CALIFORNIA STATE SCIENCE FAIR
2016 PROJECT SUMMARY

Name(s)

Joshua M. Pritz

Project Number

36871

Project Title

Investigation and Applications of the Lithium-Oxygen Battery Cell Cathodes

Abstract

Objectives/Goals

This research examines the most integral, yet disputed component of the avant garde lithium air battery: the cathode. The cathode of this battery, which utilizes oxygen gas in an oxidation reduction reaction responsible for producing electricity, must conduct electricity, facilitate the flow of oxygen gas, and catalyze the reduction of oxygen gas. The porous carbon black based cathode has elsewhere demonstrated a keen ability to satisfy all three criteria both theoretically and practically. The chemical composition of such cathodes were varied with respect to carbon black, the conductive material, and dibutyl phthalate, the sacrificial material, to optimize performance.

Methods/Materials

The chemical composition of such cathodes were varied with respect to carbon black, the conductive material, and dibutyl phthalate, the sacrificial material, to optimize performance. Performance was measured in terms of electrical conductivity and air diffusion rates. Conductivity was measured in a simple electrical circuit, while diffusivity was calculated using measurements of pH via diffusion of H+ ions through the membrane over time.

Results

Of the five cathodes created using this method, Cathode 1 demonstrated an ohmic resistance of 0.28 ohms and a sixty minute hydrogen ion diffusion of 3.22e-6 molar. Cathode 2 recorded a resistance of 39.0 ohms and a sixty minute diffusivity of 1.47e-4 molar. Cathode 3 recorded a resistance of 460 ohms and a diffusivity of 2.68e-4 molar. Cathode 4 recorded a resistance of 1120 and a diffusivity of 4.39e-4 molar. Lastly, cathode 5 recorded a resistance of 253,000 ohms and a diffusivity of 4.91e-4 molar.

Conclusions/Discussion

The cathode with the highest percentage of carbon black proved to be the most conductive and the cathode with the highest percentage of dibutyl phthalate demonstrated the best ability to conduct air flow. Ultimately, an ideal cathode for the lithium air battery is a major step in making such batteries commercially feasible.

Summary Statement

Five cathodes for use in the lithium-oxygen battery were created, in which the concentration of dibutyl phthalate and carbon black were varied, and tested with regard to conductivity and diffusivity to optimize their composition.

Help Received

I designed and performed my experiments by myself. I used equipment provided by Thousand Oaks High School and Dr. Nikki Malhotra. Dr. Greg Cauchon assisted me with scientific writing and method revision.