

Supporting Information for

Electrically Conducting Collagen and Collagen-Mineral Composites for Current Stimulation

*M. Ramesh Kumar and Michael S. Freund**

S1. Electrochemical Aggregation of Collagen

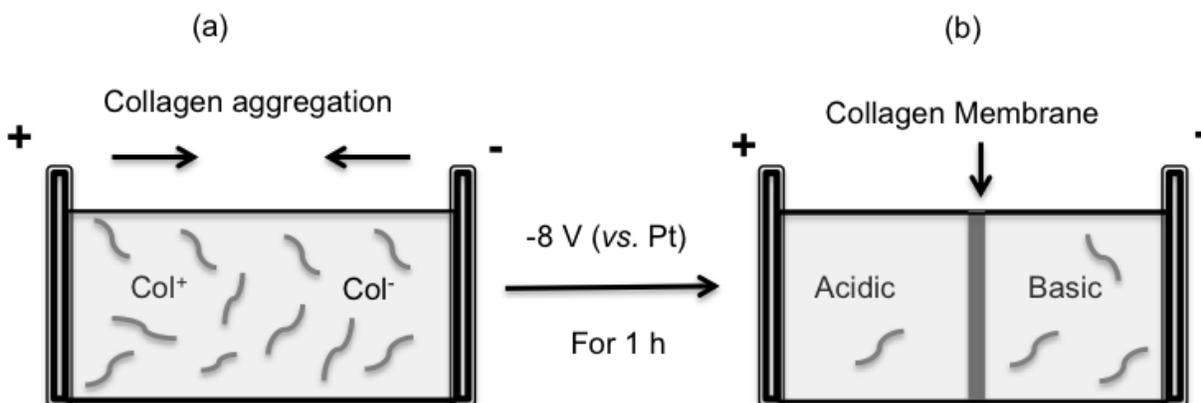


Figure S1. A schematic illustration of the electrochemical aggregation of collagen membrane.

(a) An applied voltage creates the acidic and basic regions in the electrochemical cell, thus forming positive and negatively charged collagen molecules depending in the solution pH. (b) At its isoelectric point collagen loses all its electric charge and forms a membrane.

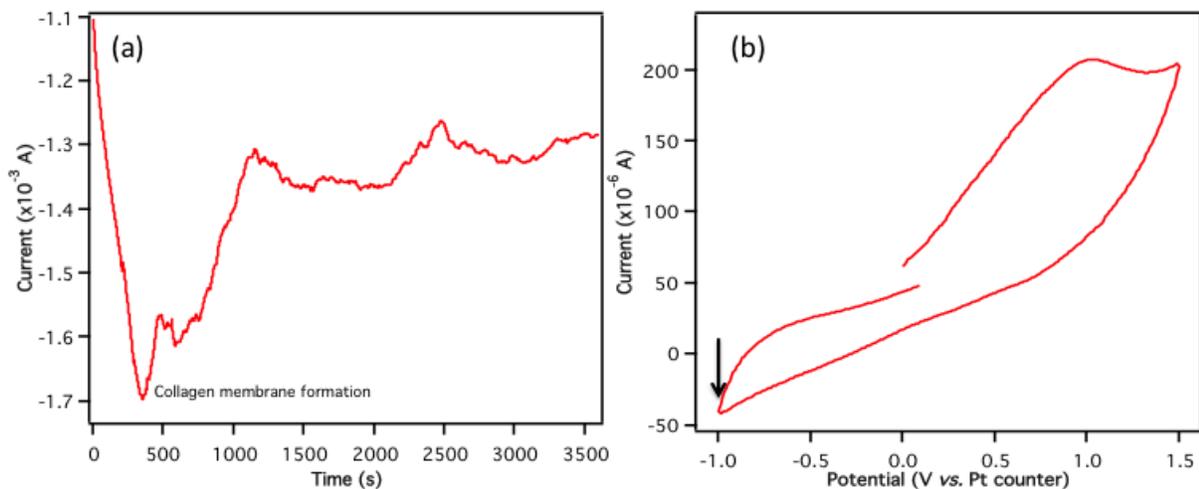


Figure S2. (a) Current versus time response of electrochemical aggregation of collagen at -8 V (vs. Pt counter). The current drops initially and starts growing after sometime (~ 400 s), indicating the formation of collagen membrane. The current increases with the growth of collagen membrane in the electrolyte, and stays constant once the membrane is fully formed. (b) CV of Pt electrode on PEDOT:PSS (0.045 mg/mL) containing collagen electrolyte. The arrow indicates the active potential of PEDOT:PSS that was used to grow a layer of PEDOT:PSS over the electrochemically aligned collagen membrane

