Supplemental information

Table S1. Equivalent circuit analysis of Nyquist plots for various electrode configurations. EIS data was analyzed with the Randles-Ershler model. Results are shown for charge transfer resistance (R), solution resistance (R_s), Capacitance (Q_v and Q_a), Warburg impedance (W) and Chi-squared (ChiSq).

Table S1. Nyquist Simulation Results

	Bare Platinum	PGP	PGP + CHI + AOX	PGP + PNI + AOX	PGP + SILK + AOX	PGP + CNC + AOX
R (Ω)	9.27E+03	7.24E+03	1.08E+03	3.88E+03	5.37E+03	4.28E+03
R_s (Ω)	1.53E+03	7.79E+02	4.60E+02	6.07E+02	6.30E+02	7.22E+02
Q_y	6.85E-05	6.37E-04	3.61E-04	7.37E+02	2.38E-04	1.15E+01
Q_a	3.42E-06	1.50E-04	4.30E-04	2.58E-04	3.20E-04	2.40E-04
W	7.59E-01	6.92E-01	5.89E-01	5.82E-01	6.12E-01	6.20E-01
ChiSq	3.38E-03	3.45E-03	3.24E-03	3.92E-03	2.79E-03	1.30E-03

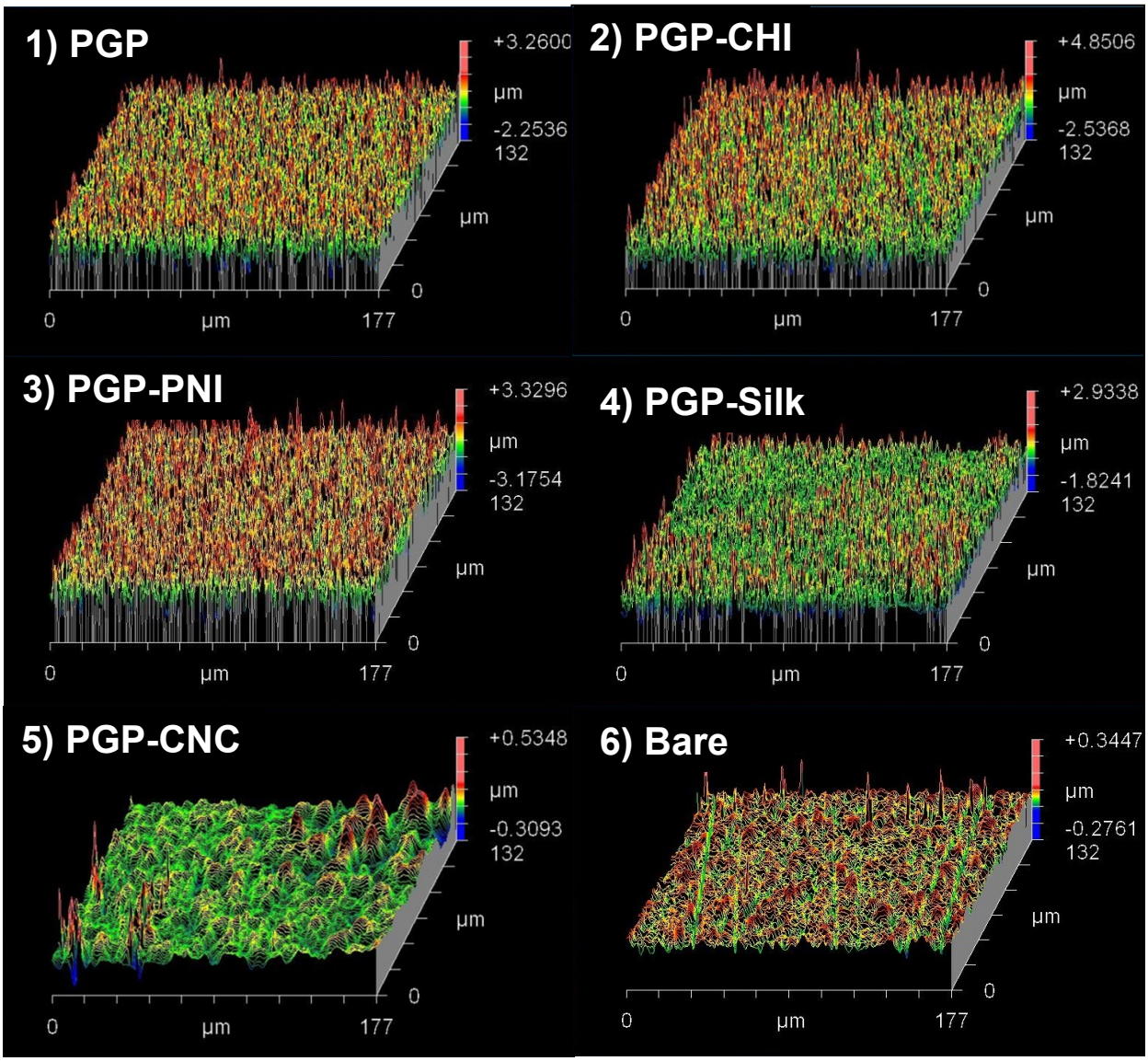
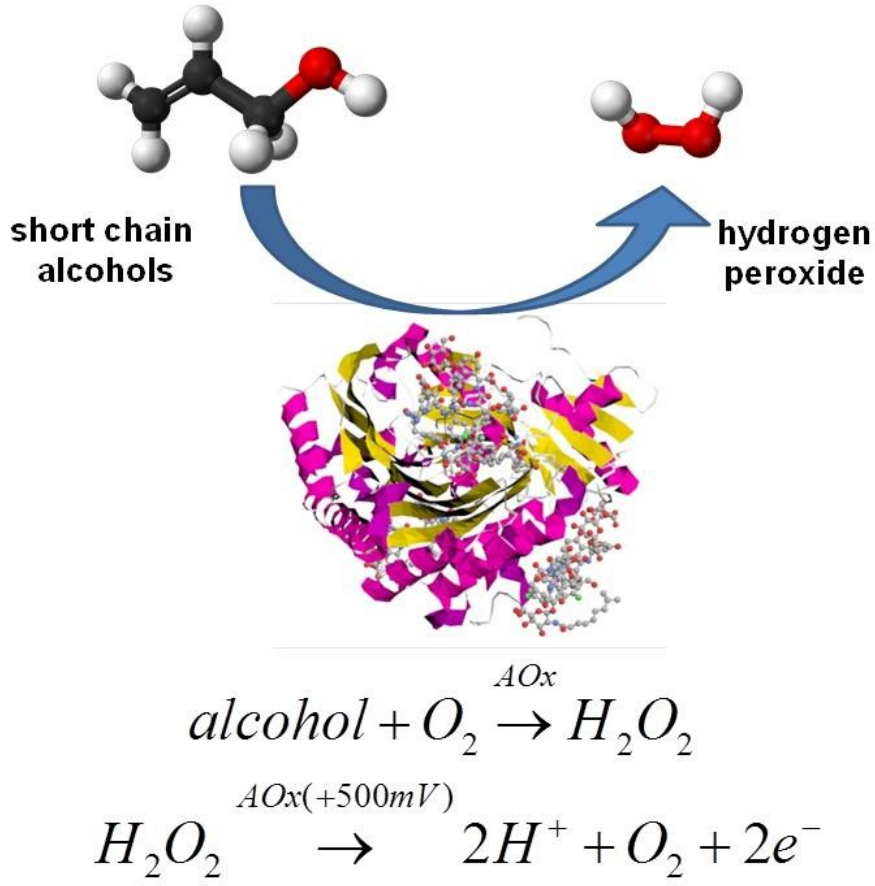


