SAND2022-13065C

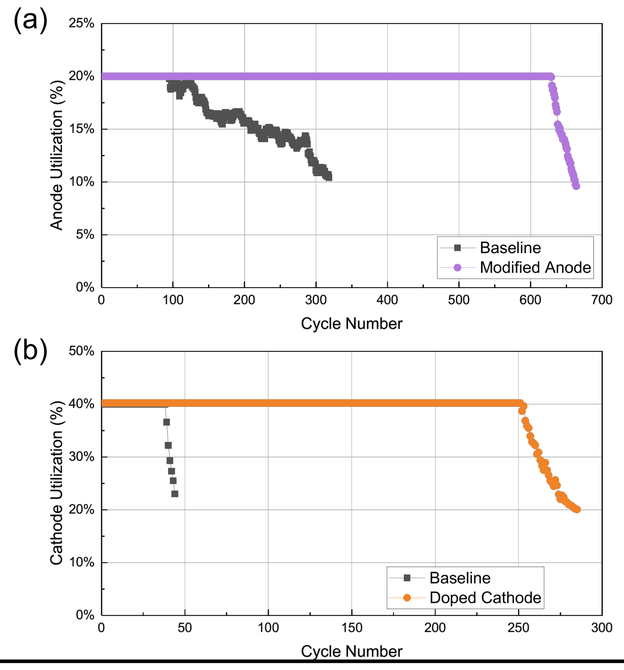
Zinc-Manganese Dioxide Battery Development and Commercialization at Urban Electric Power

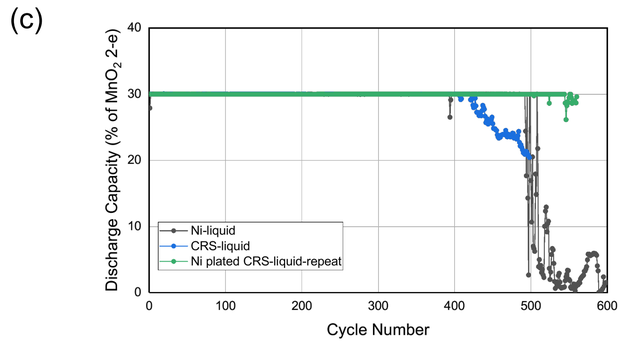
Jinchao Huang[1], Gautam G. Yadav[1], Meir Weiner[1], Kristen Vitale[1], Shinju Yang[1], Sanbir Rahman[1], Bryan R. Wygant[2], Timothy N. Lambert[2], Sanjoy Banerjee[1]

***Corresponding Author: jinchao@urbanelectricpower.com; gautam@urbanelectricpower.com**

1. Urban Electric Power Inc., Pearl River, 2. Sandia National Laboratories

Development of Energy Dense 1st electron Zn-MnO_2 Batteries



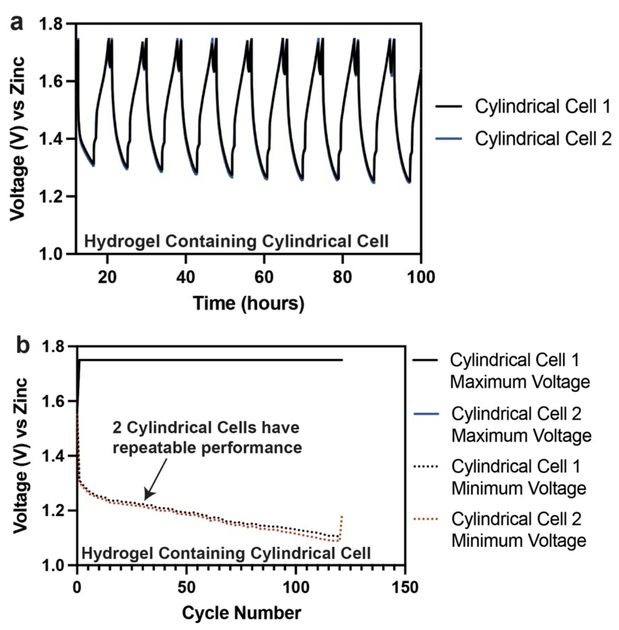


- Figure 1 (a) Cycle life comparison of UEP baseline anode and improved anode cycling at 20% of anode active material utilizations (164 mAh/g-Zn).
- Figure 1 (b) Cycle life comparison of UEP baseline cathode and improved cathode cycling at 40% of cathode active material utilizations (123 mAh/g-MnO_2).
- Figure 1 (c) Cycle life comparison of UEP electrodes with different current collector materials.