S2. Electrochemical Aggregation of Collagen – Calcium Phosphate

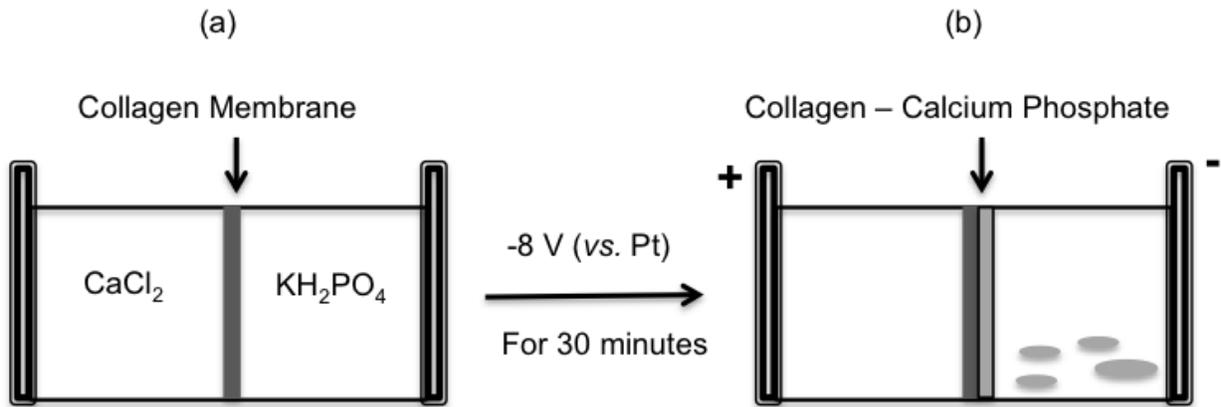


Figure S3. A schematic illustration of the aggregation of collagen – calcium phosphate membrane. (a) Once the collagen membrane is formed by isoelectric focusing method, CaCl_2 and KH_2PO_4 were added on anode and cathode sides respectively. (b) Applied potential forms a layer of calcium phosphate over the collagen membrane on the cathode side alone as any formed calcium phosphate in the anode side would have dissolved immediately in the acid.

