Silver-Zinc Microbatteries

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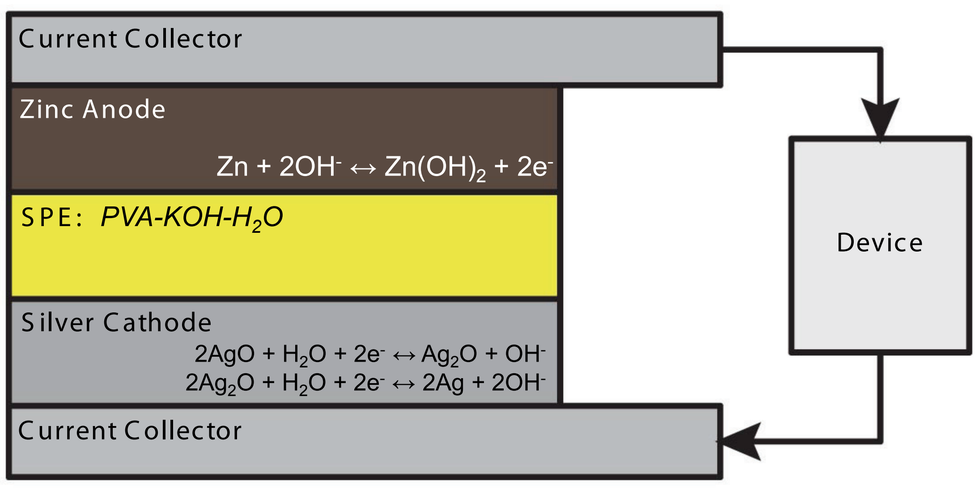
Vision

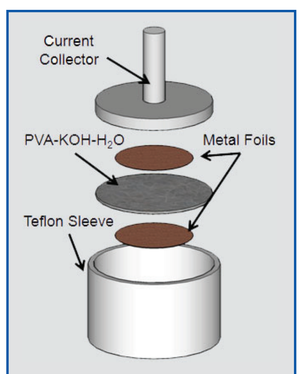
Silver-zinc batteries offers the highest power densities of commercial rechargeable batteries with up to 600 W/kg for continuous operation and up to 2500 W/kg for short duration pulses. Silver-zinc systems are considered for applications where weight and safety are a major concern. Silver-zinc systems, however, are hampered by a short wet life and rapid degradation in capacity from cycle to cycle.

In this work, we are analyzing the use of solid polymer electrolytes (SPE) for silver-zinc battery systems to improve both the wet life and cycle life in microbattery applications. Furthermore, incorporating a solid polymer electrolyte will greatly simplify the packaging required for microbatteries (no liquid components).

