A new vision for fuel cells: application in cancer biomarker screening

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BIOMARK Sensor Research

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Introduction

Objectives

Merging fuel cell technology with Biosensors. Development of a disposable, lightweight, user-friendly and self-powered biosensor for screening/ monitoring important cancer biomarkers.

Hybrid **Biosensor/DMFC**, with a suitable configuration for point of care (POC) applications, as it operates only with few drops of a methanol diluted solution and O_2 from the air.

Sensing element

The sensing recognition element was developed by molecularly imprinting polymer technology (MIP), directly in one electrode of a fuel cell, through a surface electropolymerization process.

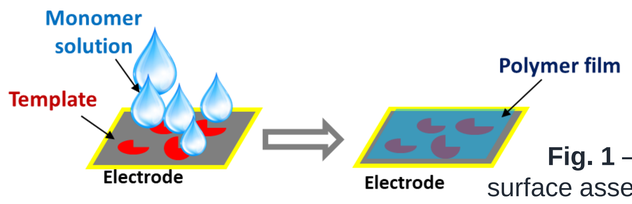


Fig. 1 – MIP surface assembly

The modified MIP electrodes are capable of interacting selectively with the target molecules, when integrated in the DMFC set-up.

Transducer

Biosensor/DMFC

A passive methanol fuel cell (DMFC) device is used as transducer and power source element.

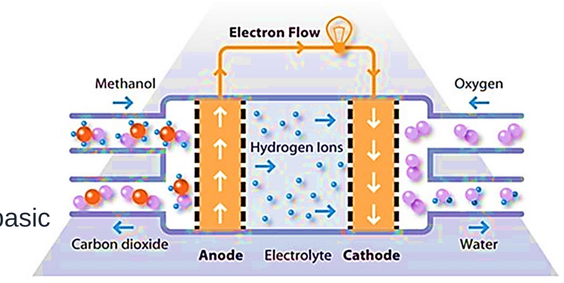


Fig. 2 – DMFC basic operation mode

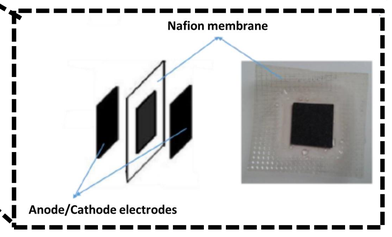
After the incubation of a fluid containing the cancer biomarker in study, a power variation is measured, signalling the interaction event in a concentration dependent mode.