S3. FTIR Analysis

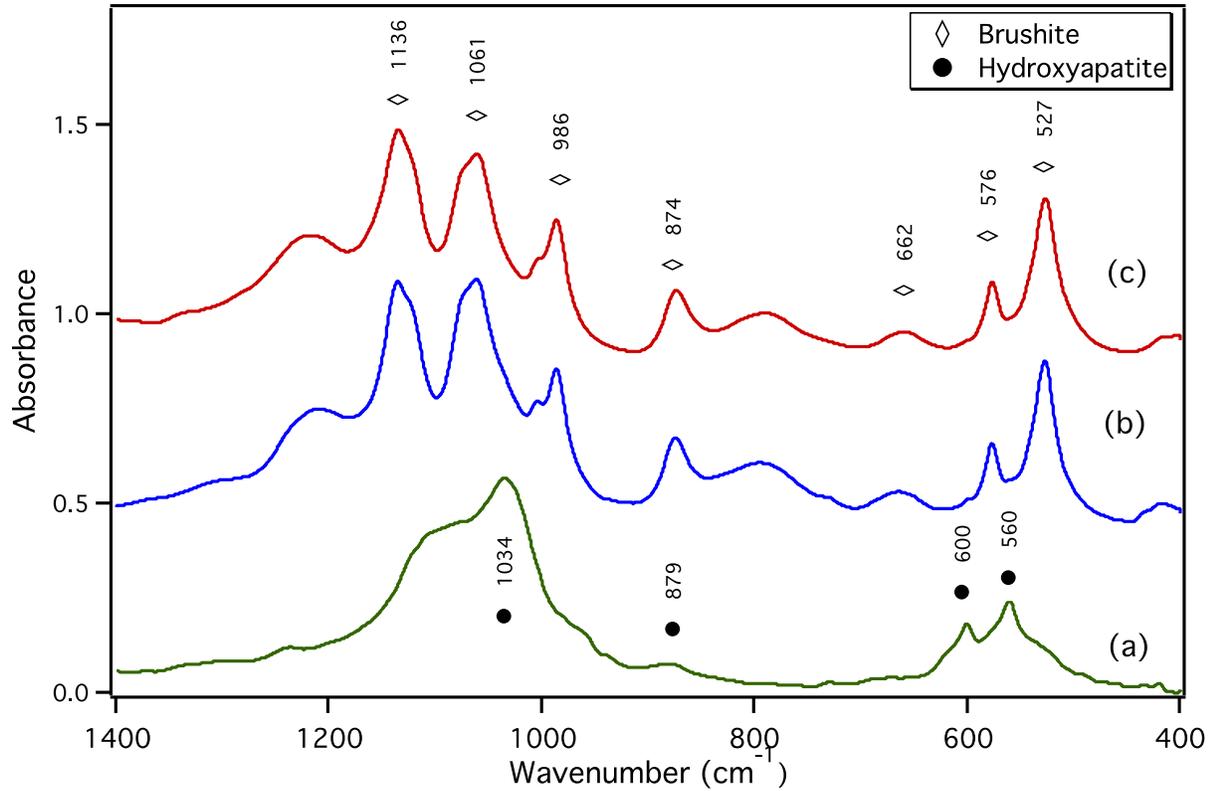


Figure S4. FTIR Spectra of collagen – calcium phosphate composite materials, synthesized using three different concentrations of CaCl_2 and KH_2PO_4 in the electrolyte. (a) 0.01 M – carbonated hydroxyapatite, (b) 0.025 M – brushite and (c) 0.05 M – brushite.

