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Microelectrochemical Smart Needle for Real Time Minimally Invasive Oximetry

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Supplementary Materials

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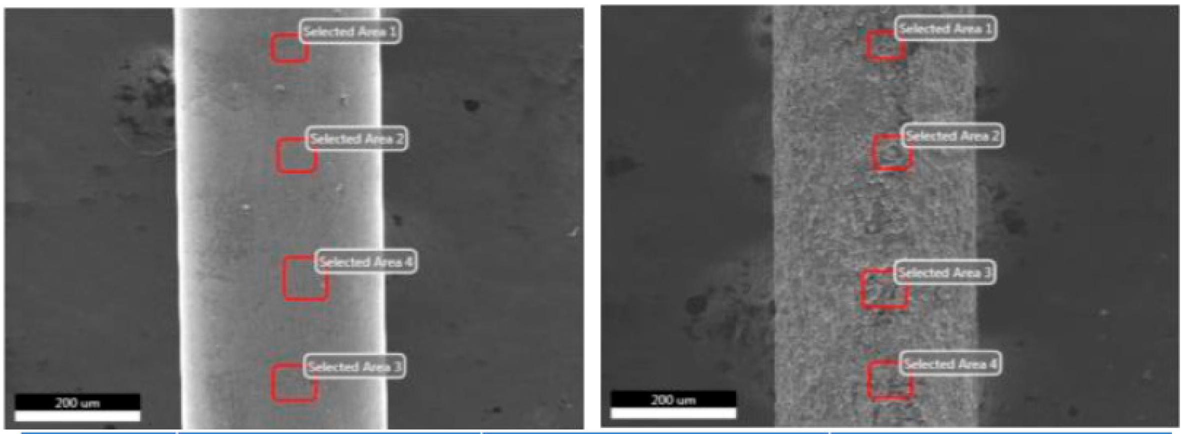

Element	UAN Weight% (SD)	PAN5 Weight % (SD)	ΔWeight%
Fe	58.52 (±0.80)	48.66 (±1.37)	-9.86
Cr	28.54 (±0.1.34)	27.81 (±2.39)	-0.7225
C	9.23 (±0.69)	5.85 (±0.96)	-3.37
O	0.25 (±0.23)	11.08 (±1.71)	10.83
Si	1.54 (±0.13)	0.64 (±0.03)	-0.9

Figure S1. EDX analysis of UAN **(left**) and PAN5 (**right**), with four selected regions of analysis to contract weight% and shifts in elemental constituents prior to and post electrochemical pitting corrosion.

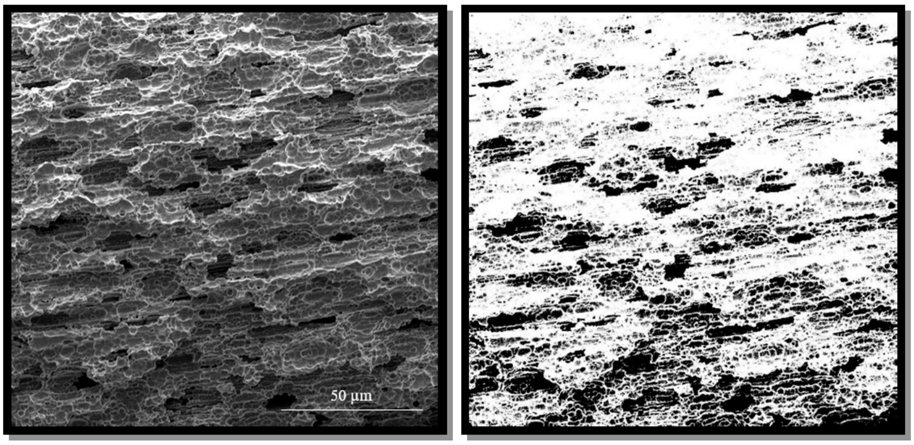

Figure S2. Schematic of SEM-image treating using FIJI software to characterize porosity. (**a**) SEM images of PAN5 and PAN10 (2000×), (**b**) snipped to a 300 × 300-pixel area and skeletonized, with 40 'pits' identified and measured to scale. Resulting measure of porosity found PAN5 and PAN10 average pit size to be 0.166 μm ± 0.09 and 0.25 μm ± 0.21, respectively.

