

Titre: Microelectrochemical smart needle for real time minimally invasive oximetry. Supplément
Title:

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Authors:

Date: 2020

Type: Article de revue / Article

Référence: Vieira, D., McEachern, F., Filippelli, R., Dimentberg, E., Harvey, E. J., & Merle, G. (2020). Microelectrochemical smart needle for real time minimally invasive oximetry. Biosensors, 10(11), 157 (11 pages).
Citation: <https://doi.org/10.3390/bios10110157>

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Version: Matériel supplémentaire / Supplementary material
Révisé par les pairs / Refereed

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Document publié chez l'éditeur officiel

Document issued by the official publisher

Titre de la revue: Biosensors (vol. 10, no. 11)
Journal Title:

Maison d'édition: MDPI
Publisher:

URL officiel: <https://doi.org/10.3390/bios10110157>
Official URL:

Mention légale:
Legal notice:

Article

Microelectrochemical Smart Needle for Real Time Minimally Invasive Oximetry

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Received: 15 September 2020; Accepted: 27 October 2020; Published: date

Supplementary Materials

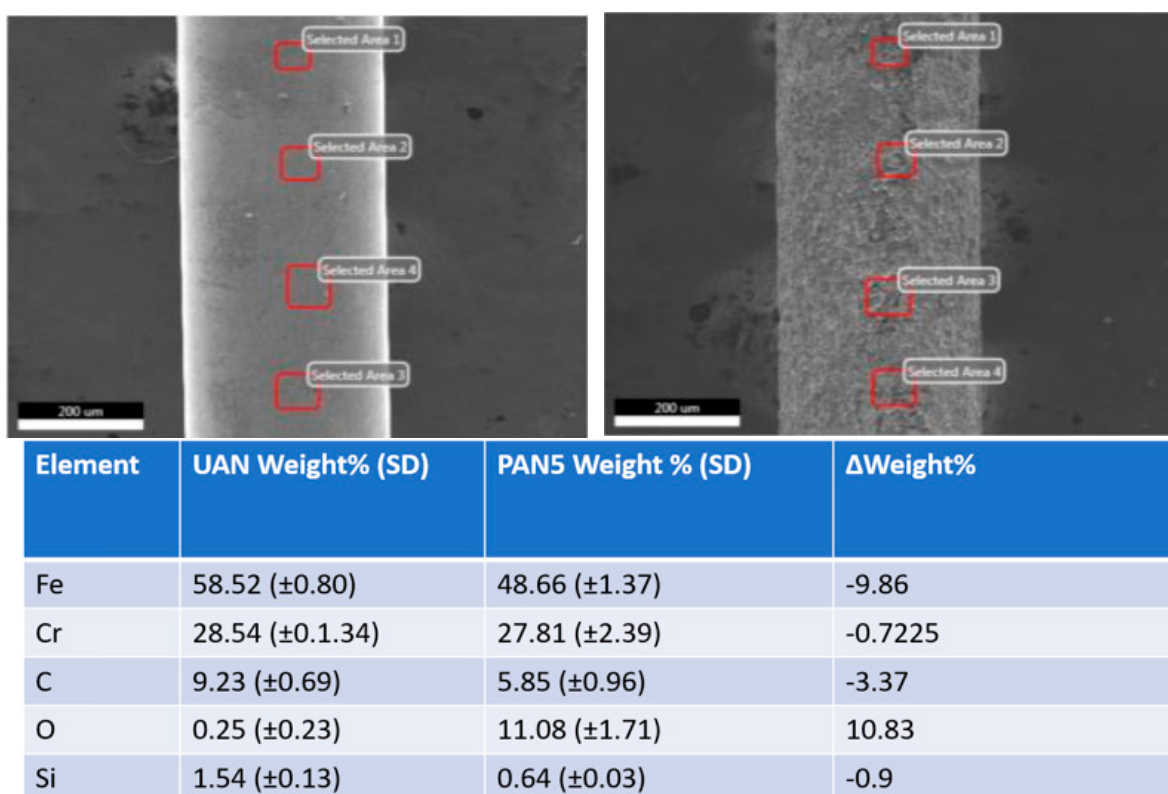


Figure S1. EDX analysis of UAN (left) and PAN5 (right), with four selected regions of analysis to contract weight% and shifts in elemental constituents prior to and post electrochemical pitting corrosion.

