Powering Sensors with Microbial Fuel Cells

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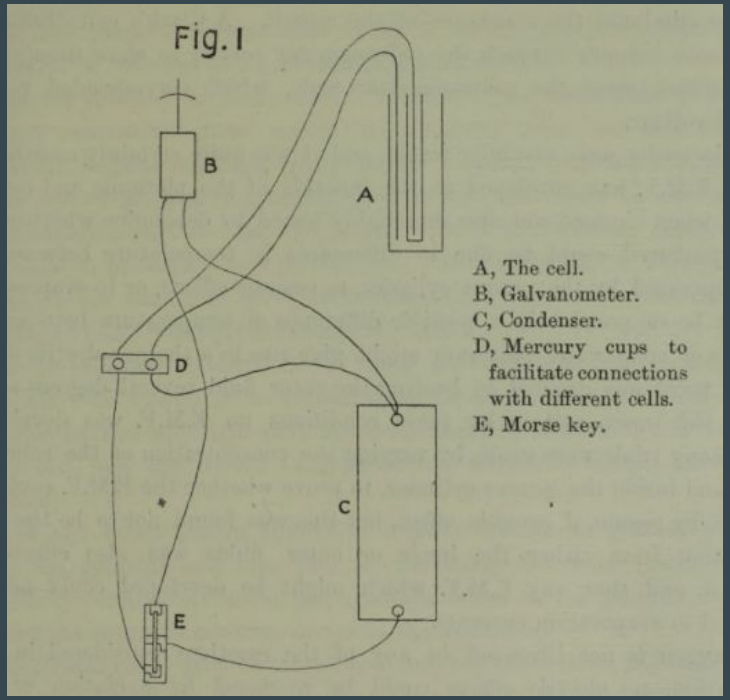
Introduction

1. City of San Diego, Public Meeting, Smart Streetlights. 2019-09-10.

Brief Background



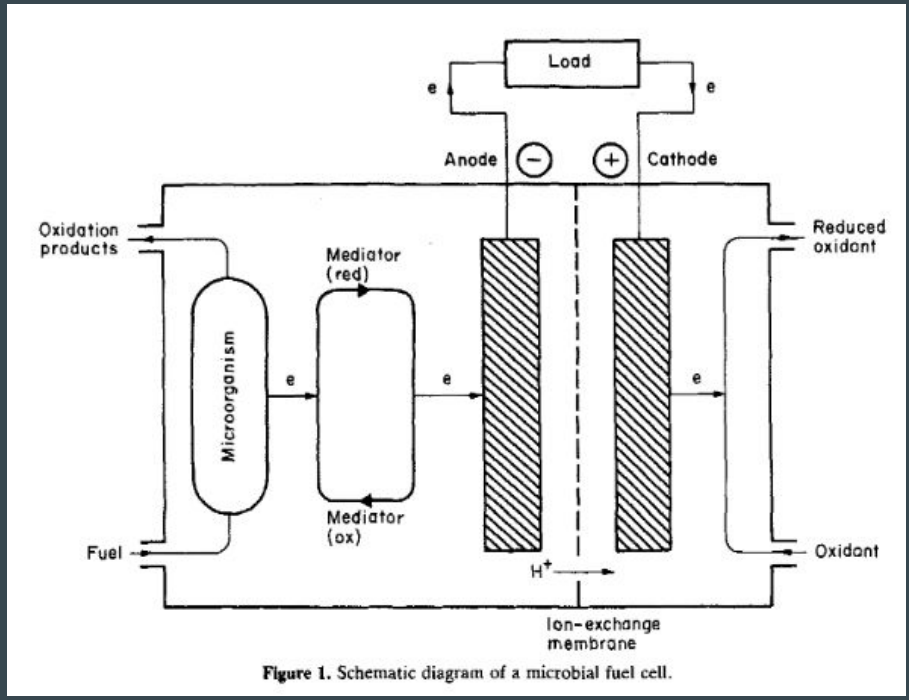


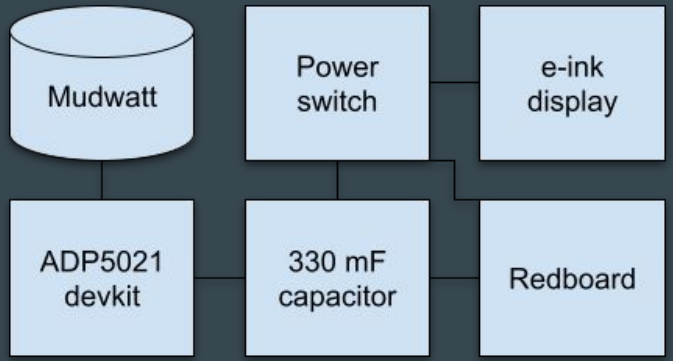
Figure 1. Schematic diagram of a microbial fuel cell.

