Cosmo Cassette: A Microfluidic Microgravity Microbial System For Synthetic Biology Unit Tests and Satellite Missions

Aaron J. Berliner
USRA NASA Ames Research Center
aaron.j.berliner@nasa.gov

Introduction

Problem
- Need low-mass, controllable, repeatable platform for space based Microbial Fuel Cell (MFC) experiments on small satellite and International Space Station.
- Need standard hardware and assay for unit testing forward MFC.

Proposed Solution
- A microfluidic MFC device for small satellite and space station applications.
- Bioelectrosynthesis technology for In-Situ Resource Utilization (ISRU) and the production of food, fuel and biomaterials in space.
- Double the sample size, cost efficiency, and speed of iteration.
- A demonstration of this platform via a unit test for synthetic biology.

Science of MTR Pathway

The MTR pathway is a metabolic pathway from the microbe *Shewanella oneidensis* which reduces the iron ions for the production of electricity[2][3]. Electrogenesis will be useful in space where the traditional methods of electricity generation must be modified to accommodate limited feedstock. In this case, a metal reduction pathway, native to *S. oneidensis*, will be transformed into *E. coli* and yeast through synthetic biology techniques.

Technology Combination

### 3D Printing

- **Figure 3:** AutoCAD Diagram of MFC. Parts List: tubing, valves, anode chassis, cathode chassis, PEM membrane, and electrode pins, and carbon felt electrodes.

### Voltage and Current Outputs

- **Figure 5:** Left: Current and Voltage vs Time. Middle: Current vs Voltage; Right: Power vs Time. blue, black, and green are identical experimental wells, red is control.

### Table 1: Voltage, Current, and Power Outputs of printed MFC. Experimental wells contained approx. 0.4 mL of [16 mL 50mM PBS, 4 grams glucose and 6mL LB media]. Control contained 0.4 mL of [16 mL 50mM PBS, 4 grams glucose and 6mL S. oneidensis in LB media].

<table>
<thead>
<tr>
<th>Well Contents</th>
<th>Color</th>
<th>Mean Current [µA]</th>
<th>Std Current [µA]</th>
</tr>
</thead>
<tbody>
<tr>
<td>1 S.Onei + LB</td>
<td>Blue</td>
<td>0.274</td>
<td>0.033</td>
</tr>
<tr>
<td>2 S.Onei + LB</td>
<td>Black</td>
<td>0.481</td>
<td>0.039</td>
</tr>
<tr>
<td>3 S.Onei + LB</td>
<td>Green</td>
<td>0.040</td>
<td>0.031</td>
</tr>
<tr>
<td>4 LB</td>
<td>Red</td>
<td>0.036</td>
<td>0.026</td>
</tr>
</tbody>
</table>

### References