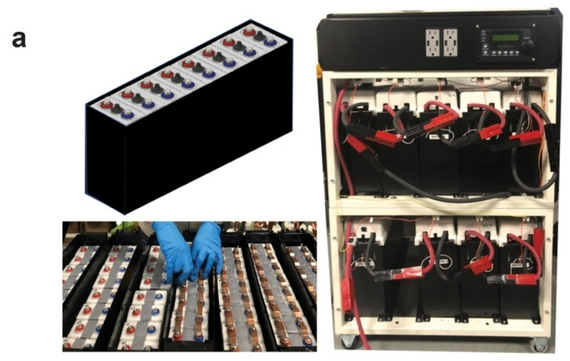
1. Developed Improved Zn anodes with 20% utilization >600 cycles
2. Developed improved MnO_2. cathode with 40% utilization with a cycle life > 250 cycles.
3. Cheaper current collectors like CRS and Ni plated CRS mesh have been developed to reduce the cost of the battery and showed good stability throughout cycling.
4. Electrodes manufactured on the manufacturing floor repeat lab-made electrodes.

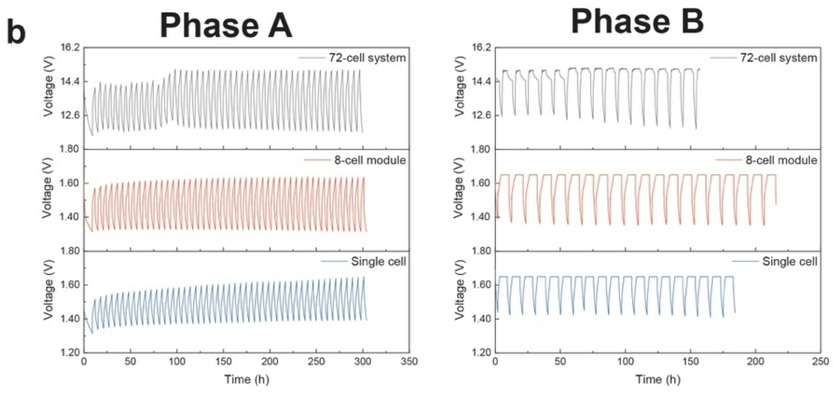
1. Manuscript in preparation

Development of Non-Spillable Gelled Zn-MnO_2 Batteries



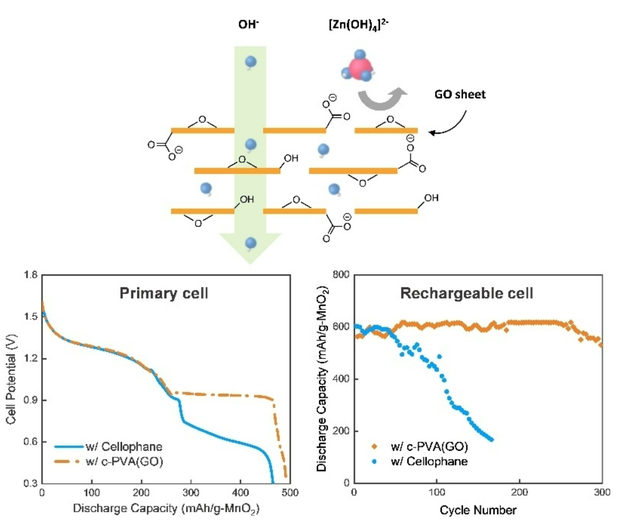
J. Cho et al. Polymers 14 (3), 417



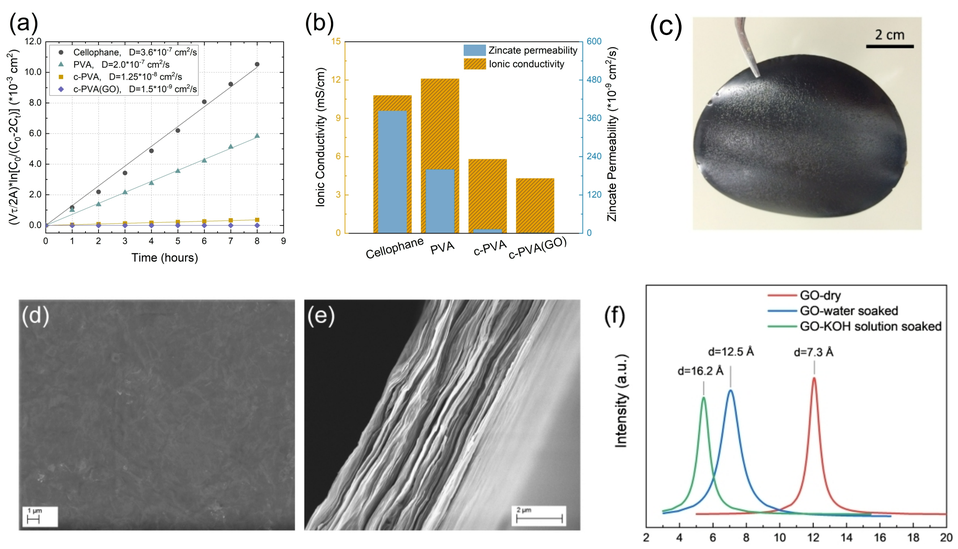


1. A non-spillable and low-maintenance Zn-MnO_2 battery that meets DOT requirements for safe transportability is developed by applying a poly(acrylate-KOH-H_2O) hydrogel electrolyte.
2. An in-situ polymerization method to incorporate the hydrogels in the cells is reported that enhances contact with the electrode and reduces corrosion.
3. The hydrogel reduces zincate migration, formation of stray Zn particles and manganese dissolution to increase the utilization of the electrode materials.
4. The hydrogel also enhance the safety by reducing dendrite formation that often leads to short circuits.

Development of Zinc-ion blocking Graphene Oxide Separators

