CALIFORNIA STATE SCIENCE FAIR
2017 PROJECT SUMMARY

Name(s)

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Project Number

S1102

Project Title

Building a Cost-Effective Soil-Based Microbial Fuel Cell

Abstract

Objectives/Goals

The objective of this experiment is to test alternative, inexpensive materials to design a cost-effective microbial fuel cell (MFC) that can still produce usable amounts of energy compared to more expensive designs.

Methods/Materials

I built three different MFC prototypes. One was built inside a 1-liter plastic container using pond soil as both the substrate and proton exchange membrane, and a charred, cotton rag embedded with a 22 AWG stranded copper wire for the anode/cathode assembly (Group A). Another design was built in the same way with the exception of using a charred cellulose sponge instead of a cotton rag as the electrodes (Group B). The final design was built in the same way using garden soil as the substrate and proton exchange membrane and a charred, cotton rag as the electrodes (Group C).

Results

The best performing group was Group C, which produced an OCV of 412 mV, a current of 410.6 microA, a power density of 5.62 mW/m^2, a maximum power of 79.3 microW, and had an internal resistance of 470 ohms. Group A produced an OCV of 491 mV, a current of 142 microA, a power density of 1.46 mW/m^2, a maximum power of 20.1 microW, and had an internal resistance of 1000 ohms, and Group B produced an OCV of 356 mV, a current of 87.3 microA, a power density of 1.19 mW/m^2, a maximum power of 16.8 microW, and had an internal resistance of 2200 ohms. An ANOVA with Post-hoc HSD test showed that there was no significant difference in maximum power, current, and power density between MFC Groups A and B, but there was a significant difference between both Groups A and C, and B and C. This showed that Group C MFCs were more effective than both Groups A and B.

Conclusions/Discussion

The total cost of building this MFC was $1.24 using purchased materials or $0.07 using recycled materials. The power:cost ratio indicated that 64.0 microW of power was produced per dollar spent on materials. If all recycled materials were used, 1133 microW of power could have been produced per dollar spent. By combining multiple MFCs of this design in series and parallel, comparable OCVs and power can be generated for a fraction of the cost of producing just one MFC using premium materials.

Summary Statement

I designed and built a microbial fuel using alternative, cheaper materials that can produce a comparable amount of power to those built using premium materials.

Help Received

None. I researched, designed, built, and conducted the experiment myself.