Figure S1. Representative SWLI images for all bionanocomposites. RMS values for each treatment were measured in triplicate (n > 3): 1=PGP (RMS = 587.0 ± 63.4 nm), 2=PGP_CHI (RMS = 699.5 ± 113.2 nm), 3=PGP_PNI (RMS = 712.6 ± 31.4 nm), 4=PGP_SILK (RMS = 267.9 ± 144.2 nm), 5=PGP_CNC (RMS = 44.8 ± 0.8 nm), 6=Bare (RMS = 25.89 ± 1.83 nm).



$$alcohol + O_2 \xrightarrow{AOx} H_2O_2$$

$$H_2O_2 \xrightarrow{AOx(+500mV)} 2H^+ + O_2 + 2e^-$$

Figure S2. Schematic diagram depicting the oxidation of short chain alcohols by alcohol oxidase (AOx). Byproducts of this reaction are carbonyl compounds and hydrogen peroxide. Under oxidative bias, hydrogen peroxide deprotonates to produce free electrons which are measured as current (not drawn to scale).

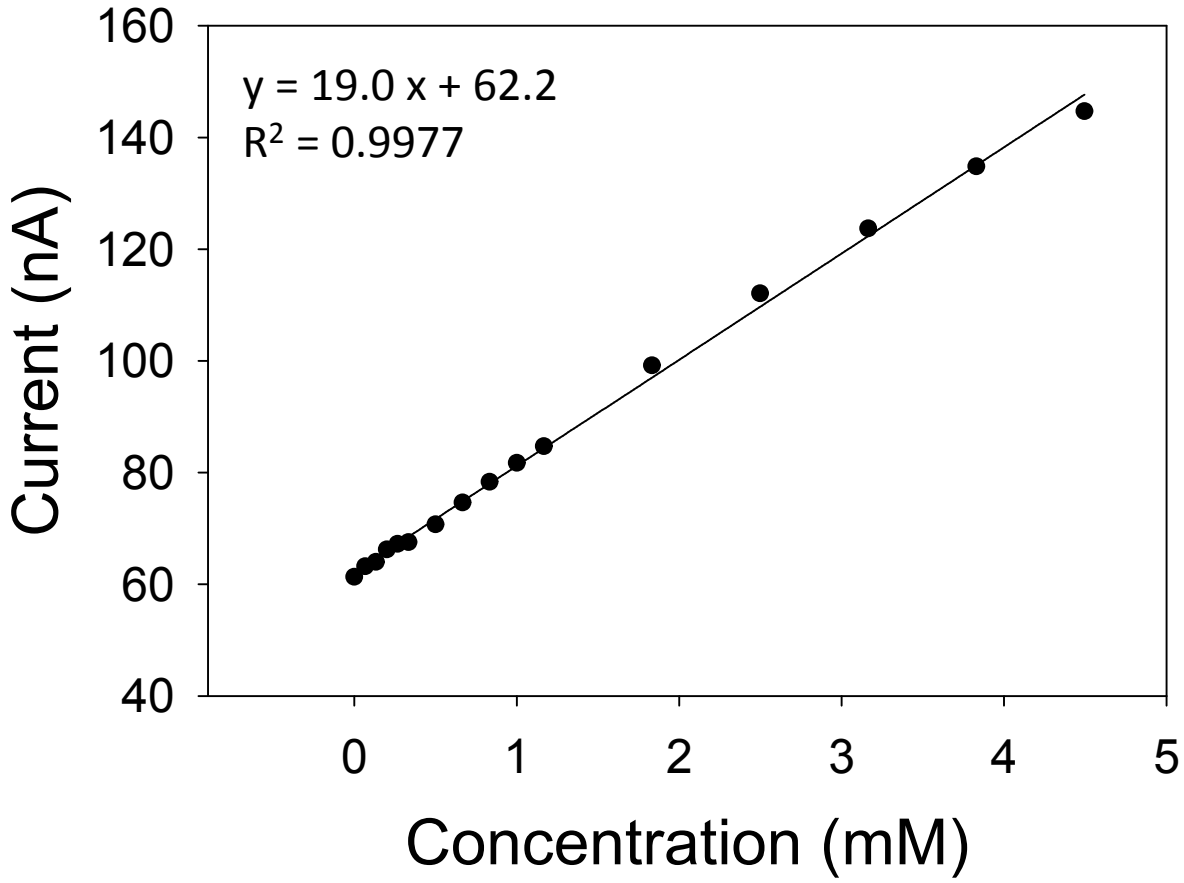


Figure S3. Representative average current versus methanol concentration plot from DCPA time series for AOx immobilized in chitosan on a PGP sandwich nanocomposite platform.