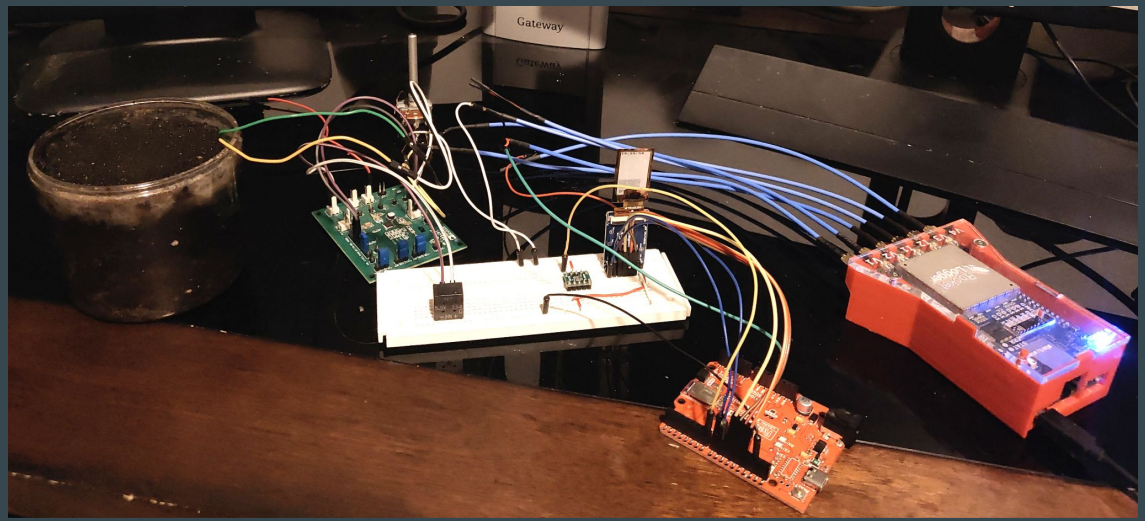
1. M. C. Potter. 1911. Electrical Effects Accompanying the Decomposition of Organic Compounds.
2. Sibel D. Roller et al. 1984. Electron-transfer coupling in microbial fuel cells: 1. comparison of redox-mediator reduction rates and respiratory rates of bacteria.

Soil Microbial Fuel Cells

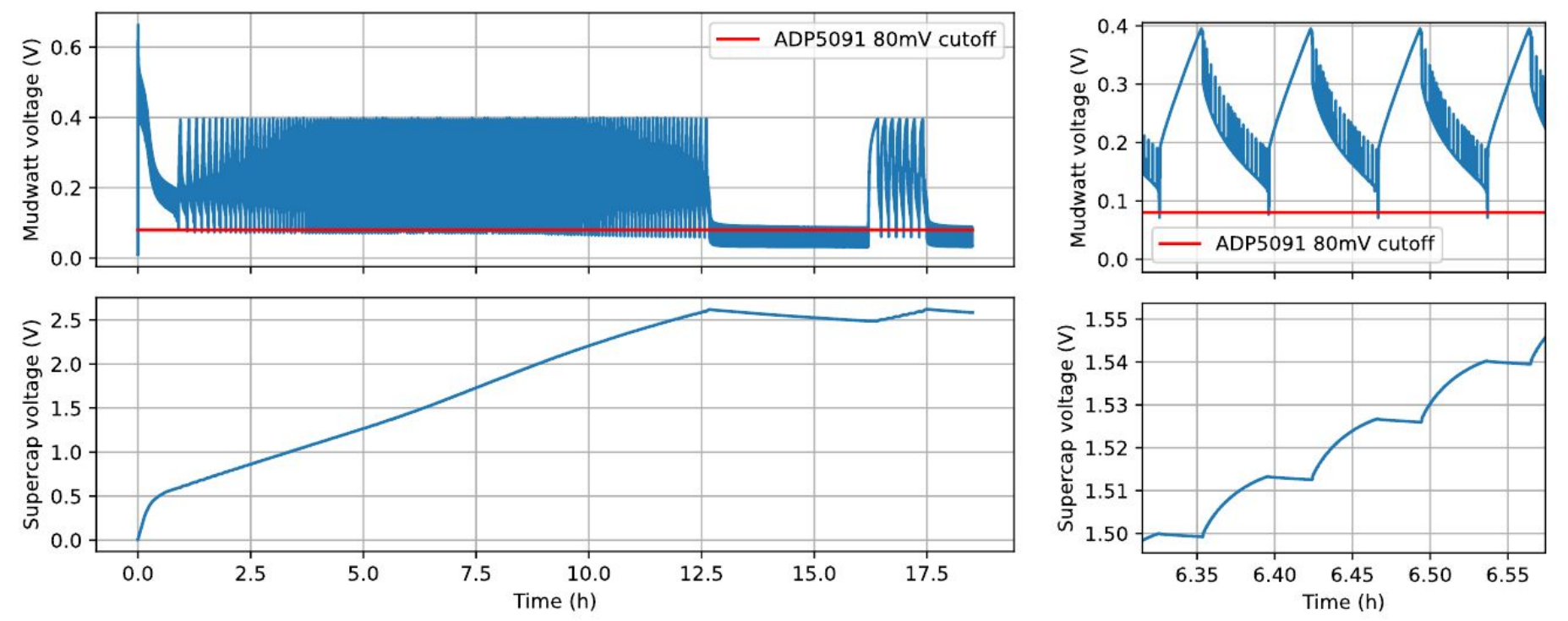
1. Mudwatt. https://www.magicalmicrobes.com. Accessed 2021-11-10.
2. Soil MFC setup by Northwestern University.

