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Beneficial Electroactive Biofilm for Sensing: Feasibility and Perspective

AZRI Yamina Mounia*, TOU Insaf, BEROUAKEN Amine, and SADI Meriem

Centre de Développement des Energies Renouvelables, CDER, PB. 62. Route de l'Observatoire, Bouzaréah, 16340 Algiers, Algeria

*Corresponding Author's e-mail address: *y.azri@cder.dz*

ABSTRACT

Objective of this work is to develop electroactive biofilms from various natural environments (soil and sediment). The ultimate goal of studying behavior of EABs is to gain necessary information on engineering biofilms that can be powerful and efficient in field-scale applications, such as, biosensing. In this study chronoamperometry is an efficient technique to form electroactive biofilms (EAB) on conductive electrodes. The rhizospheric soil of CDER and sediment Dounia parc lac were analyzed as a potential inoculum to form MFC anodes with the use of acetate as substrate. Working electrodes (WE) polarized at +0.155 V/SCE gave better results compared to +0.3 V/SCE and -0.3 V/SCE. For soil the sediment test +0.2V/SCE was appropriate potential for bio-current generation.

Keywords: Electroactive biofilm (EAB), Chronoamperometry, Microbial fuel cell, natural environments

1. Introduction

The well-knows features of biofilms are often considered detrimental in industrials sectors, one the principal consequences of biofilm formation are surface damage due to microbial influenced corrosion [1]. An example of the financial impact pf biocorrosion is seen in the microbially influenced pitting corrosion of heat-exchange tubing in nuclear power plants such as Ontarion hydro in Canada. It has been estimated that this corrosion can result in replacement coast of 300 000$ per unit per day for corporation [2] [Dulon 2006].However, another area of recent unexpected ability of biofilms to catalyze electron transfers between cells and their support [3], thanks to electroactive bacteria in the form of complex communities that survive attached to surfaces forming electroactive biofilms (EAB). Recently, numerous researchers have implemented EAB in microbial fuel cells to produce electricity or environmental sensing.

The EAB function is not only an attachment entity on the anode, but it also serves as an electron reserve [4] . In a few species of bacteria, as the biofilm of Geobacter Sulfurreducens are endowed electrogenic characteristics such as conductivity [5], supercapacitor [6], and transistor [7]functionalities. These characteristics allow for their widespread potential applications in harvesting electroactive biofilms have been identified in a large variety of natural ecosystems such as marine sediments , soils, seawater , fresh water , domestic and industrial wastewater , activated and anaerobic sludge, sewage sludge , further other sources have been also reported as garden compost, manure , wetland , mangrove and rumen , might have an ability to utilize their electro active microorganisms as bio- current generator, as probe for sensing various toxicants. The main objective of this study is to propose a chronoamperometry procedure suited for identifying electrochemically active biofilms two natural environments: sediment and rhizosphere of plant. The experiments were conducted under well controlled electrochemical conditions, where a constant anodic potential was applied using a conventional three-electrode system. This study discusses their electrochemical performances and their potential application as biosensoring via MFC technology.

2. Experimental

The Chlorophytum rhizospheric soil from CDER (Centre de Développement des EnergieRenouvelables-Algiers-Algeria) Garden , The sediment samplings took place at Lac des Grands Vents, located within the Dounia Park Nature Reserve, situated to the west of Algiers. Three-electrode montage was realized using a working graphite electrode, a platinum rod as an auxiliary electrode, and a saturated calomel electrode (SCE) as reference electrode. Acetate (20 mM) was added at the beginning of the experiment as a carbon source

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for electricity production. three different polarizations were tested for rhizosphere: − 0.155, + 0.155, and + 0.3 V/SCE and : -0.2, +0.155 and +0.2V were tested for sediment biofilm.