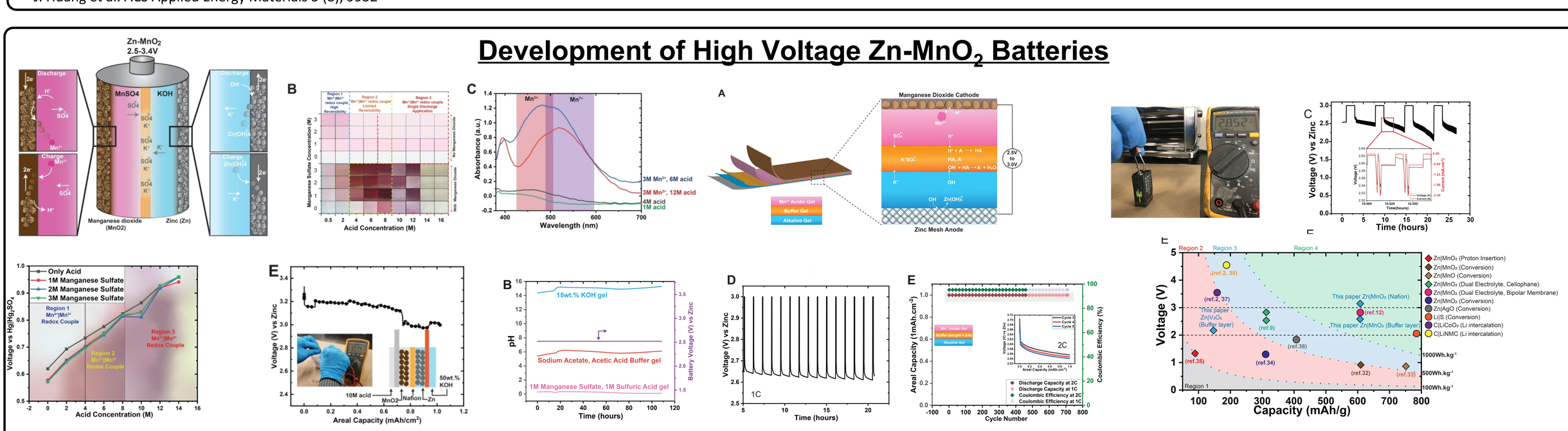


1. We demonstrate for the first-time of graphene oxide/polyvinyl alcohol (GO/PVA) composite membrane as a zincate ($[Zn(OH)_4]^{2-}$) blocking separator in alkaline Zn-MnO_2 batteries to prevent zinc poisoning for MnO_2 electrochemical redox reaction.
2. Near full utilization of the MnO_2 electrode's 2-electron capacity (~617 mAh/g-MnO_2) is demonstrated in a primary cell.
3. An enhanced cycle life is reported in rechargeable Zn-MnO_2 cells accessing the 2nd electron capacity of MnO_2.



J. Huang et al. ACS Applied Energy Materials 5 (8), 9952

Development of High Voltage Zn-MnO_2 Batteries



G.G. Yadav et al. Materials Horizons, 2022

Acknowledgements

The authors would like to thank Sandia National Laboratories for funding for this work. Sandia National Laboratories is a multi-mission laboratory managed and operated by National Technology and Engineering Solutions of Sandia,LLC., a wholly owned subsidiary of Honeywell International, Inc., for the U.S. Department of Energy's National Nuclear Security Administration under contract DE-NA-0003525. The views expressed herein do not necessarily represent the views of the U.S. Department of Energy or the United States Government. Dr. Imre Gyuk, Energy Storage Program Manager, Office of Electricity is thanked for his financial support