV-Vis spectroscopy measurements. The spectra were acquired using a Lambda 900 Perkin Elmer Absorption spectrometer with a resolution of 5 nm from 300 to 900 nm. To obtain the ETE-S contribution on the treated root extract we subtracted the spectra of the untreated root extract from the treated root extract. The characteristic peaks of the ETE-S and undoped p(ETE-S) are observed showing that the root contains both polymer and monomer after ETE-S treatment.

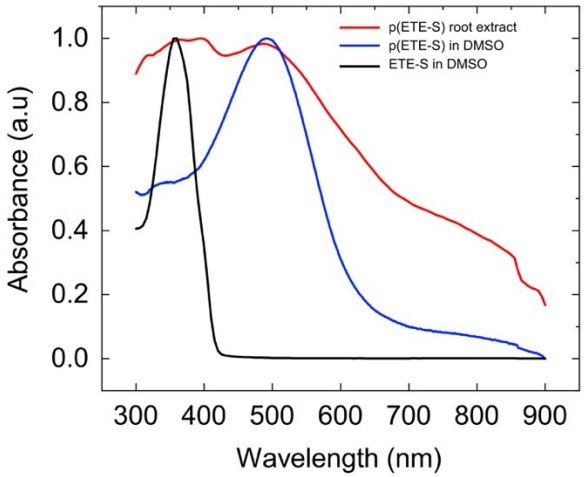

Figure S1: UV-Vis spectra of p(ETE-S) root homogenized in DMSO (tissue contribution subtracted) in red, in vitro enzymatically polymerized p(ETE-S) dissolved in DMSO in blue, and ETE-S dissolved DMSO in black.

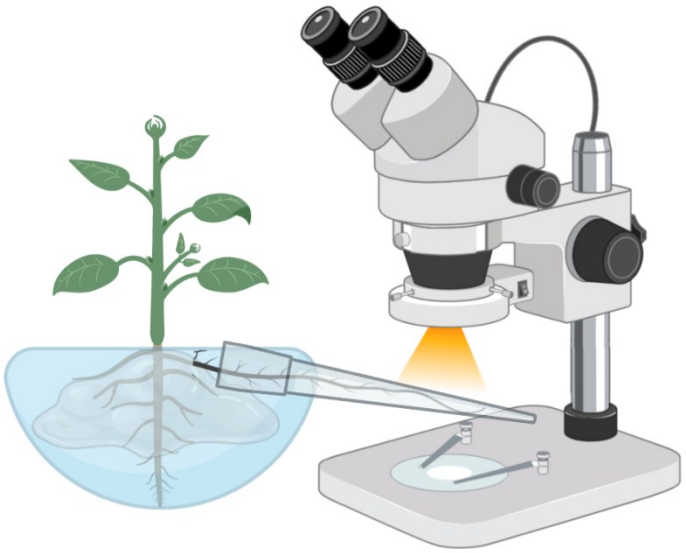

Figure S2: Schematic of the experimental set-up for monitoring in-situ the ETE-S polymerization on the root that is still attached on the plant using timelapse microscopy.

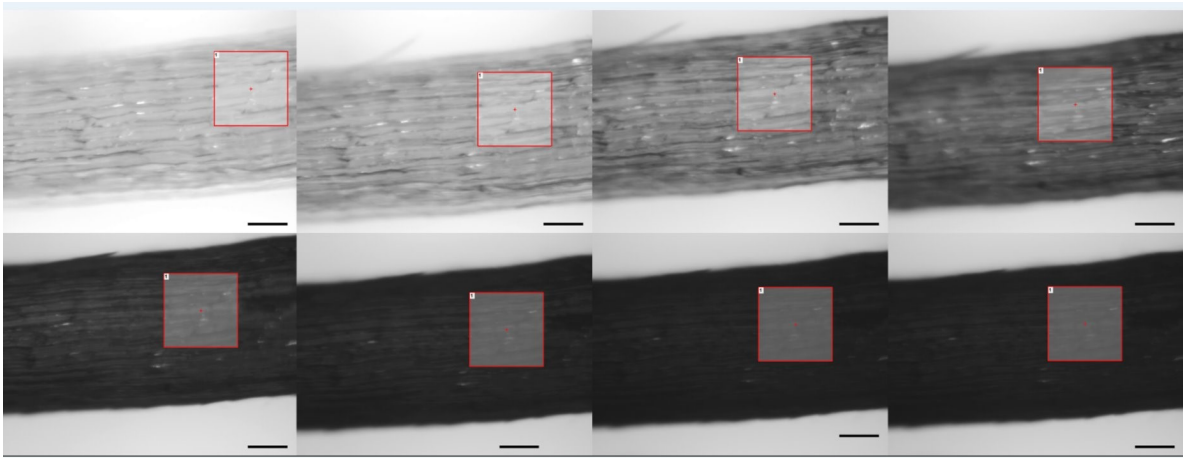

Figure S3: Selected micrographs of root during ETE-S polymerization at different times converted to greyscale. Red square shows the selected region of interest (ROI) for analyzing the ETE-S polymerization kinetics as shown in Figure 1C, (scalebar 100mm).