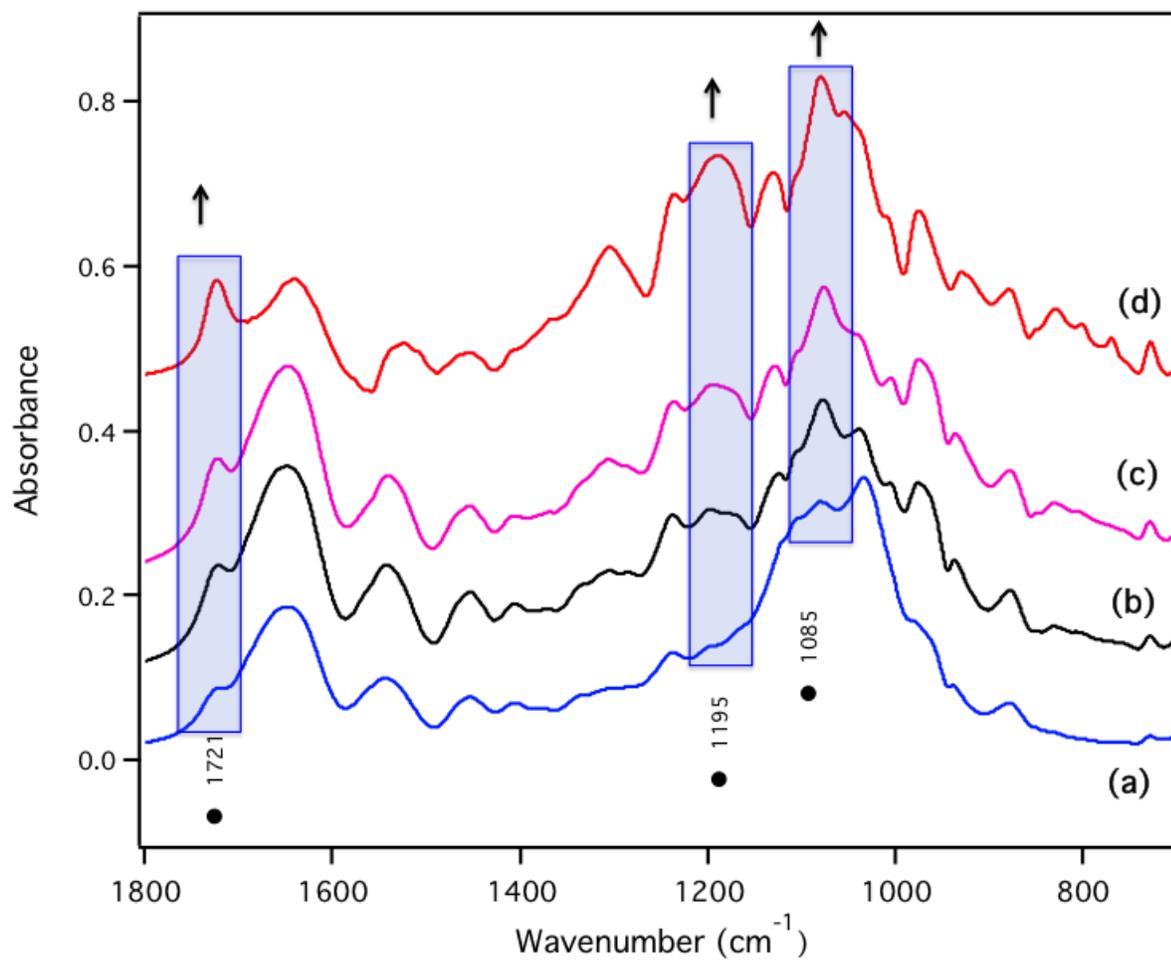


Figure S5. FTIR spectra of collagen – hydroxyapatite – PEDOT:PSS hybrid membranes prepared using four different concentrations of PEDOT:PSS in the electrolyte. (a) 0.015 mg/mL, (b) 0.030 mg/mL, (c) 0.045 mg/mL and (d) 0.060 mg/mL.

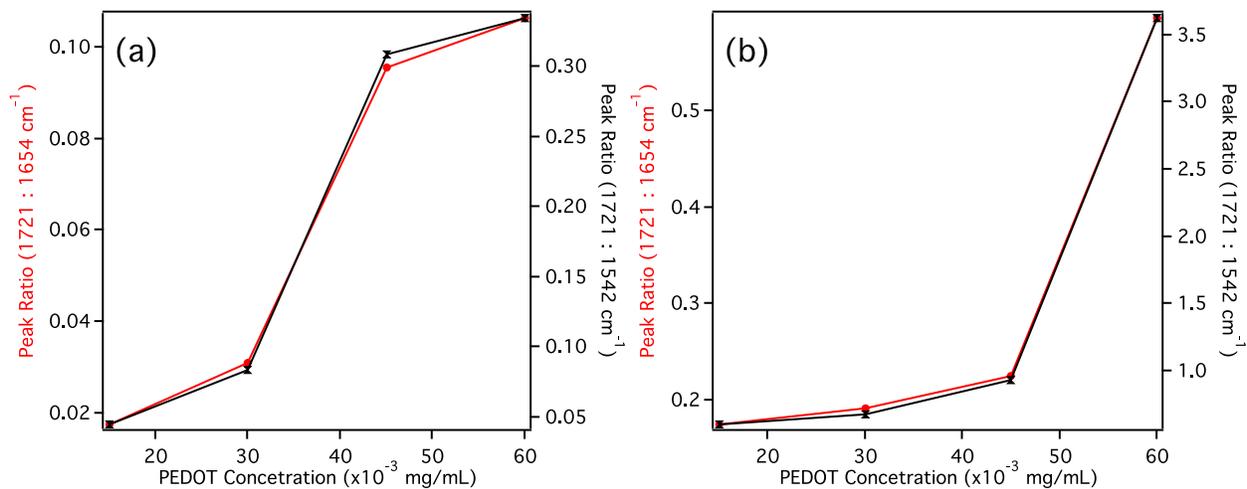


Figure S6. FTIR peak area ratio between collagen amide (1542 and 1654 cm⁻¹) and PEDOT:PSS (1721 cm⁻¹) peaks for (a) collagen – PEDOT:PSS samples and (b) collagen – hydroxyapatite – PEDOT:PSS samples.