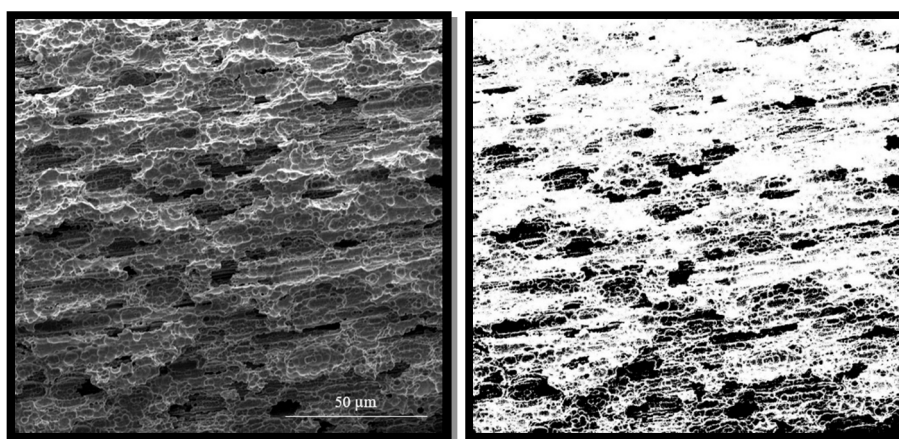


Figure S2. Schematic of SEM-image treating using FIJI software to characterize porosity. (a) SEM images of PAN5 and PAN10 (2000×), (b) snipped to a 300 × 300-pixel area and skeletonized, with 40 ‘pits’ identified and measured to scale. Resulting measure of porosity found PAN5 and PAN10 average pit size to be $0.166 \mu\text{m} \pm 0.09$ and $0.25 \mu\text{m} \pm 0.21$, 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 $10 \mu\text{m}^2$ 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 (μM^2)	10	10	10	10

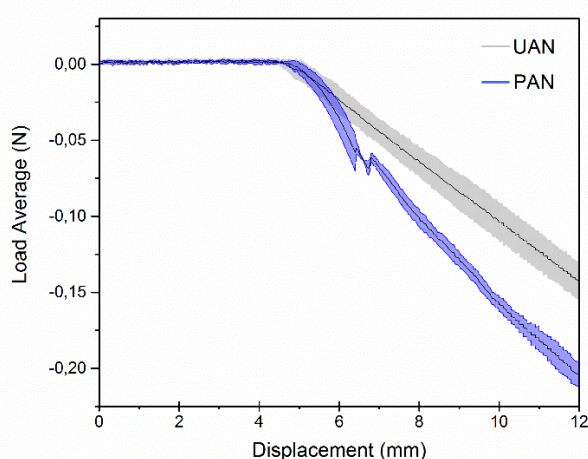
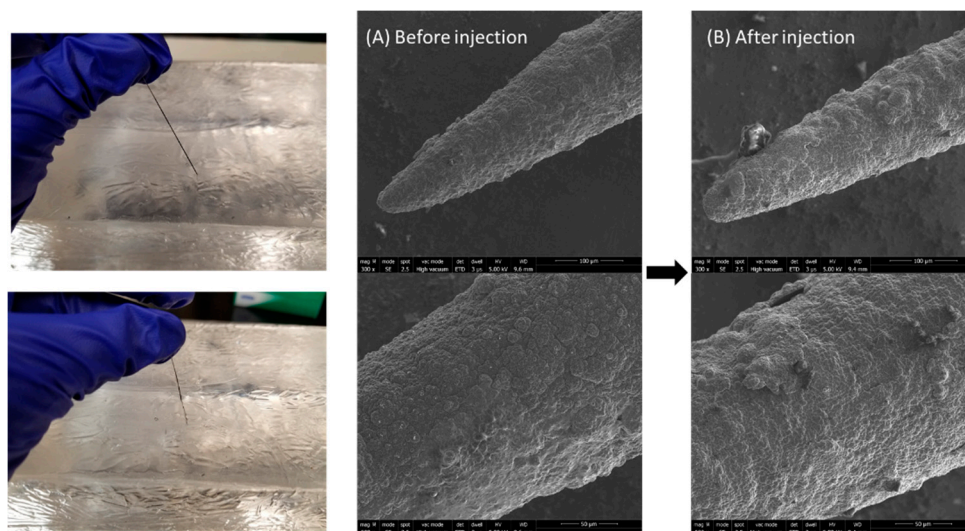
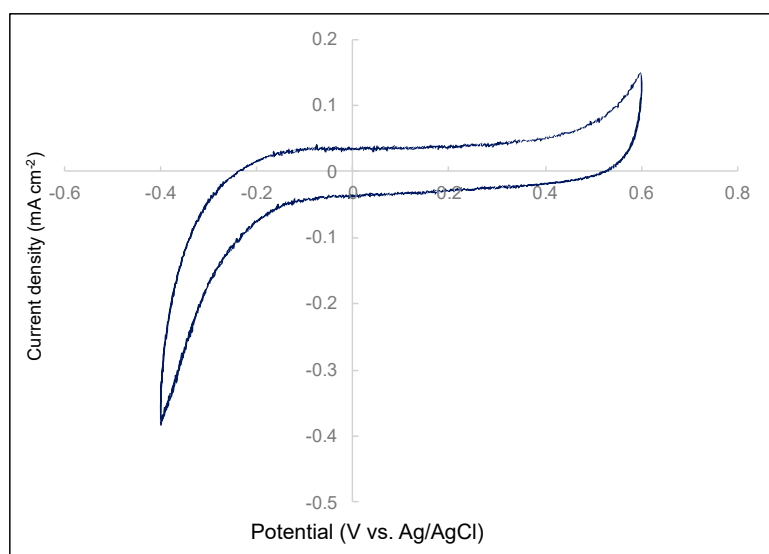