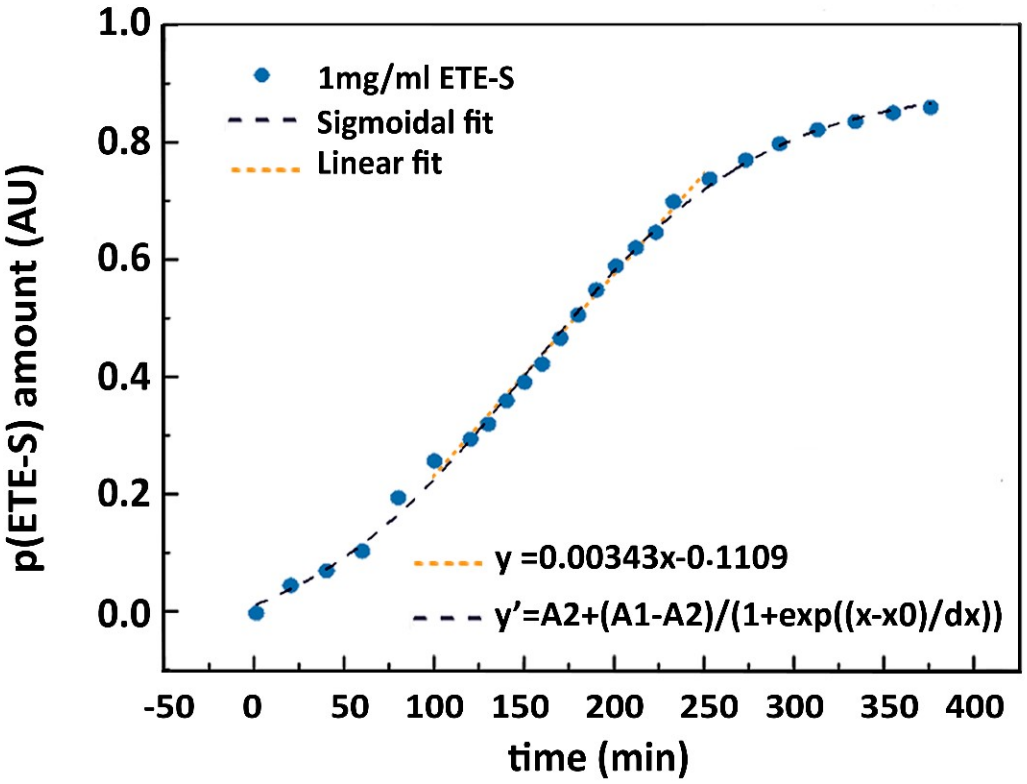

Figure S4: Temporal evolution of p(ETE-S) amount on the root with an overall sigmoidal trend, and a linear trend from 100 to 250 min. Linear fit has a R^2 =0.9898. For the Sigmoidal fit: A1= -0.072±0.021, A2= 0.899±0.0120, x0=152.345±2.977, dx=65.199± 3.329 with R^2 =0.9977.

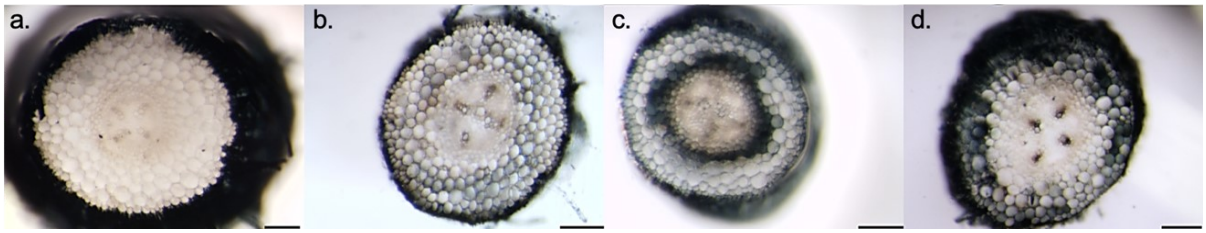

Figure S5: a) Transversal cross section of p(ETE-S) root. Transversal cross sections of wounded roots with p(ETE-S) on ground and vascular tissue b) on the cortex, c) on the pericycle, d) on the cortex and xylem. (Scalebar 100µm)

