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Electrochemical transformation reaction of Cu-MnO in aqueous rechargeable zinc-ion batteries for high performance and long cycle life

Fekadu Wubatu Fenta[1] (4th year Ph.D. candidate), Advisor: Bing Joe-Hwang*[1, 2]

[1]Department of Chemical Engineering, National Taiwan University of Science and Technology, Taipei, 106, Taiwan

[2]Synchrotron Radiation Research Centre, Hsinchu, 30076, Taiwan

Abstract

Aqueous zinc-ion batteries (ZIBs) are emerging as alternative lithium-ion batteries for large-scale energy storage applications due to their safety and environmental friendliness. However, the development of high-performance cathode materials is one of the main challenges. We designed Cu-MnO cathode material having abundant defects. The electrochemical mechanism investigation indicates the transformation of Cu-MnO into Cu-MnO_2.nH_2O during initial charging. The subsequent Zn^{2+} storage mechanism takes place in Cu-MnO_2.nH_2O. As a result, the structure delivered high specific capacity and long cycling stability when applied to cathode materials for ZIBs.

Experiment:

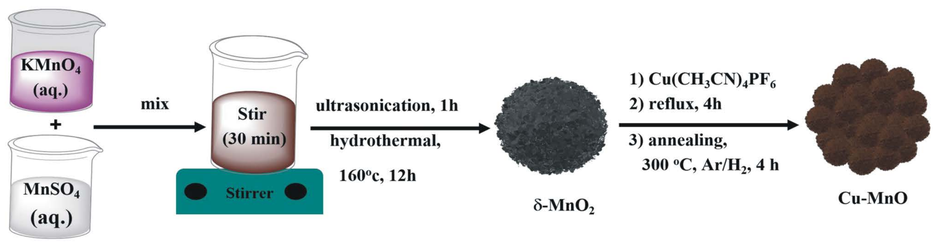

Figure 1: Schematic illustrating preparation process of Cu-MnO nanospheres.

Results:

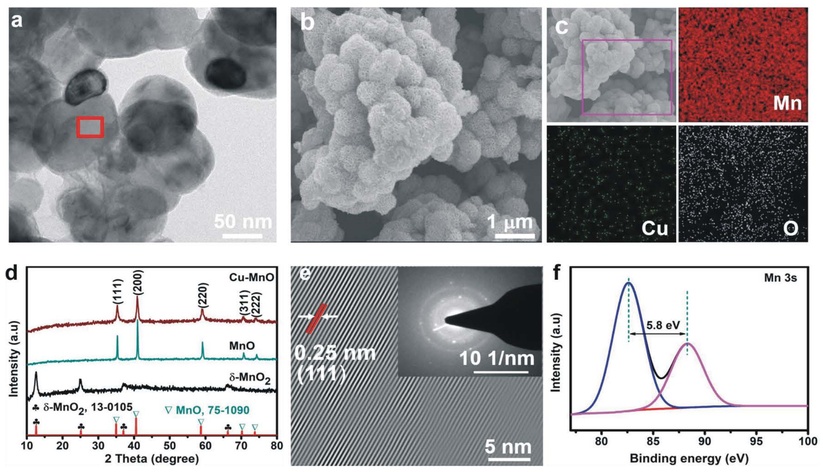

Figure 2. Morphology and crystal structure of Cu-MnO. (a) TEM image (b) SEM image (c) SEM elemental mapping images (d) XRD patterns (e) HRTEM (f) Mn 3s XPS spectra

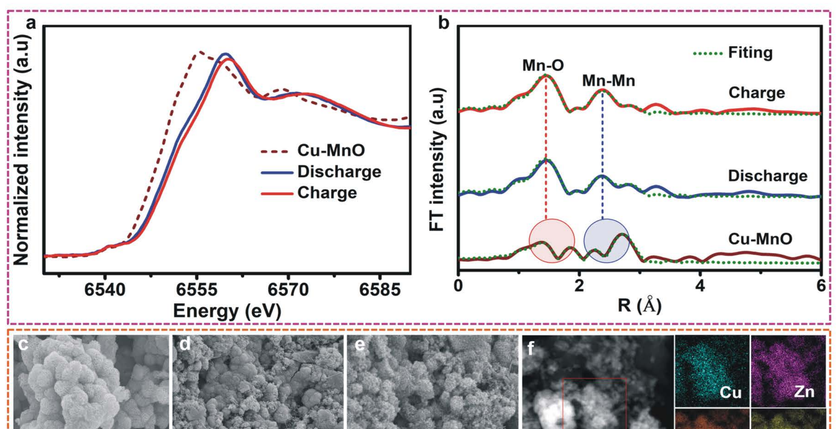

Figure 3. Structural, morphological, and compositional analysis of Cu-MnO during charge/discharge. (a) Mn K-edge XANES spectra. (b) EXAFS spectra. (c) SEM image of Cu-MnO. SEM images of Cu-MnO on (d) 1st and (e) 5th charged states. (f) STEM and STEM-EDS mapping images upon charge.