Figure S3. Instron graph detailing the average load for both UAN and PAN subtypes ($n = 3$, respectively) while compressing into ballistic gel. Initial penetration of ballistic gel achieved at $\sim 5\text{mm}$ of displacement from the 100 N force plate. Error bands mark the standard deviation of the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

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

Material	Current density (O ₂ saturated) (mA/cm ²)	Electrode size (mm)
Lacc-CNP-PPy/PAN (this work)	−4.2	0.3
Carbon microfiber - Co/N/C [1]	−1	0.15
Auragen™ 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}.

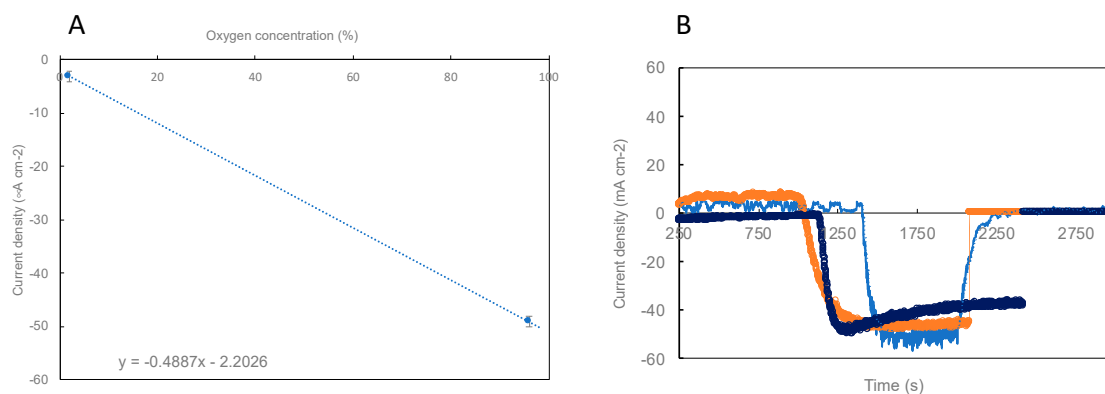


Figure S6. (A) Plot of the calibrated O_2 -concentrations function of the measured current across the Lacc-CNP-PPy/PAN electrode and counter electrode. (B) Electrocatalytic oxygen reduction performance at three different Lacc-CNP-PPy/PAN electrodes in PBS solution (pH 7.4) at room temperature.

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