

Self-Discharge of Secondary Zinc Electrode Deposits Subjected to Various Plating Conditions

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Objectives and Materials

Rechargeable Zn-air batteries may soon become a reality, at which point Zn-air cells may find many commercial applications due to their inherent safety, inexpensiveness, sustainability, high specific energy and high volumetric energy density. Instead of investing time and resources on Li-air batteries, we believe labs should set up to study Zn-air cells. In our continuing efforts to produce a rechargeable, high cycle life Zn-air coin cell,¹ it is important to understand the behaviour of the Zn electrode and how different plating conditions change the self-discharge rate.

Work by Cairns' group in the 1980s^{2,3} and more recently by Bae⁴ have determined nucleation potentials for Zn deposition onto several substrates (current collector materials) and Zn deposit morphologies on those substrates. Those studies did not measure self-discharge (Zn corrosion) or H₂ evolution rates which should depend on the surface area of the Zn deposit, and thus the morphology. Here, the effects of different charge current densities, deposited capacities, substrates and electrolyte concentrations on self-discharge and H₂ evolution rates are reported.

Results

Figure 1 shows that the current density (or charging current) does not affect the self-discharge rate for Zn plated on Sn foil. Results on other materials will be presented as well. Figure 2 shows the remarkable drop in self-discharge rate that accompanies an increase in KOH concentration. Figure 2 also shows that whether the cell is designed with a higher or lower KOH concentration, lead, indium and tin are clearly better current collector materials than the more commonly used nickel and copper. Although lead appears to be the best current collector in general, its propensity for alloying with zinc and promoting boulder-like deposits result in higher overpotentials during discharge. Indium and tin promote more uniform zinc deposits that yield lower overpotentials during discharge. The data shown here

reflects approximately 0.5 μm thick deposits; however, the self-discharge rates of zinc deposits of various thicknesses will also be presented at the meeting.

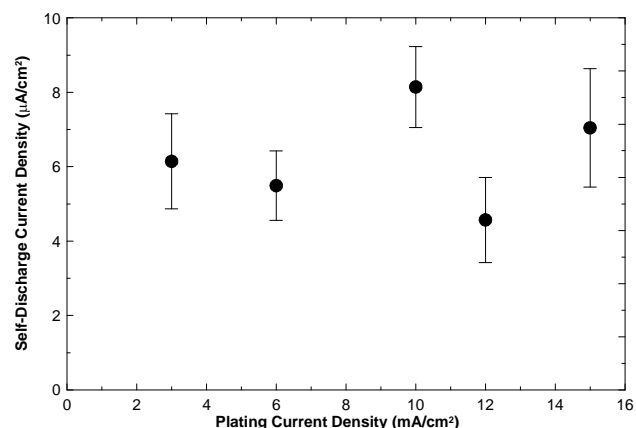


Figure 1: Self-discharge current density of zinc deposits that were deposited at increasing charge current densities.

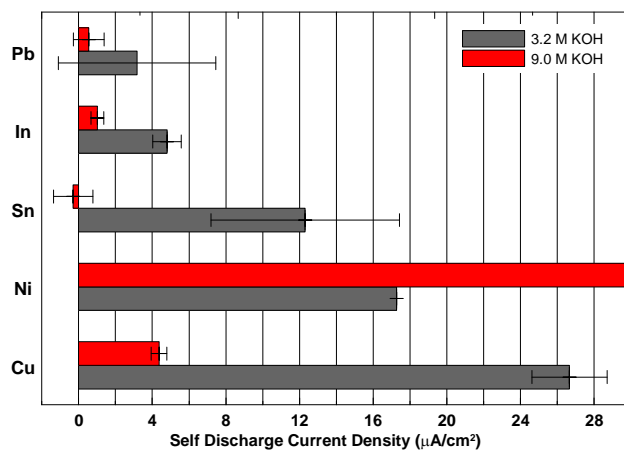


Figure 2: Self-discharge rates of zinc deposits on different material substrates (current collectors) in 3.2 M and 9 M KOH electrolytes.

References

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4. I. T. Bae, *J. Electrochem. Soc.* **155**, D395 (2008).