Experimental Setup

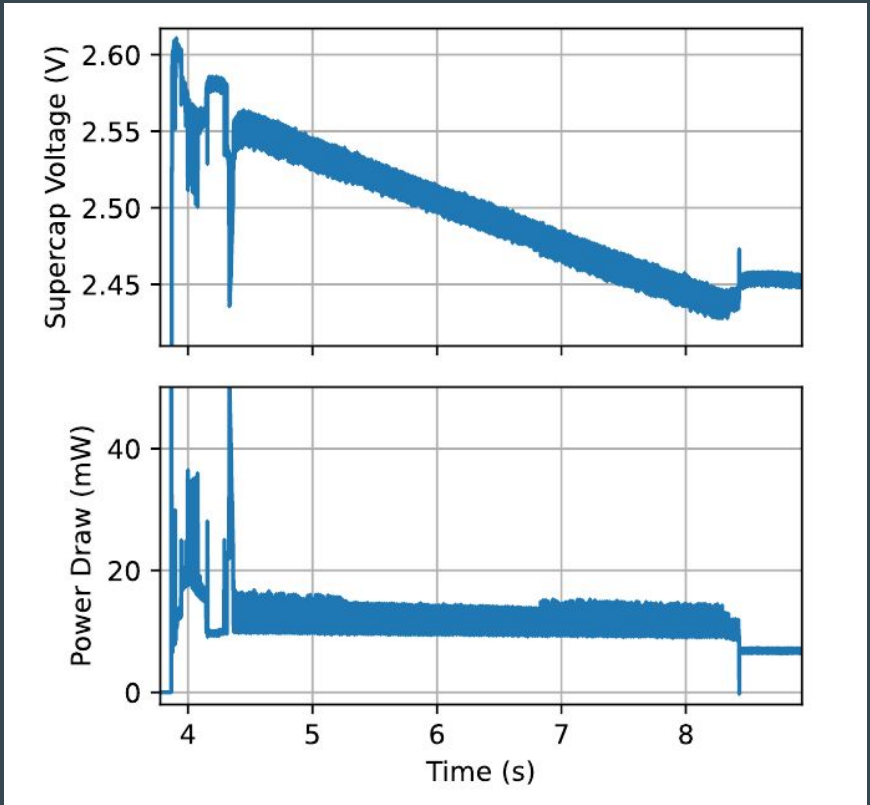




Experimental Results: Charging behavior



Experimental Results: Supercap Voltage and System Power Draw



Component	Expected (mW)	Actual (mW)
Artemis (active)	1.5	10
Artemis (sleep)	0.006	7
ADP	0.0018	-
E-ink (update)	40	4

Any Questions?

In summary:

- Soil MFCs provide power in the order of 1-100μW
- Integrated over time, this enables large energy events, such as a 55 mJ e-ink refresh
- Energy harvesting algorithms in current ICs do not harvest optimally from MFCs

Summary & Future Work

- Soil MFCs provide power in the order of 1-100μW
- Integrated over time, this enables intermittent large energy events
- Energy harvesting algorithms in current ICs do not harvest optimally from MFCs
- Could MPPT be customized to optimally harvest from soil MFCs?