Methodology

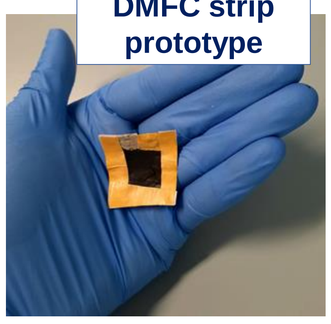
DMFC assembly

Passive DMFC used in the first tests

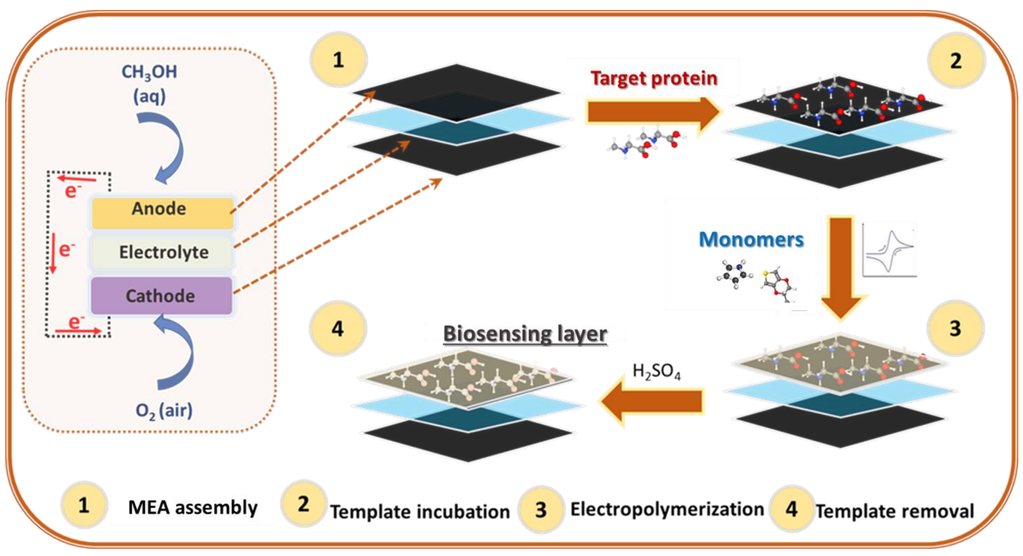
Membrane electrode assembly



DMFC strip prototype

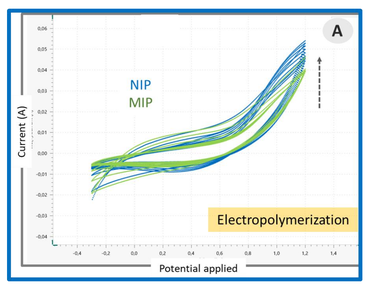


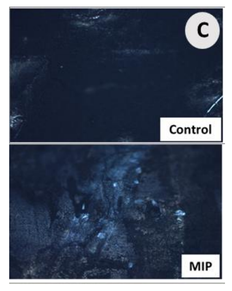
Preparation of the sensing element

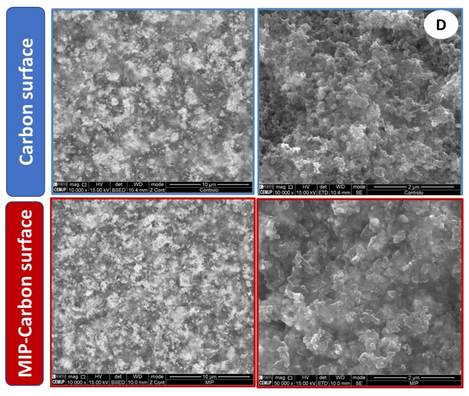


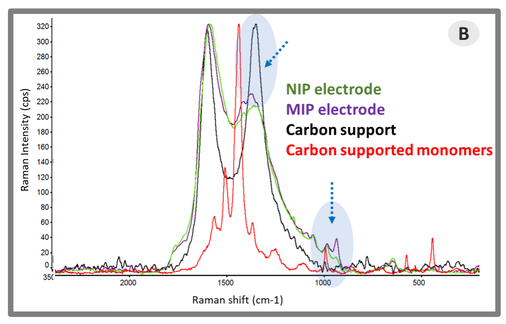
Results

Electrodes characterization





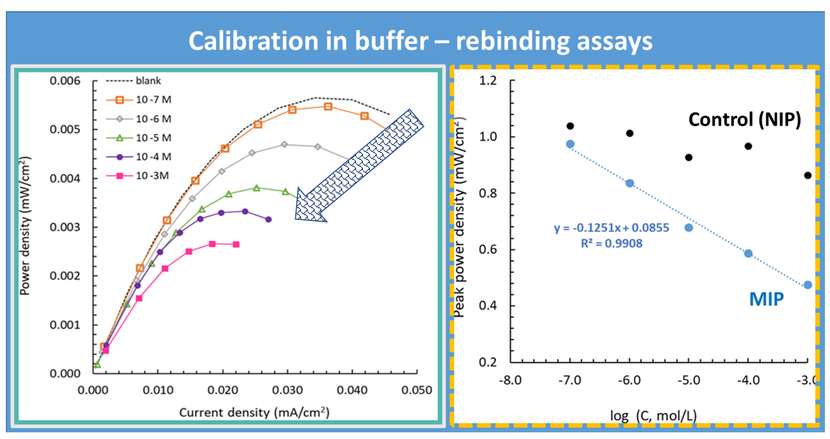




(A) Electrochemical construction of sensing electrode (MIP) and control (NIP).
(B) Raman spectroscopy analysis of all obtained electrodes.
(C) Confocal images obtained in Raman microscope.
(D) SEM analysis of a MIP electrode compared with a non-modified electrode.

Calibration – response evaluation

➢ **Example of a calibration obtained with the developed DMFC strip prototype**



A decrease in the measured power is observed with the MIP configuration.

General considerations

The work developed in this PhD plan demonstrates that it is possible to successfully combine Fuel Cell and Biosensors technologies, allowing the development of an electrical independent sensing device with good sensitivity for tracking some important cancer biomarkers. This novel biosensing concept is simple, inexpensive and effective, and may undergo additional developments to meet point-of-care requirements.

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