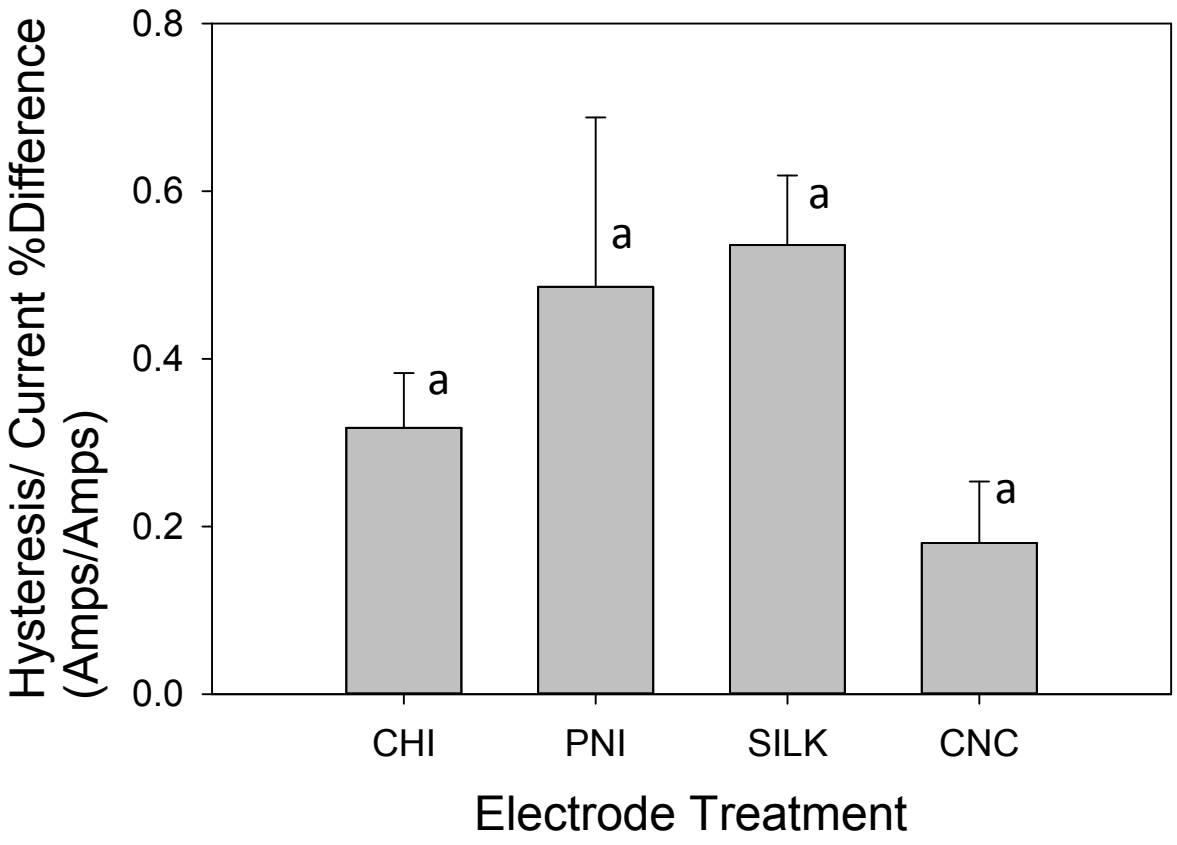


Figure S4. Average percent difference in polarization current for treated electrodes. Hysteresis measurements for AOx immobilized in various hydrogels on PGP-modified electrodes ($n \geq 3$). PGP_CHI= 31.8% ± 6.6%, PGP_PNI= 48.6% ± 20.2%, PGP_SILK=53.6% ± 8.3%, PGP_CNC=18.0% ± 7.3%. A Tukey pairwise comparison was used to group electrodes with no statistically significant differences in performance (indicated by the letter a).

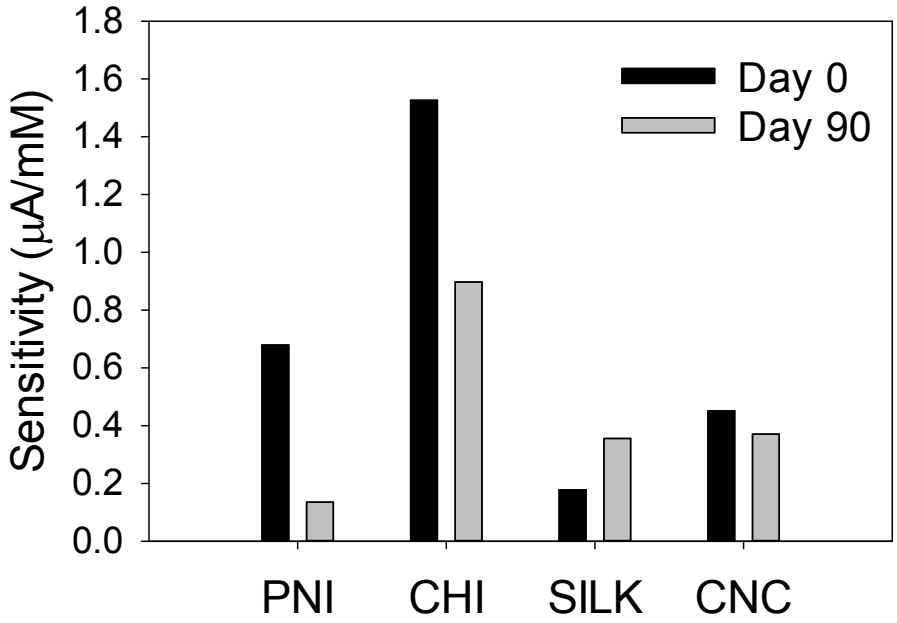


Figure S5. Shelf life study of hybrid bionanocomposites after storage in PBS at 4°C