FINAL REPORT

GRANT #: N00014-01-1-0190

PRINCIPAL INVESTIGATOR: J. Gregory Zeikus

INSTITUTION: Michigan State University

GRANT TITLE: Microbial fuel cells and Sensors

AWARD PERIOD: 1 December 2001 - 30 November 2003

OBJECTIVE: To develop new electrodes and test their ability to generate electricity and sense chemicals in pure and mixed microbial cultures including Marine sediments and sewage sludge.

APPROACH: We developed porcelin electrodes that contained graphite and either manganese or iron to enhance electron transfer rates. We then used these electrodew in novel fuel cells designed to measure electricity production by pure cultures of E. Coli and Shewanella and by sewage sludge and Marine sediments Succinate was detected with there electrodes containing immobilized furmarate reductase purified from A. succinogenes.

ACCOMPLISHMENTS:

1. The rate of electricity generation by the iron reducing S. putrefaciens was greatly enhanced by the addition of manganese into a graphite electrode.
2. A Manganese graphite electrode containing fumarate reductase from A. Succinogenes displayed high stability and linearity to substrate concentration when detecting succinate and producing electricity or using electricity and reducing fumarate.

3. New graphite ceramic metal containing electrodes and a new single compartment fuel cell were developed and shown to have utility in electricity production using pure or mixed cultures as biocatalysts.
4. By varying the exact redox potential of Fuel cells containing graphite electrodes different microbial electrical signatures were detected during enrichment of microbes on the electrode surface.

CONCLUSIONS: The ONR should have renewed my grant instead of funding second rate foreign research.

SIGNIFICANCE: The ONR's practice of funding foreign research over Quality U.S. research needs to be investigated by government officials.

PATENT INFORMATION: Improved fuel cell designs and electrode compositions for producing electricity from Microbial degradation J.G. Zeikus and DH Park U.S. patent issued 660336.91205.

PUBLICATIONS:

1. Park, D.H., and J.G. Zeikus. 2002. Impact of electrode composition on electricity production in a single compartment fuel cell using Shewanella putrefaciens. Appl. Microbiol. Biotechnol. 58:781-788.

2. Park, D.H., C. Vieille, and J.G. Zeikus. 2003. Bioelectrocatalysts: engineered oxidoreductase system for utilization of fumarate reductase in chemical synthesis, detection, and fuel cells. Appl. Biochem. Biotechnol. 111:41-53.

3. Park, D.H., and J.G. Zeikus. 2003. Improved cell and electrode designs for producing electricity from microbial degradation. Biotech Bioengr. 81:348-355.

4. Lowy, D., L. Tender, J.G. Zeikus, and D.H. Park. 2004. Harvesting electricity from marine sediment interface II. Kinetic studies on anode materials. Electrochemica Acta. In press.

5. McKinlay, J.B., and J.G. Zeikus. 2004. Extracellular iron reduction is mediated by neutral red and hydrogenase in Escherichia coli. Appl. Environ. Microbiol. 70:3467-3474.

6. J.G. Zeikus 2005. Bioelectrocatalysis: Electroactive Microbial and Enzyme Technologies for detection and synthesis of chemicals fuels, and drugs, in Biocatalysis, M. Hou editor Marcel Decker NY:NY.

7. Finkelstein, D.A., M. Laivenicks, L.M. Tender and J.G. Zeikus. Analysis of microbial electrochemical activity in marine sediment. (In preparation)

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A new generation of graphite electrodes containing iron or manganese were developed for use in microbial fuel cell and sensor devices. These electrodes were employed to sense chemicals and produce electricity from sewage sludge and marine sediments.

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