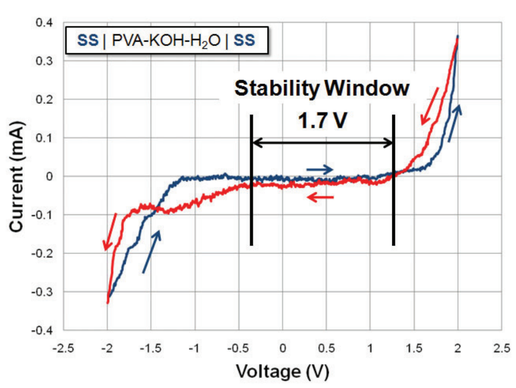


Schematic of silver-zinc battery system with charge-discharge reactions

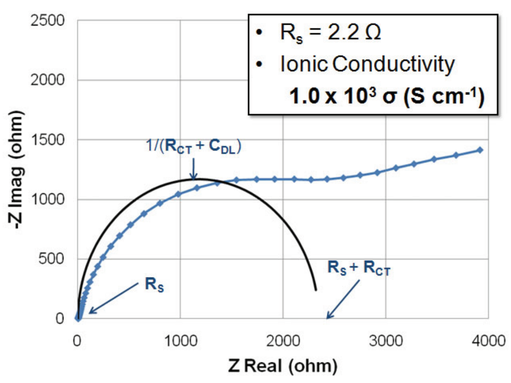
Findings



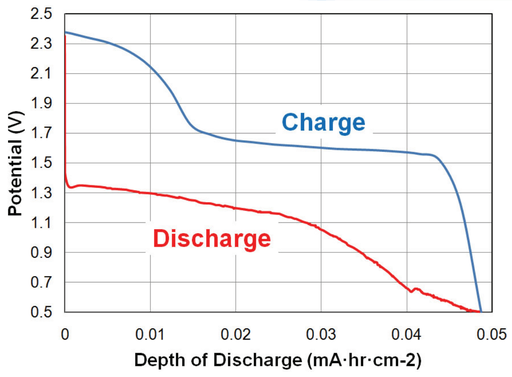
Experimental setup for electrochemical analysis



Stability window for the PVA-KOH-H_2O film by cyclic voltammetry analysis between stainless steel electrodes



Nyquist plot of impedance spectroscopy of PVA-KOH-H_2O film between zinc electrodes



Charge and discharge potentials for system after 50 cycles

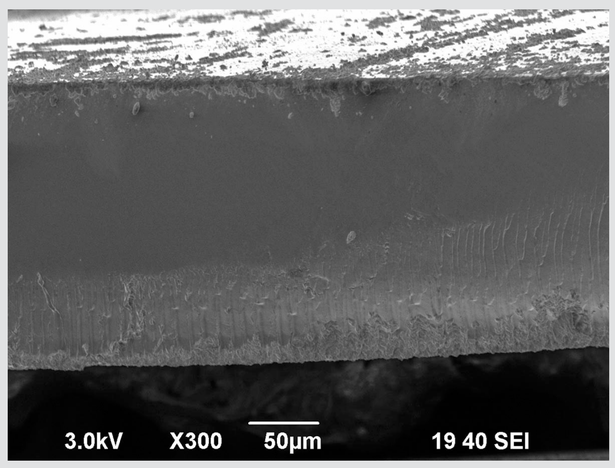
Initial Findings - *Silver-Zinc System with PVA-KOH-H_2O*
- Battery capacity ~ 0.03 mA·hr/cm^2 at 1.2V
- Cycle Life ~ 50 cycles

Research

SPE

Currently, silver-zinc alkaline batteries utilize a chemically basic aqueous electrolyte such as potassium hydroxide (KOH) dissolved in water. The alkaline electrolyte allows for a high watt-hour output per unit volume. However, the strong basic aqueous solution corrodes and dissolves the zinc anode over time resulting in a short wet life.

As an alternative to an aqueous electrolyte, we are investigating the solid polymer electrolyte (SPE) of polyvinyl alcohol (PVA) dissolved in water and mixed with KOH for alkaline microbatteries. PVA is a polymer that exhibits a high solvent retention capacity, high gel strength, and is inexpensive. The cast PVA with KOH forms a solid film with high strength while exhibiting liquid like transport properties.



Cross section of PVA – KOH – H2O alkaline gel electrolyte (20 wt% KOH) exhibiting almost complete solution of KOH

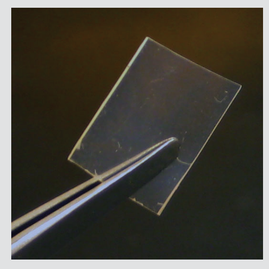


Photo of PVA – KOH – H_2O alkaline gel electrolyte

Findings

Solid polymer electrolyte (SPE) were prepared by casting a PVA, KOH, H2O solution and drying the solution to a film with a thickness ranging from 100 to 200 µm. The stability window of the film was analyzed by cyclic voltammetry between stainless steel electrodes and was determined to be around 1.7 V. The ionic conductivity of the SPE was analyzed by conducting impendence spectroscopy between zinc electrodes. The ionic conductivity for the SPE was calculated to be around 1.0 x 103 σ (S cm-1). These good electrochemical properties suggest a potential application of PVA-KOH solid polymer electrolytes for microbattery applications.