# Metal Air Batteries for EVs and Electronic Devices


Project Team Members - *Alexis Burt, Logan Nielsen, and Ian Thompson*

Department of Mechanical and Materials Engineering - Dr. Junghsen Lieh and Dr. Amir Farajian

WRIGHT STATE UNIVERSITY


## Project Background

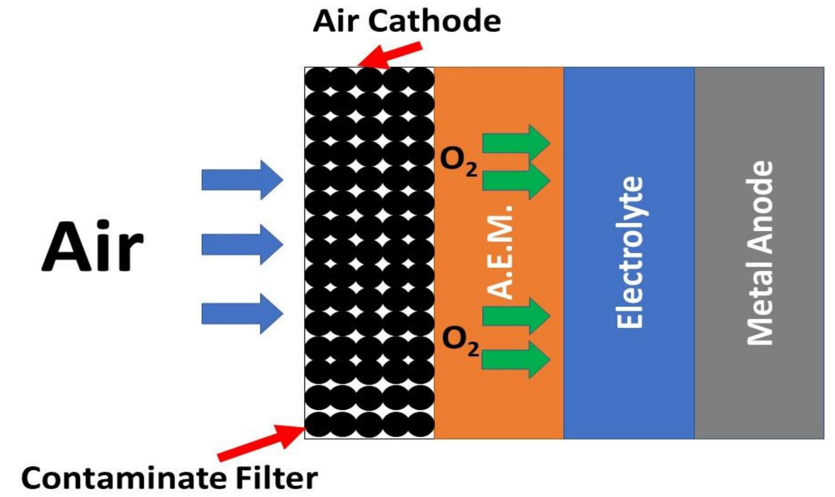

### ABSTRACT

Lithium-ion batteries have been the industry standard for both electric vehicles and electronic devices. However, this causes issues due to their tendency to overheat resulting in self-firing incidents. In addition, lithium is a rare earth element that could be depleted in the next decade. This project aims to evaluate and compare various metal-air batteries as an alternative to lithium-ion batteries.


### GOALS

Develop a metal-air battery that is safer than lithium-ion batteries and uses material components that are more abundant than lithium.

## Components




### CATHODE DESIGN

- Trace elements in the air cause undesirable chemical reactions during the electrochemical process.
- Reactions contribute to degradation of the AEM and metal anode.
- To countermeasure, a permeable medium is included in the air cathode.
- The design uses a carbon filter to purify incoming ambient air to reduce adverse reactions.

### ANION EXCHANGE MEMBRANE

- Used in fuel cell applications. However, also useful for Air-Metal Battery applications.
- The Anion Exchange Membrane facilitates the transfer of hydroxide molecules during the oxidation process.
- Requires pre-treatment in electrolyte solution.
- Our design uses cellophane.

### ELECTROLYTE SOLUTION

- Electrolytes Considered:
  - Potassium Hydroxide
  - Sodium Hydroxide
  - Magnesium Hydroxide
- Selected Potassium Hydroxide at:
  - 1.8 Mol, 4 Mol, and 8 Mol

### METAL ANODE

Aluminum, Zinc, Iron, and Lithium were the four metals considered for testing upon the start of our project. Results for Zinc and Iron were acquired.

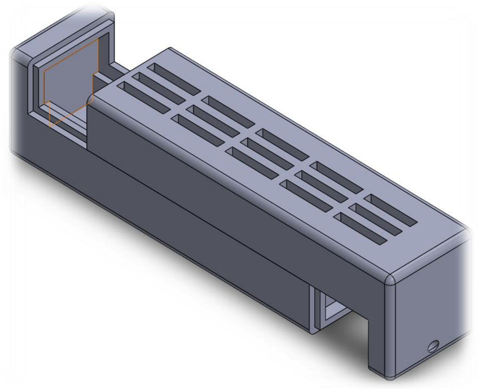
## Prototype Design

### BATTERY CELL

The battery cell requirements were primarily material based and had the restrictions listed below:

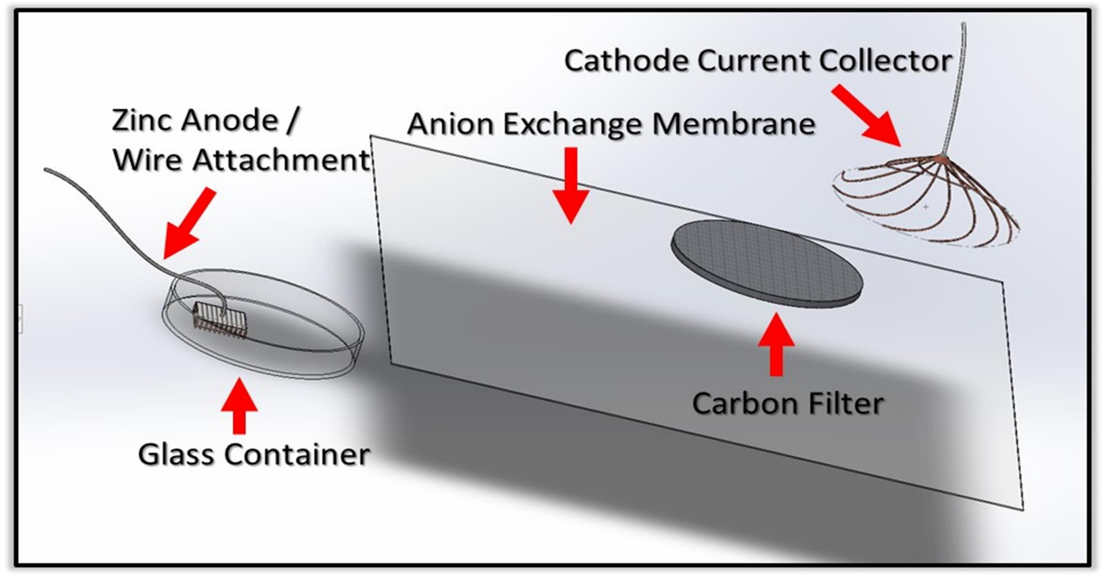
- Should not interfere with the conductivity of the other materials
- Should be resistant to chemical and electrical corrosion
- Must have ventilation to allow air access
- Should be easily assembled and manufactured

With these constraints, a 3D printed PLA battery cell was designed and manufactured



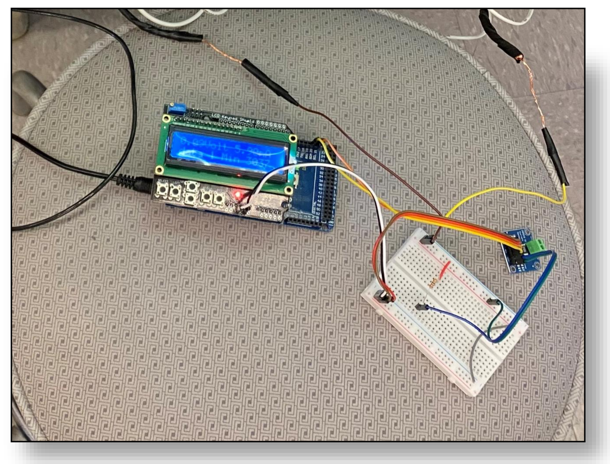
### TESTING APPARATUS

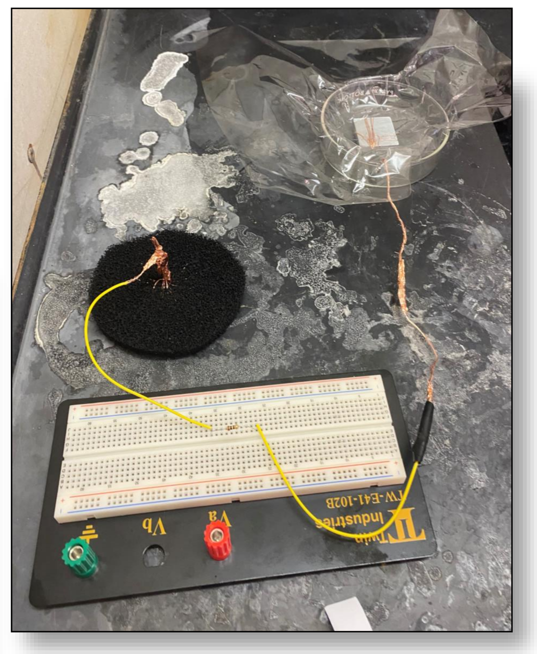
- The testing apparatus connects to a breadboard which is setup for either manual or Arduino data monitoring.