Table S1. Atomic force microscopy data, displaying measures of physical characterization such a range (max, min) along the z-axis, RMS, SA, scan size for 10 μm² for the UAN, PAN5, and PAN10 electrode sample.

AFM DATA	UAN	UAN (2)	PAN5	PAN10
NUMBER OF POINTS	262,144	262,144	262,144	262,144
MAX-Z (μM)	32.65	48.03	738.02	1682.00
MIN-Z (μM)	22.92	38.29	908.032	1127.00
RMS (μM)	5.45	7.54	224.37	270.343
PERCENT XY (%)	100	100	100	100
SA (μM)	100.1	100.4	117.9	159.6
SCAN SIZE (μM2)	10	10	10	10

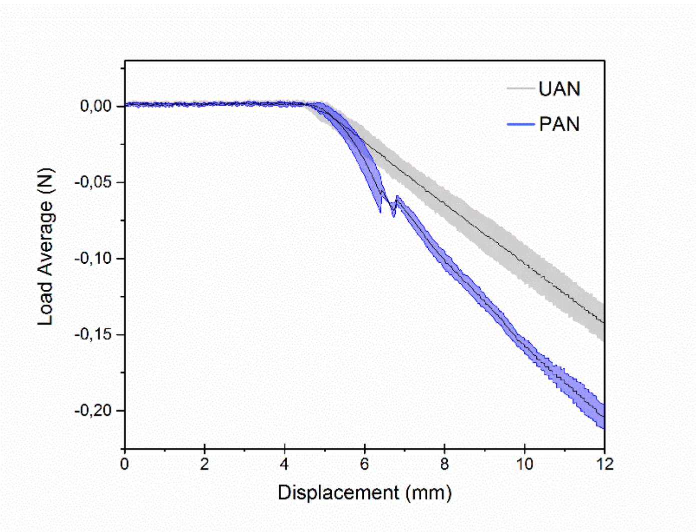

Figure S3. Instron graph detailing the average load for both UAN and PAN subtypes (n = 3, respectively) while compressing into ballistic gel. Initial penetration of ballistic gel achieved at ~5mm of displacement from the 100 N force plate. Error bands mark the standard deviation of the moving load averages for both groups.

Table S2. Comparative study showing the efficiency of the Lacc-CNP-PPy/PAN electrode.

Material	Current density (O2 saturated) (mA/cm2)	Electrode size (mm)
Lacc-CNP-PPy/PAN (this work)	−4.2	0.3
Carbon microfiber - Co/N/C [1]	−1	0.15
AuragenTM Depth Electrode (Pt) [2]	−0.35	1.2
Pt/Nafion [3]	−2.16	0.5

