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2D AND 3D PYROLYTIC CARBON MICROELECTRODES FOR ELECTROCHEMISTRY

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This work presents the electrochemical characterization of 2D and multi-layered three-dimensional (3D) pyrolytic carbon microelectrodes for electrochemical applications. The fabricated three electrode electrochemical cell is characterized with cyclic voltammetry (CV) and impedance spectroscopy (EIS) using the standard potassium ferri-ferrocyanide redox probe.

Carbon materials offer several attractive properties such as wide electrochemical potential window, biocompatibility, chemical stability and ease of functionalization. These features makes carbon an ideal material for microelectrodes used as biosensor, scaffolds or energy storage devices [1, 2]. The most common carbon microfabrication techniques, such as screen printing, produce planar two-dimensional (2D) microelectrodes. However, device sensitivity and biological signals from 2D pattern are limited due to the 2D nature of the electrode. Towards this a 3D carbon microelectrode is fabricated and transferred on the working electrode of an electrochemical cell using UV photolithography followed by pyrolysis [3]. The feature size as small as 5µm is fabricated.

Depending on the desired application, different 3D carbon microelectrodes can be fabricated (figure 1). Figure 2.a shows the experimental set-up with magnetic clamping to seal the cavity. Figure 2.b and c shows the electrochemical characterization of a three electrodes system, comparing planar and 3D carbon working electrodes. The cyclic voltammograms performed in 10mM ferri-ferrocyanide show higher peak current (2 folds higher) for the 3D microelectrodes compared to the 2D ones (figure 2.b) and a smaller charge transfer resistance (figure 2.c). The 3D microelectrodes potentially increase the overall sensitivity in amperometric monitoring of cell response due to the increase surface area and enhanced interaction with cells [2].

References
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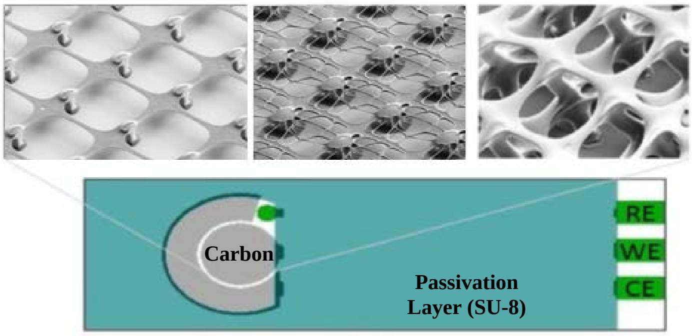

Figure 1 : Three electrode electrochemical cell (Working and Counter electrode – Carbon, and Reference electrode – Gold)

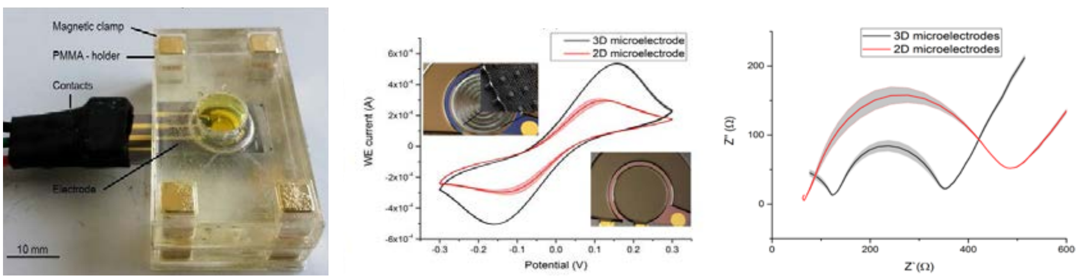

Figure 2 : (a) Experimental set-up, (b) and (c) Electrochemical characterisation (CV and EIS) of 3D and 2D chips (Data are presented as mean ± standard deviation (n = 3)