Microbattery Design and Development for Specialty Market

Conner Martin[1], Katherine Hinds[1], Mindy Quach[2], Kellan Yoshikawa[2], Bhagyesh Trivedi[2]

1. Department of Materials Science and Engineering
2. Department of Mechanical Engineering

Wright Energy Institute

MECHANICAL ENGINEERING UNIVERSITY of WASHINGTON | MATERIALS SCIENCE & ENGINEERING UNIVERSITY of WASHINGTON

Problem Statement

Our objective is to **pioneer the design of microbatteries with new materials** to enable the variety of innovative applications in the real world. We identified **microrobotics** as a potential application for our microbatteries and have pursued multiple routes to achieve this application.

Background

In order to achieve our goals in implementing our microbattery into microrobotics, we split into two teams:

1) Battery Chemistry
- Need 360-600 mW to power 200 mg micro-drone for 30s flight time
- In order to improve the microbattery, we replicated the battery chemistry in a **coin cell**
- Tested **three generations** of batteries, **changing the binder**, **electrolyte**, and **cathode thickness**
- Through testing, we discovered a **preconditioning step** that improves the rate capability (replicated in coin-cells and micro-batteries)

2) Microrobot Design
- Micro robotics powered by our microbatteries will advance applications such as **search and rescue**, **mapping terrains**, and **defense applications**
- We have **designed** a ground-travelling robot as a proof-of-concept
- The ground-travelling robot features **Bluetooth-controlled speed and steering, powered entirely by microbatteries, and carbon fiber legs**

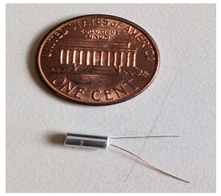


Figure 1: Microbattery compared to a penny.

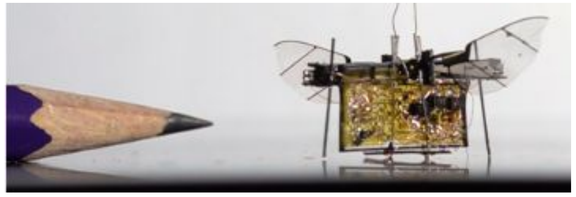
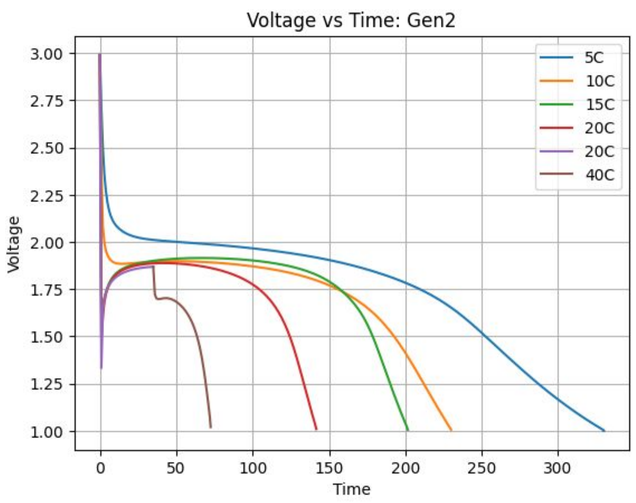


Figure 2: Micro-drone (RoboFly) made by AIR Lab UW

Results



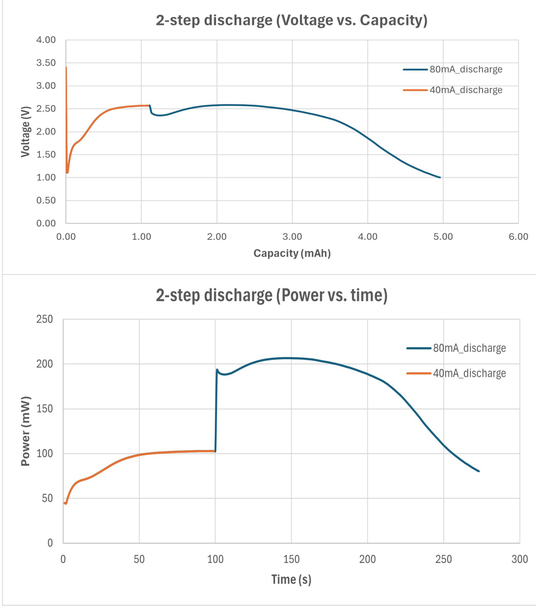


Figure 7 (above): Gen 2 Discharge Results with different C rates

Figure 8 (right): Microbattery 2-Step Discharge: (Top) Voltage vs. Capacity, (Bottom) Power vs. Time

Methods - Ground Travelling Robot

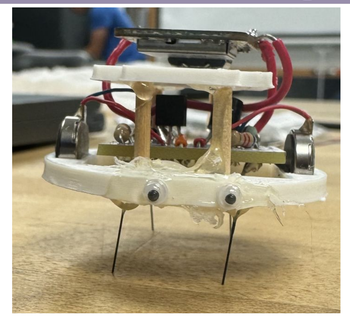


Figure 3: Design for ground-travelling robot fully powered by micro batteries

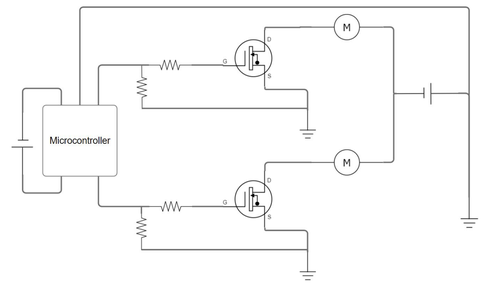


Figure 4: Circuit schematic for PWM control of transistors to power vibration motors

Requirement	Design Aspect
Controlled 3.3-4V to power vibration motors	Transistors controlled by PWM signal from micro-controller
Steering and speed control	Bluetooth control of micro controller with phone and arduino IDE
Low weight	Includes three microbatteries (70 mg/each), two transistors (56 mg/each), platform (2.58g)

Methods - Battery Chemistry

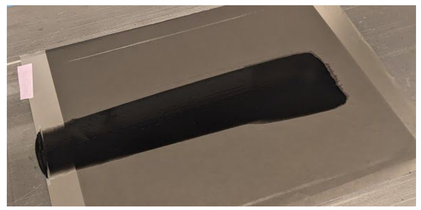


Figure 5: Casting of slurry for coin cell cathode

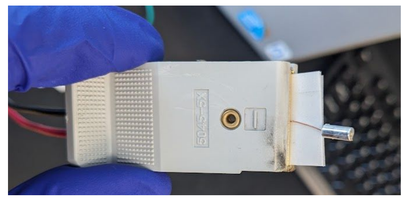


Figure 6: Microbattery in potentiostat testing.

Conclusion

After successfully creating the microbatteries using a procedure developed by the PNNL, we connected with the Autonomous Insect Lab (AIR) in the UW Mechanical Engineering department at UW in order to use this microbattery in micro-robotic applications. Our team designed a ground traveling microrobot that can be powered by the microbattery. From our promising results of our two-step microbattery discharge test, we plan to implement the microbattery in micro-drones developed by the AIR lab.

Acknowledgments

We would like to thank Zhi Peng, Professor Jun Liu, Professor Luna Huang, and Dr. Victor Chen for their continuous support and mentorship throughout this project. We would also like to thank Johannes James, Dr. Sawyer Fuller, and the Autonomous Insect Robotics Lab for their guidance in the development of this project.