### PHYSICAL ASSEMBLY

The testing setups below show the two ways in which data was collected. The first photo (left) is the method utilizing an Arduino while the second Photo (right) is manual.

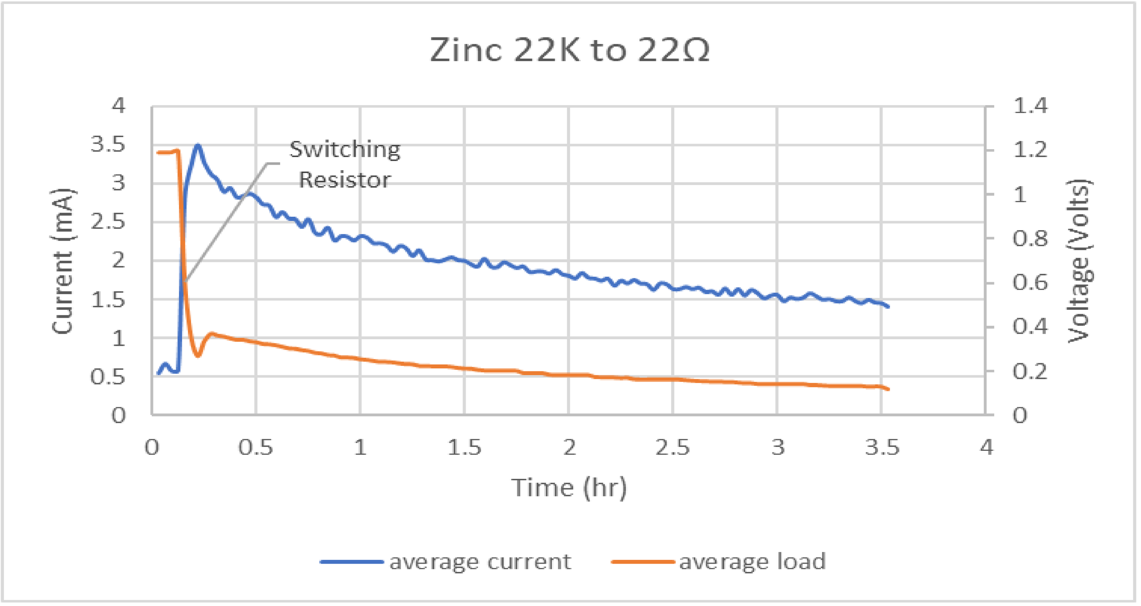




## Results and Data

### INITIAL TESTING

Initial Testing was done with a Zinc anode, cellophane AEM, 8 Mol Solution of KOH, and 2.2K ohm resistors.

