Flexible Ion-Selective Separators for Alkaline Zinc Batteries

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Background and Objectives

Alkaline zinc batteries are one of the core DOE/DOE technologies for grid storage and feature energy-dense, safe, abundant, low-cost materials

Alkaline Batteries Today

- Zinc
- KOH
- Ni/C

Performance-Limiting Issues

1) Passivation
2) Shape change
3) Dendrite formation
4) H₂ evolution
5) Zincate crossover

Restricting migration of zincate is key

Objectives

- Fabricate and characterize a thin, flexible, scalable polymeric separator for alkaline zinc systems that selectively blocks zincate ions while allowing transport of hydroxide and cations
- Implement the separator into practical Zn/Ni cells cycled at high zinc utilization (≥ 20%) and demonstrate an improvement in performance compared to cells with commercial separators

Separator Screening and Properties

Presence of Bi, Cd, and Pb allows for consistent results when determining [Zn]

Anodic stripping voltammetry (ASV) enables much faster screening of ion transport through separators compared to ICP-MS, with similar limits of detection and no need for dilution or pH modification.

Comparison to Literature

50% DOD cells with Separator 1 offer a high combination of cycle life, active material utilization, and areal capacity compared to other recent developments, along with less complex processing requirements.

Conclusions and Research Output

- Prepared flexible polymeric membranes that are effectively impervious to zincate, while maintaining hydroxide transport on par with commercial separators
- Zn/Ni cells with anodes wrapped in our separator show substantial cycle life improvement at high Zn utilization (≥ 20%) over cells with commercial separators only—which are the best performers in recent literature
- Our separator mitigates the fundamental problems of Zn redistribution and shorting and can be easily adapted to any alkaline Zn battery
- Future studies to incorporate our separator into Zn/MgO cells with Bi/Cu-modified cathodes that can reversibly deliver the full 671 mAh/g capacity of MgO, preventing or delay inactivation of MgO by zincate

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