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Using of an Artificial Biofilm for the Characterization of Direct Transfer of Electrons by *Thillobacillus Denitrificans*

Abada Bachira[1*], Etienne Mathieu[2]

[1]Centre de développement des Énergies Renouvelable, Algérie
[2]Laboratoire de Chimie Physique et Microbiologie pour les Matériaux et l'Environnement, Unité Mixte de Recherche - UMR 7564, CNRS / Université de Lorraine; France
*Corresponding author's email: b.abada@cder.dz

ABSTRACT

Thiobacillus denitrificans named *T. denitrificans* is a Gram negative anaerobic bacteria and obligately chemolithoautotrophic it reduces metal ions, because his metabolism essentially uses periplasm reductase. Multiheme cytochrome transmit electrons to insoluble reductases as the terminal acceptors on the membrane surface or soluble reductases [1]. We are studying the capacity of *T. denitrificans* to catalyze fumarate and fumarate electro reduction. For that, we used an artificial biofilm. Made of carbon nanotubes and living cells which is used as the working electrode in electrochemical cell under permanent nitrogen flow. All experiments are performed in the potential range from +0.2V to -0.8V/Ag/AgCl. The experiments show that T. denitificans has capacity to participate to direct electron transfer associated to the targeted reactions. The temperature is an important factor; at 30°C the signal of reduction is more pronounced than at the room temperature. *E. coli* and *Pseudomonase are* have been using in this stady as control,

Keywords: *Thiobacillus denitrificans* , denitrification, biofilm, nitrate, nitrite.

1 Introduction

The future of the planet is compromised by increasing entropic activity. The drastic consumption of natural resources such as water and fossil fuels represents a major threat to the climate and the environment. In fact, the global energy sector will require a varied mix of energy resources, not only to meet growing energy demand, but also to preserve available stocks of fossil fuels, the environment and the climate. It has become essential to prioritize sustainable and renewable solutions in order to best preserve the environment, the sustainability of species and the availability of water for future generations. The production of "clean" energy and the restoration of the natural environment present major environmental and socio-economic challenges. Sustainable subsidiaries include bioenergy and bioremediation, which have the potential to reduce greenhouse gas emissions and clean up natural environments such as waterways and soils. Fossil fuels are replaced by biogases such as methane or hydrogen. Hydrogen is particularly interesting because it is abundant in nature, and its combustion generates only water vapor, with no greenhouse gas emissions. Bioremediation is one of the most promising techniques in the fight against pollution.

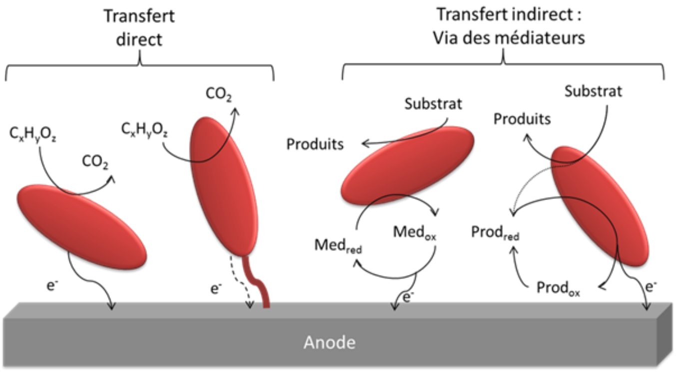

Figure 1: Electron transfer mechanism's at electrodes.