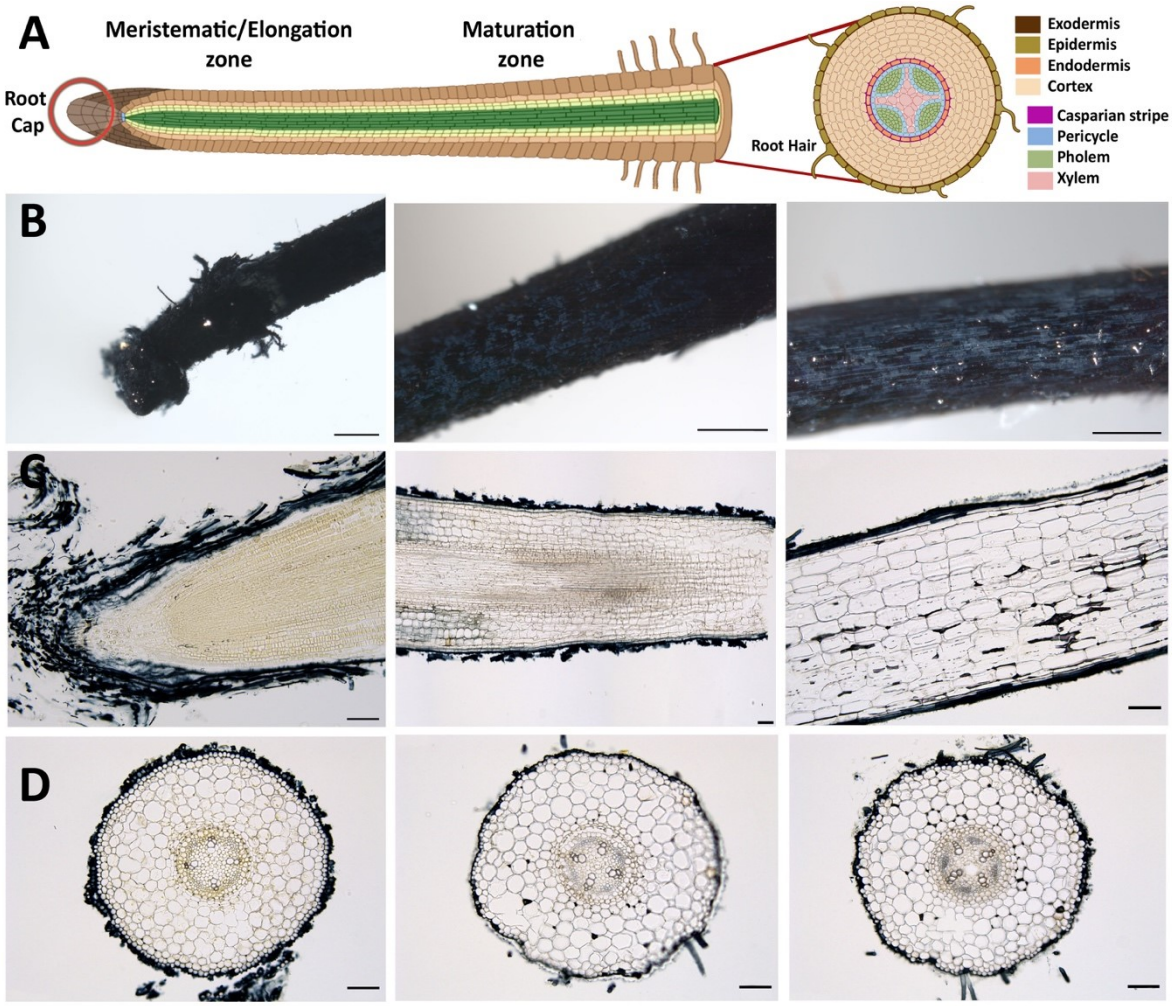

Figure S*6*: Root functionalized with 2 mg ml^{-1} of ETE-S for 3 days. A) Schematic of root anatomy indicating the various tissues and developmental zones. p(ETE-S) fixed root micrographs for B) plane view (scalebar 500µm) C) longitudinal cross section, (scalebar 100µm) and D) transversal cross (scalebar 100µm). In B-D first column corresponds to meristematic/elongation zone while second and third column to the maturation zone of the root.

