applied sciences

SUPPORTING INFORMATION: COMPARISON OF ACTIVATION METHODS OF 3D-PRINTED ELECTRODES FOR MICROBIAL ELECTROCHEMICAL TECHNOLOGIES

Raúl M. Alonso [1], Isabel San Martín [1], Antonio Morán [1] and *Adrián Escapa [1,2]

[1] Chemical and Environmental Bioprocess Engineering Group, Natural Resources Institute (IRENA), Universidad de León, Avda. de Portugal 41, E-24009 Leon, Spain
[2] Department of Electrical Engineering and Automatic Systems, Universidad de León, Campus de Vegazana s/n, E-24071 León, Spain
* Correspondence: author

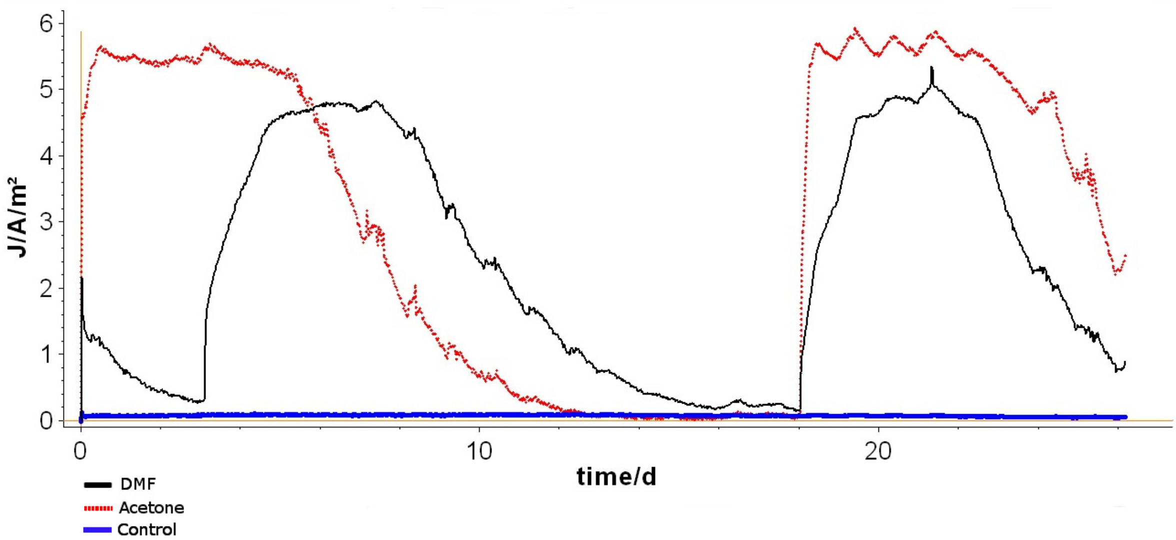

Figure S1. Current density profiles of two successive cycles at the end of a 60 days period that allowed for the development of a stable biofilm.

Electrochemical Impedance Spectroscopy Analysis (EIS)

The EIS spectra obtained during the abiotic characterization of the PLA/Graphene electrodes (Figure 3) were fitted to equivalent circuits to facilitate the interpretation of the results. Two equivalent circuits (EC) have been proposed. Circuit 1 (Fig. SI1 1)) has proved to be useful in the modelling of successfully activated electrodes (DMF and acetone). The main characteristics of the spectra can be explained using a modified pore model version. In this model the impedance of the pore wall is modelled by a charge transfer resistance (R_2), a Warburg impedance (W_2) and a constant phase element (Q_2) accounts the pseudo-capacitive processes that occur at the electrode-electrolyte interface. Table 1 summarizes the fitted parameters to EC 1. The parameter a2 allows to compare the near capacitive behavior of DMF electrode in contrast to the pseudo-capacitive behaviour of acetone electrode (a_2=1 in an ideal capacitor).

EC 2 has served as model from control and electrochemical-treated electrodes. Its elements respond to the modelling of two different pseudo-capacitive processes, perhaps because they occur at two different spatial scales.

The impedances of constants phase elements were adjusted to the expression:

$$Z_Q = \frac{1}{Q\omega(j\omega)^a}$$

Where Q is the pseudocapacitance ($F.s^{a-1}$), j the imaginary unit, ω is the angular frequency (s^{-1}) and a is an empirical dimensionless parameter (0 for a resistor and 1 for an ideal capacitor).

The impedance of Warburg element is described by:

$$Z_W = \frac{S}{\sqrt{j\omega}}$$

Where S is in ($\Omega.s^{-1/2}$), j the imaginary unit, ω is the angular frequency (s^{-1}).

Electrode	Equivalent circuit	R_1 (Ω)	R_2 (Ω)	Q_2 ($F.s^{a-1}$)	a_2	S_2 ($\Omega.s^{-1/2}$)
DMF	(1)	14.5	313.8	$5.38x10^{-4}$	0.907	23.38
Acetone	(1)	23.6	238	$1.04x10^{-4}$	0.623	9.81

Table S1. Fitted parameters to EC 1 (DMF and acetone electrodes).

Electrode	Equivalent circuit	R_1 (Ω)	R_2 (Ω)	R_3 (Ω)	Q_2 ($F.s^{a-1}$)	a_2	Q_3 ($F.s^{a-1}$)	a_3
Control	(2)	25.8	119.6	13921	$7.4x10^{-5}$	0.45	$1.2x10^{-4}$	0.57
Electrochemical	(2)	23.5	80.3	1205	$8.7x10^{-6}$	0.73	$1.12x10^{-3}$	0.612

Table S2. Fitted parameters to EC 2 (control and electrochemical-treated electrodes).

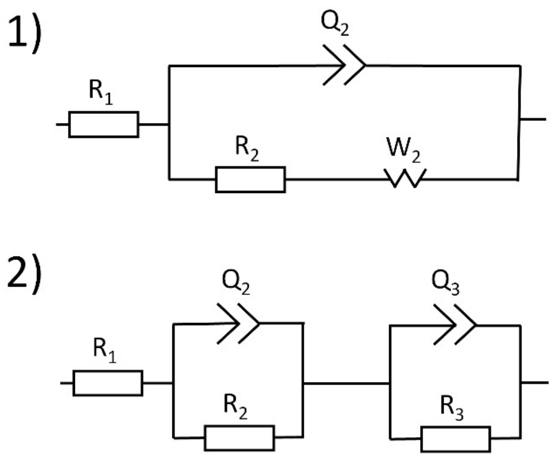

Figure S2. Equivalent circuits for abiotic electrode essays´ modellization.1) DMF and acetone 2) Control and electrochemical treatment.