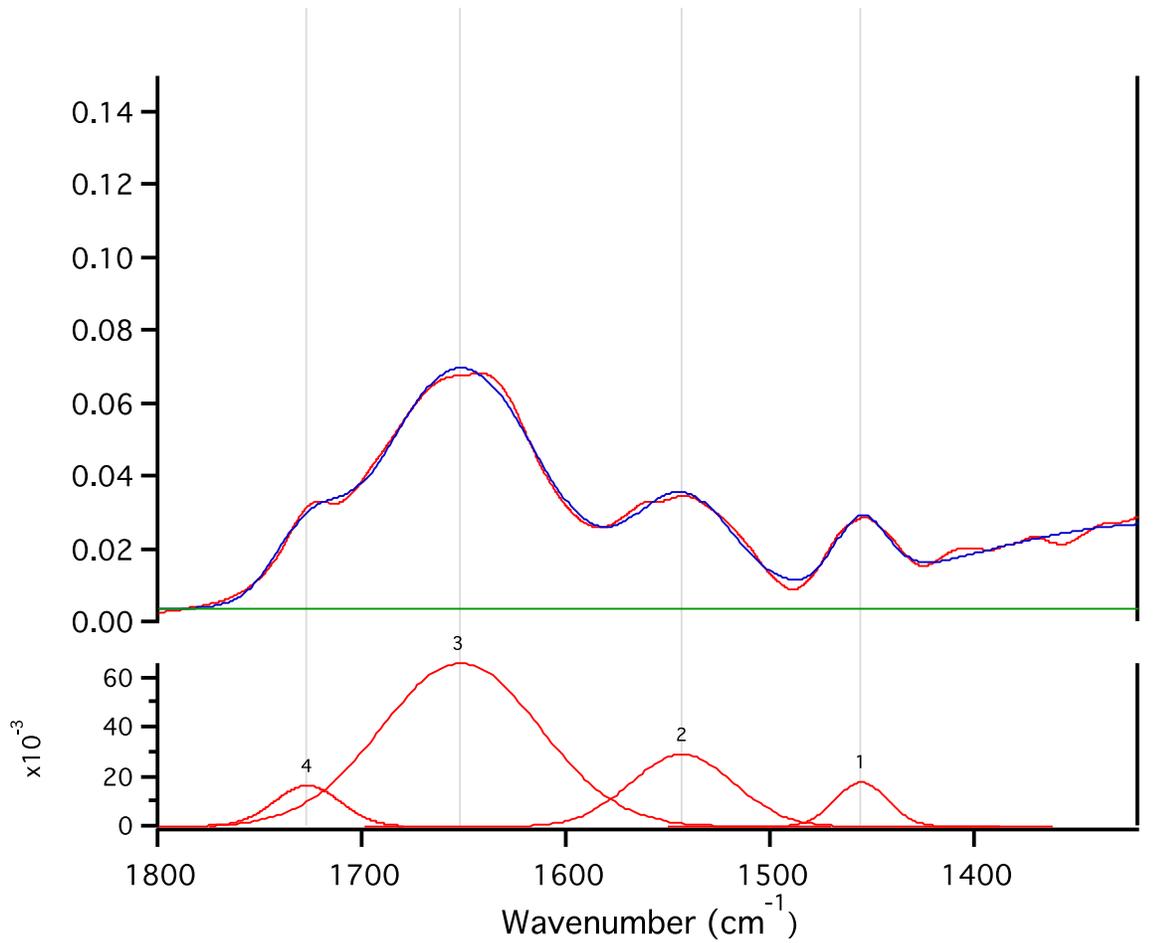


Figure S7. Gaussian fit of FTIR peaks of collagen – hydroxyapatite – PEDOT:PSS (0.045 mg/mL) hybrid membrane.