Figure S7: Longitudinal cross sections of functionalized bean root for 3 days in 2mg ml^{-1} ETE-S fixed with PFA. The micrographs show that the root hairs are coated with P(ETE-S).

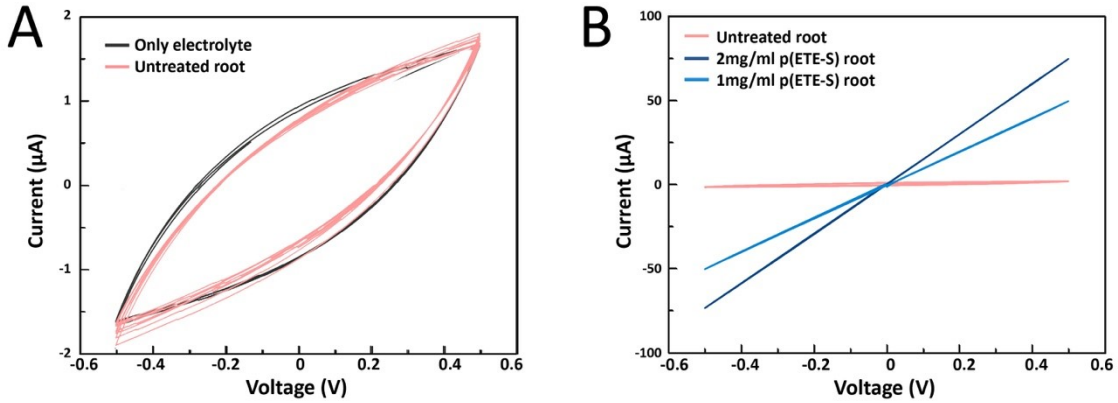

Figure S8: A) IV curve of untreated bean root with 20mm interelectrode distance (red) compared with the electrolytic contribution measured with and carbon fiber probes (black). B) IV curves of p(ETE-S) roots treated with 1 and 2mg/ml ETE-S.

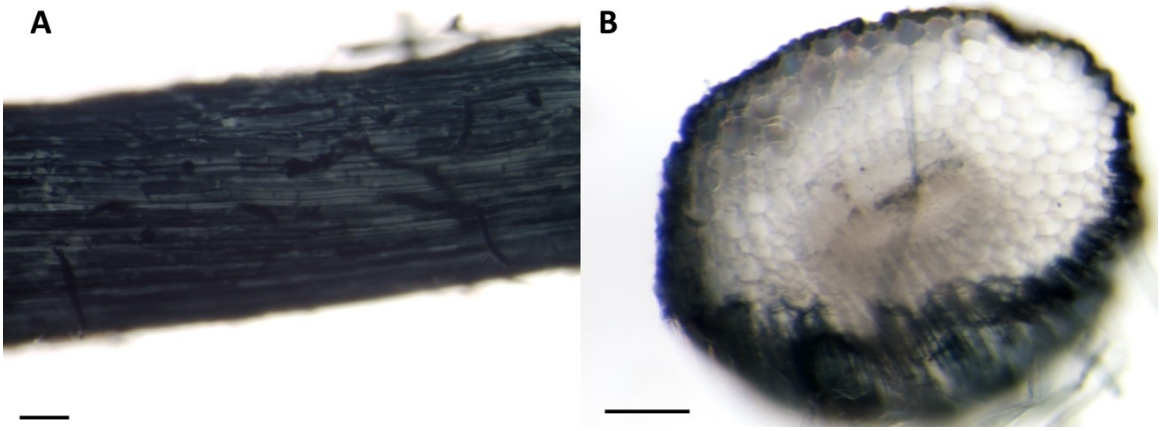

Figure S9: A) Plane view and B) cross section of a Pea plant (Pisum sativum) root functionalized with 1mg ml^{-1} ETE-S solution. ETE-S polymerized on the root forming a polymer coating on the root epidermis. For the functionalization the same methodology was used as for bean plant roots (see methods section). Scale bar 100µm.

Current (μA)	Capacitance (mF)	ESR (KΩ)
5	8.07	1.8
10	6.54	1.75
20	5.34	1.89
30	4.89	1.8
40	4.36	1.5
50	3.95	1.3

Table S1: Capacitance and ESR values calculated form galvanostatic charge/discharge measurements on root supercapacitor.