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2 Experimental

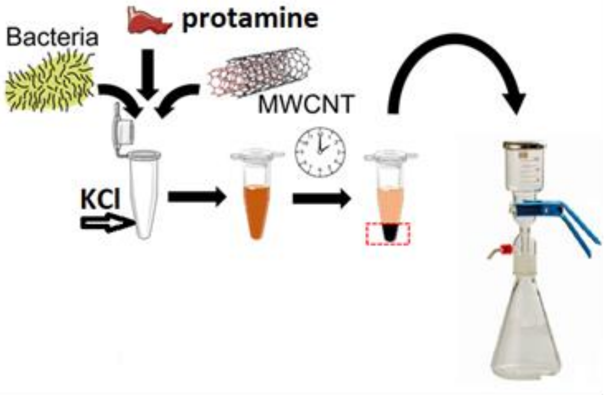

Figure 2: diagram of the bacterial bio composite assembly protocol.

3 Results and Discussion

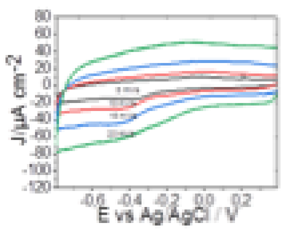

Figure3: Scan rate profile applied to biocomposite carrying T. denitrificans in the presence of 10mM nitrate over a range of +0.4 vs Ag/AgCl V and -0.8 vs Ag/AgCl V.

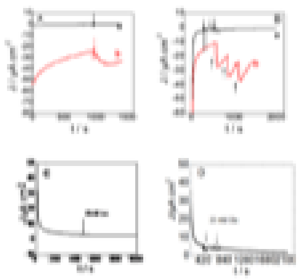

Figure4: Chronoamperometry of T. denitrificans, S. oneidensis, E coli and P. fluorescens

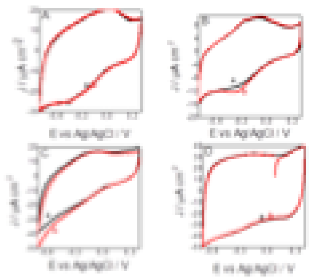

Figure5: Evolution of the cathodic signal of the composite Bacteria-free control (A) and T. denitrificans from 5-day (B), 10-day (C and 15-day (D) cultures in the presence of 20 mM nitrate.)

4 Conclusions

This work demonstrated for the first time the EET characteristics of the denitrifying biocathode. An artificial biofilm in which Thiobacillus denitrificans was devoid of all metabolites acting as electron mediators and in a hostile composite. It was successfully used to study the thermodynamics of EET as well as the CV analysis of a denitrifying biocathode, which showed that nitrate reduction to nitrite occurs at -0.46 V and nitrite reduction at -0.68 V. The results presented provide a better understanding of the EET principles of denitrifying cathodes based on Thiobacillus denitrificans. The engineering used in the preparation of the artificial biofilm can help implement the operation of denitrifying bioelectrochemical systems, for example the rate of nitrate removal as a function of cathode potential. In addition, the strategy of using these artificial biofilms helped answer questions related to the effect of temperature on extracellular transfer and the denitrification activity of Thiobacillus denitrificans, which gave a better increase in current at 30°C than at room temperature, which was 21°C.

References

[1] B.E. Logan, K. Rabaey, Conversion of wastesintobioelectricity and chemicals by using microbial electrochemical technologies, Science 337 (2012) 686–690 http://dx.doi.org/10.1126/science.1217412

[2] D. G. Weissbrodt, T. R, Neu, U. Kuhlicke, Y. Rappaz, & C. Holliger, (2013). Assessment of bacterial and structural dynamics in aerobic granular biofilms. Frontiers in Microbiology, 4, 175. http://doi.org.10.3389/fmicb.2013.00175

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[3] H. Niu, Z. Zhang, X. Wang, X. Wan, C. Shao, Y. Guo. Theoretical Insights into the Mechanism of Selective Nitrate to Ammonia Electroreduction on Single Atom Catalysts. Advanced Functional Materials 2021, 31 (11), 2008533. https://doi.org/10.1002/adfm.202008533

[4] I. Katsounaros. On the assessment of electrocatalysts for nitrate reduction. Current Opinion in Electrochemistry 2021, 28 , 100721. https://doi.org/10.1016/j.coelec.2021.100721

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