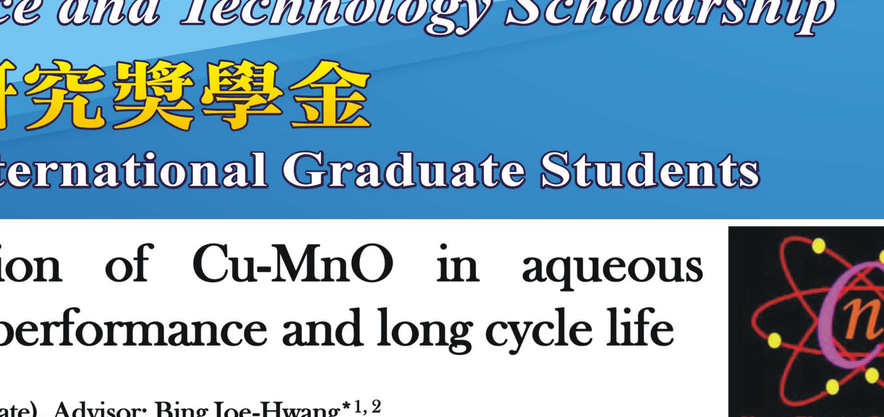

Figure 3. Electrochemical performance. Cycling performance at (a) 0.5C and (b) 3C

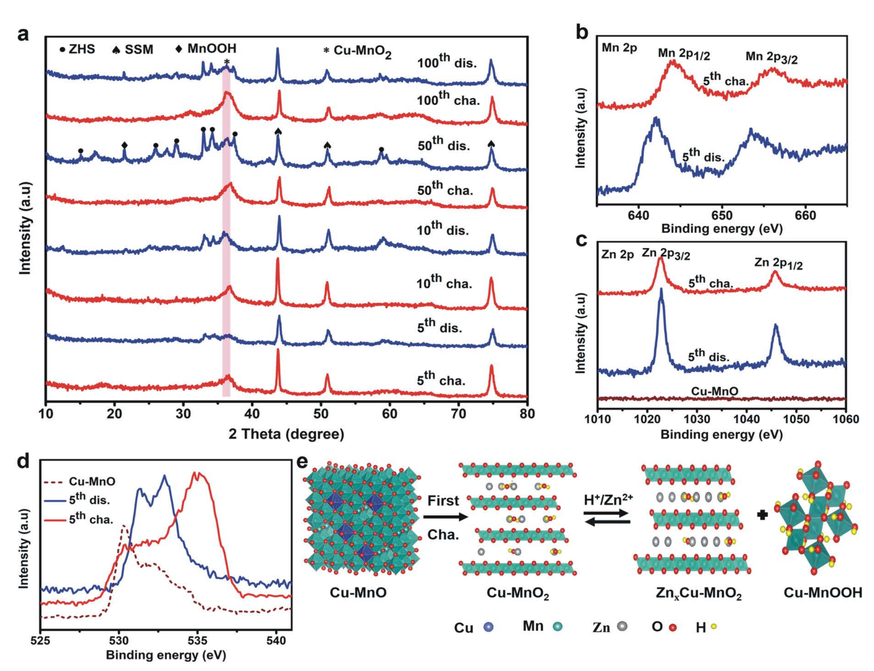

Figure 4. Crystal structure evolution energy storage mechanism. (a) Ex-situ XRD patterns. Ex-situ high-resolution XPS spectra of (b) Mn 2p, (c) Zn 2p, and (d) O 1s. (e) Schematics showing electrode reaction mechanism.

Summary:

- In summary, we successfully synthesized a copper modified Cu-MnO nanospheres using hydrothermal, reflux and calcination steps.
- We confirm structural transformation Cu-MnO to the layered type phase during electrochemical reaction.
- This work broadens the horizon of suitable cathode materials for aqueous ZIBs

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publications:

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