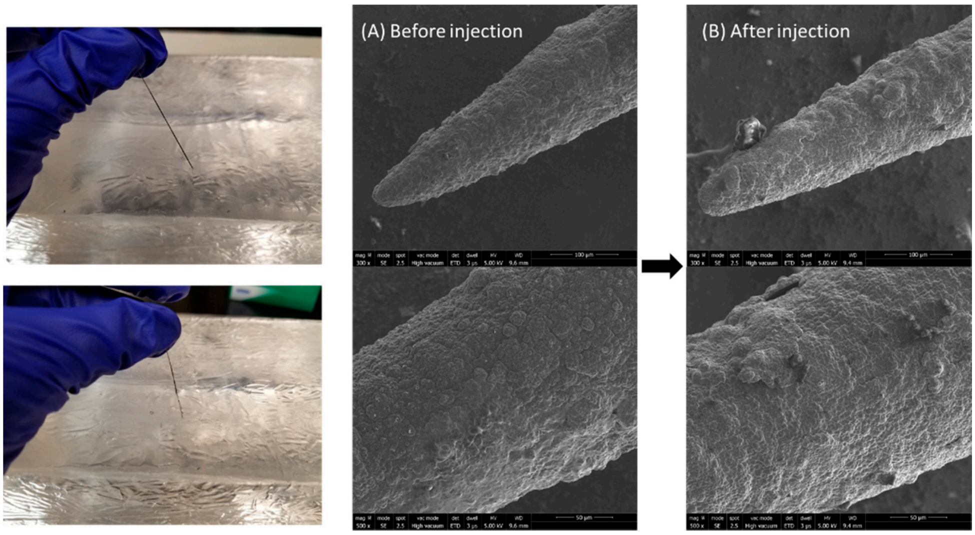

Figure S4. SEM pictures (**A**) before and (**B**) after simulating the injection of the Lacc-CNP-PPy/PAN needle in ballistic gel.

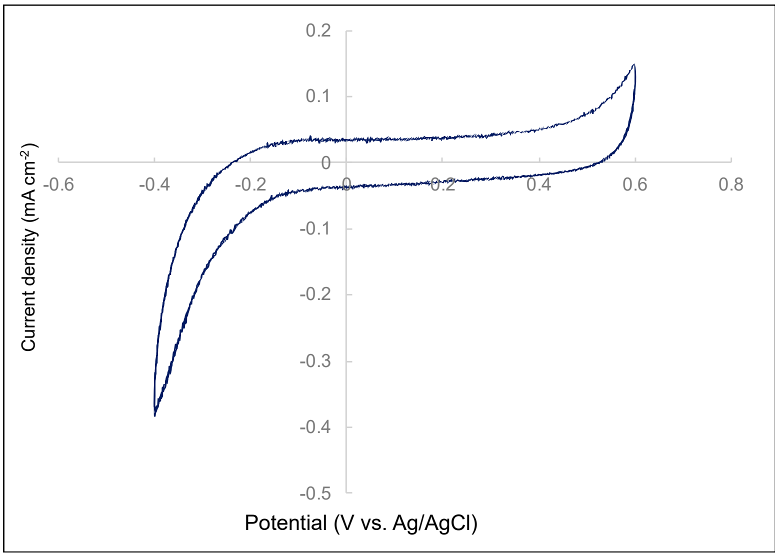

Figure S5. Cyclic voltammograms of the CNP-PPy/PAN electrode. The experiments were performed in 0.1 M phosphate buffer, pH 7.5, in a nitrogen solution at scan rates of 5 mV s-1.

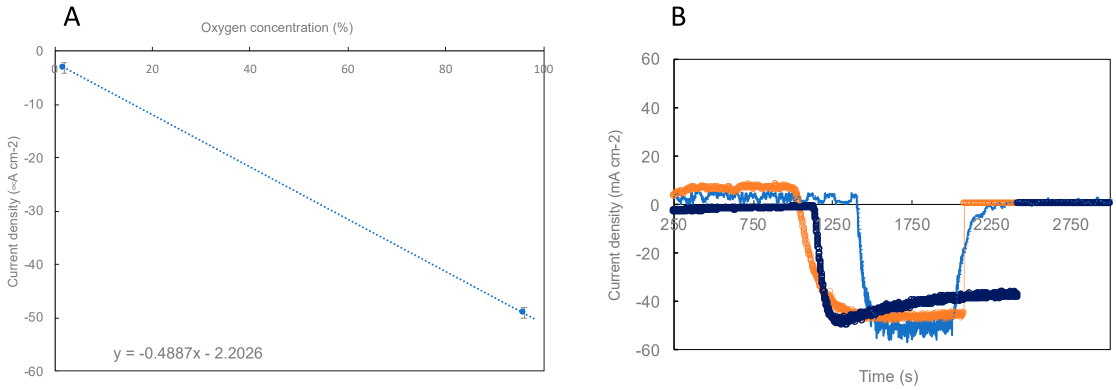

Figure S6. (**A**) Plot of the calibrated O_2-concentrations function of the measured current across the Lacc-CNP-PPy/PAN electrode and counter electrode. (**B**) Electrocatalytic oxygen reduction performance at three different Lacc-CNP-PPy/PAN electrodes in PBS solution (pH 7.4) at room temperature.

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