S4. SEM Images

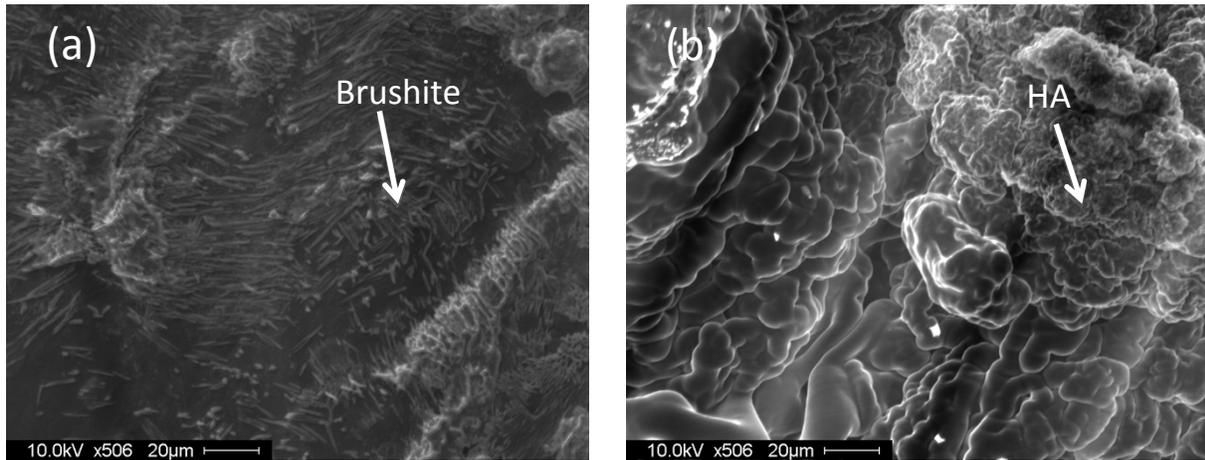


Figure S8. SEM images of (a) collagen-brushite and (b) collagen-hydroxyapatite membranes.

S5. EDX Analysis

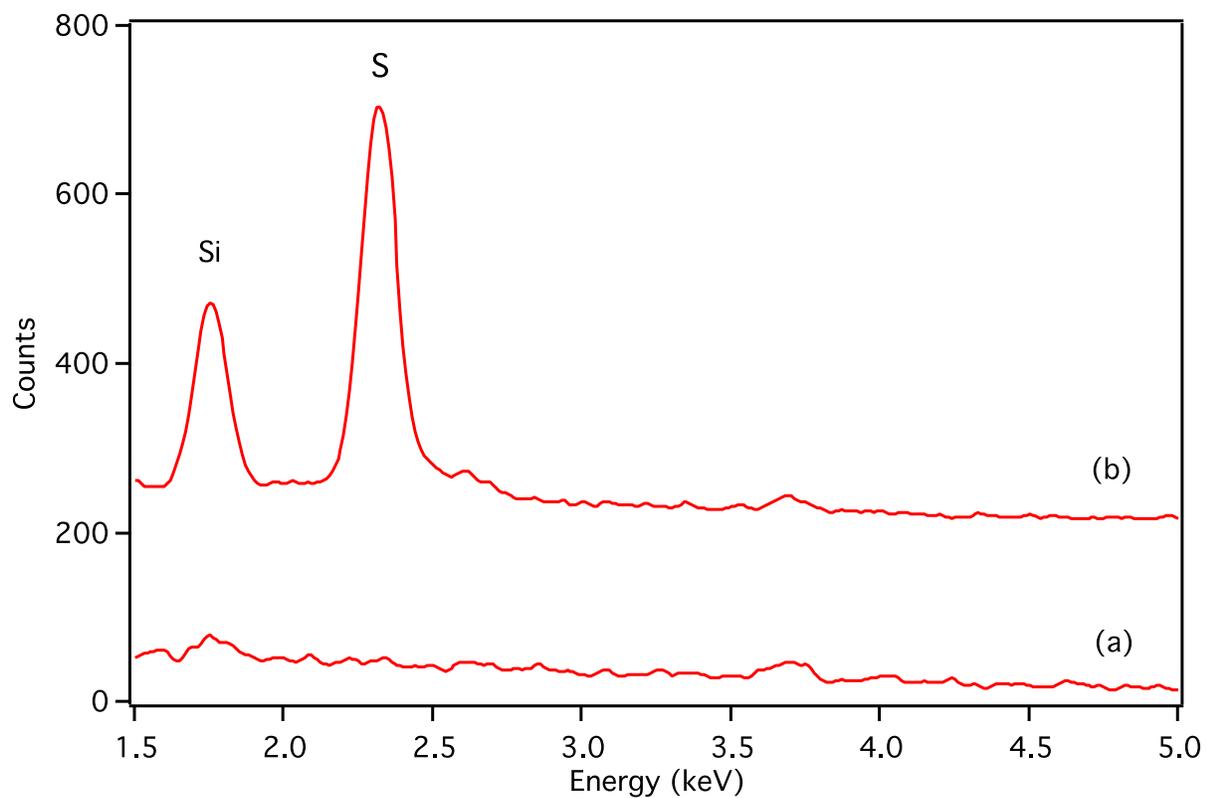


Figure S9. EDX spectra of (a) collagen and (b) collagen-PEDOT:PSS prepared with 0.06 mg/mL of PEDOT in the electrolyte.