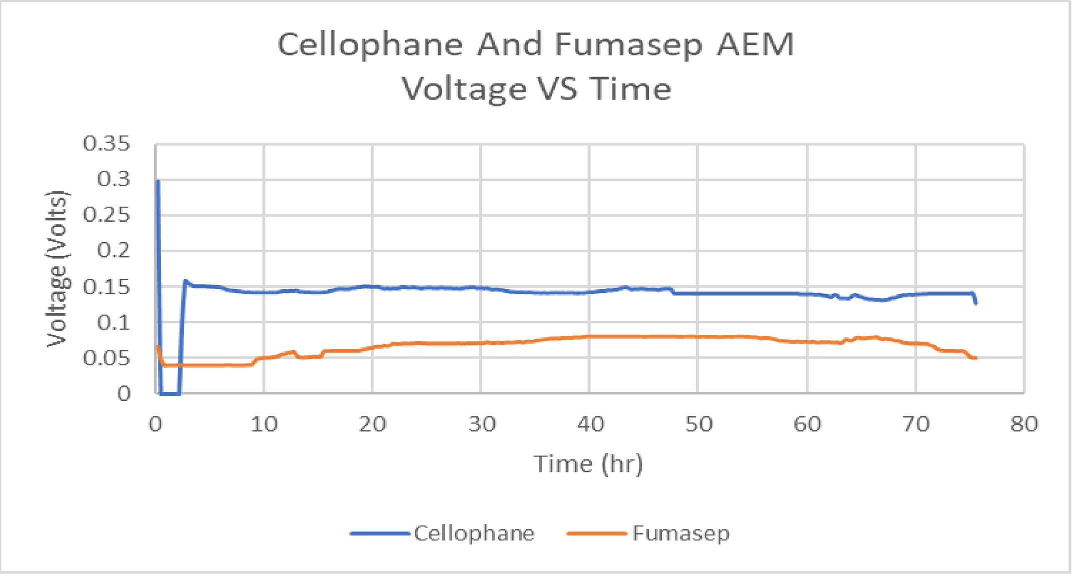



### TESTING CONTINUED

After initial testing was completed, all further testing involved using a 22-ohm resistor, KOH electrolyte, and Zinc Anode.

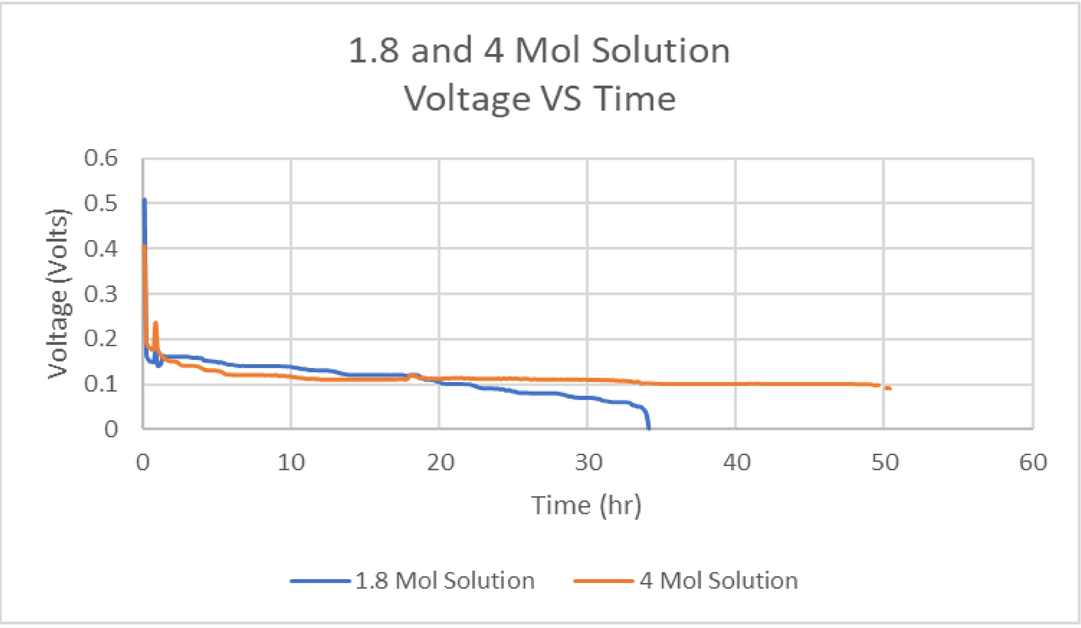
### AEM TESTING

Both cellophane and a Fuel Cell AEM were tested showing that the Cellophane was better.




### ELECTROLYTE TESTING

Three different molarities of KOH were tested, 8 Mol was used in all other tests, 1.8 and 4 Mol were tested by themselves and are shown below.




## Conclusion

Using cellophane as an AEM and enhancing the metal anode through alloys and hierarchical material combinations appears to be the two most promising possibilities for an advancement in this research.