3. Results and Discussion

Formation of electroactive biofilms under chronoamperometry with two inoculum sources (soil of chlorophytum and sediment lac): Chronoamperometry of two natural media: Chlorophytum rhizospheric soil and Sediment of Dounia Parc lac was performed at different potential values in the range +0.3 to -0.155 V/SCE with graphite plate electrode. In figure 1a. The current density had stabilized around − 0.03 mA/m2 at − 0.3 V, which was low and insignificant. At potentials + 0.3 and +0.155V/SCE, a remarkable current density increase was recorded reaching respectively 606.97 mA/m2, 1473mA/m2, respectively. The potential + 0.155 V/SCE seems to stimulate the bacteria electroactivity, encouraging the metabolic pathway that allows a fast growth and a high production of the current which given the higher current density up to 1.48 A/m2. The current density remained low at all imposed potentials, with the Chronoamperogram starting on the 4th day for (+0.2V and -0.2V)Fig 1.b and on the 6th day for the imposed potential of +0.155V. The products of the current density did not exceed 100mA/m². After injection of approximately 20mM of acetate, the current increased significantly for imposed potential +0.2Vand thus registered a maximum bioelectricity activity reached current density 800mA/m² indicating the electroactive biofilm formation on the electrode surface. These results confirm the capacity of both media to be the source of efficient electroactive microbial species and suggest that biofilm microbial populations coming from chlorophytum soil may be more promising than those from sediment of lac, the same result was obtained by Parot et al. which revealed a current density higher than 385mA/m² from soil of garden, moreover the lag-time of soil was shorter 1 days and more that 3 days for sediment.

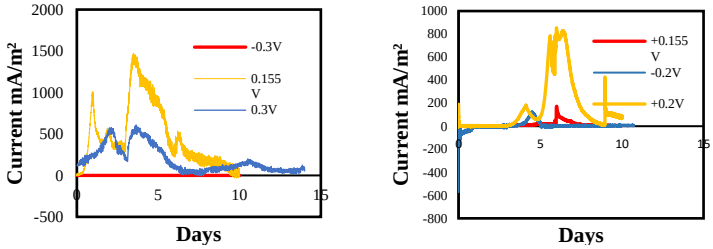

Fig. 1 Chronoamperometry of **a)** soil and **b)** sediment at different potentials

4. Conclusions

Over the past few decades, the field of biofilm research has significantly grown. from focusing on destruction to concepts aiming at utilizing biofilms for productive purposes, among proposed research, biosensors based on MFCs. This study revealed that CDER soil and Lac sediment were an interesting and easy-to-handle source of electrochemically active.

References

[1] C. M. G. L. T. X. C. &. M. J. J. Cordas, «Electroactive biofilms of sulphate reducing bacteria,» Electrochimica Acta,, vol. 45, n° %11, pp. 29-34, 2008.

[2] S. P. S. D. M. L. &. B. A. Dulon, «Electroactive biofilms: new means for electrochemistry,» Journal of applied electrochemistry, Vols. %1 sur %2173-179, p. 37, 2007.

[3] B. H. K. H. J. H. M. S. &. P. D. H. Kim, «Direct electrode reaction of Fe (III)-reducing bacterium, Shewanella putrefaciens,» Journal of microbiology and biotechnology, vol. 9, n° %12, pp. 127-131, 1999.

[4] K. Nishio, Y. Kimoto, J. Song, T. Konno, K. Ishihara, S. Kato, ... & et S. Nakanishi, «Extracellular electron transfer enhances polyhydroxybutyrate productivity in Ralstonia eutropha,» Environmental Science & Technology Letters,, vol. 1, n° %11, pp. 40-43, 2014.

[5] N. S. Malvankar, T. Mester , M. T. Tuominen et D. R. Lovley , «Supercapacitors based on c-type cytochromes using conductive nanostructured networks of living bacteria,» ChemPhysChem, vol. 13, p. 463 – 468, 2012.

[6] N. S. Malvankar, M. Vargas, K. P. Nevin, A. E. Franks , . C. Leang, B. C. Kim, ... & et D. R. Lovley , «Tunable metallic-like conductivity in microbial nanowire networks,» Nature nanotechnology, vol. 6, n° %19, pp. 573-579, 2011.

[7] F. Qian et Y. Li, « A natural source of nanowires,» Nature nanotechnology, vol. 6, n° %19, pp. 538-539, 2011.

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