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**Ultrathin Stabilized Zn Metal Anode for Highly Reversible Aqueous Zn-Ion Batteries**

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**Abstract Text:**

Ever-increasing demands for energy, particularly being environmentally friendly have promoted the transition from fossil fuels to renewable energy.[1] Lithium-ion batteries (LIBs), arguably the most well-studied energy storage system, have dominated the energy market since their advent in the 1990s.[2] However, challenging issues regarding safety, supply of lithium, and high price of lithium resources limit the further advancement of LIBs for large-scale energy storage applications.[3] Therefore, attention is being concentrated on an alternative electrochemical energy storage device that features high safety, low cost, and long cycle life. Rechargeable aqueous zinc-ion batteries (ZIBs) is considered one of the most promising alternative energy storage systems due to the high theoretical energy and power densities where the multiple electrons ($Zn^{2+}$) . In addition, aqueous ZIBs are safer due to non-flammable electrolyte (e.g., typically aqueous solution) and can be manufactured since they can be assembled in ambient air conditions. [4] As an essential component in aqueous Zn-based batteries, the Zn metal anode generally suffers from the growth of dendrites, which would affect battery performance in several ways. Second, the led by the loose structure of Zn dendrite may reduce the coulombic efficiency and shorten the battery lifespan.[5]

Several approaches were suggested to improve the electrochemical stability of ZIBs, such as implementing an interfacial buffer layer that separates the active Zn from the bulk electrolyte.[6] However, the and thick thickness of the conventional Zn metal foils remain a critical challenge in this field, which may diminish the energy density of the battery drastically. According to a theretical calculation, the thickness of a Zn metal anode with an areal capacity of 1 mAh $cm^{-2}$ is about 1.7 μm. However, existing extrusion-based fabrication technologies are not capable of downscaling the thickness Zn metal foils below 20 μm.

Herein, we demonstrate a thickness controllable coating approach to fabricate an ultrathin Zn metal anode as well as a thin dielectric oxide separator. First, a 1.7 μm Zn layer was uniformly thermally evaporated onto a Cu foil. Then, $Al_2O_3$ , the separator was deposited through sputtering on the Zn layer to a thickness of 10 nm. The inert and high hardness $Al_2O_3$ layer is expected to lower the polarization and restrain the growth of Zn dendrites. Atomic force microscopy was employed to evaluate the roughness of the surface of the deposited Zn and $Al_2O_3$/Zn anode structures. Long-term cycling stability was gauged under the symmetrical cells at 0.5 mA $cm^{-2}$ for 1 mAh $cm^{-2}$. Then the fabricated Zn anode was paired with $MnO_2$ as a full cell for further electrochemical performance testing. To investigate the evolution of the interface between the Zn anode and the electrolyte, a home-developed in-situ optical observation battery cage was employed to record and compare the process of Zn deposition on the anodes of the $Al_2O_3$/Zn (demonstrated in this study) and the procured thick Zn anode. The surface morphology of the two Zn anodes after circulation was characterized and compared through scanning electron microscopy. The tunable ultrathin Zn metal anode with enhanced anode stability provides a pathway for future high-energy-density Zn-ion batteries.

1. Obama, B., The irreversible momentum of clean energy. *Science* **2017,** *355* (6321), 126-129.
2. Goodenough, J. B.; Park, K. S., The Li-ion rechargeable battery: a perspective. *J Am Chem Soc* **2013,** *135* (4), 1167-76.
3. Li, C.; Xie, X.; Liang, S.; Zhou, J., Issues and Future Perspective on Zinc Metal Anode for Rechargeable Aqueous Zinc-ion Batteries. *Energy & Environmental Materials* **2020,** *3* (2), 146-159.
4. Jia, H.; Wang, Z.; Tawiah, B.; Wang, Y.; Chan, C.-Y.; Fei, B.; Pan, F., Recent advances in zinc anodes for high-performance aqueous Zn-ion batteries. *Nano Energy* **2020,** *70*.
5. Yang, J.; Yin, B.; Sun, Y.; Pan, H.; Sun, W.; Jia, B.; Zhang, S.; Ma, T., Zinc Anode for Mild Aqueous Zinc-Ion Batteries: Challenges, Strategies, and Perspectives. *Nanomicro Lett* **2022,** *14* (1), 42.

6. Yang, Q.; Li, Q.; Liu, Z.; Wang, D.; Guo, Y.; Li, X.; Tang, Y.; Li, H.; Dong, B.; Zhi, C., Dendrites in Zn-Based Batteries. *Adv Mater* **2020,** *32* (48), e2001854.

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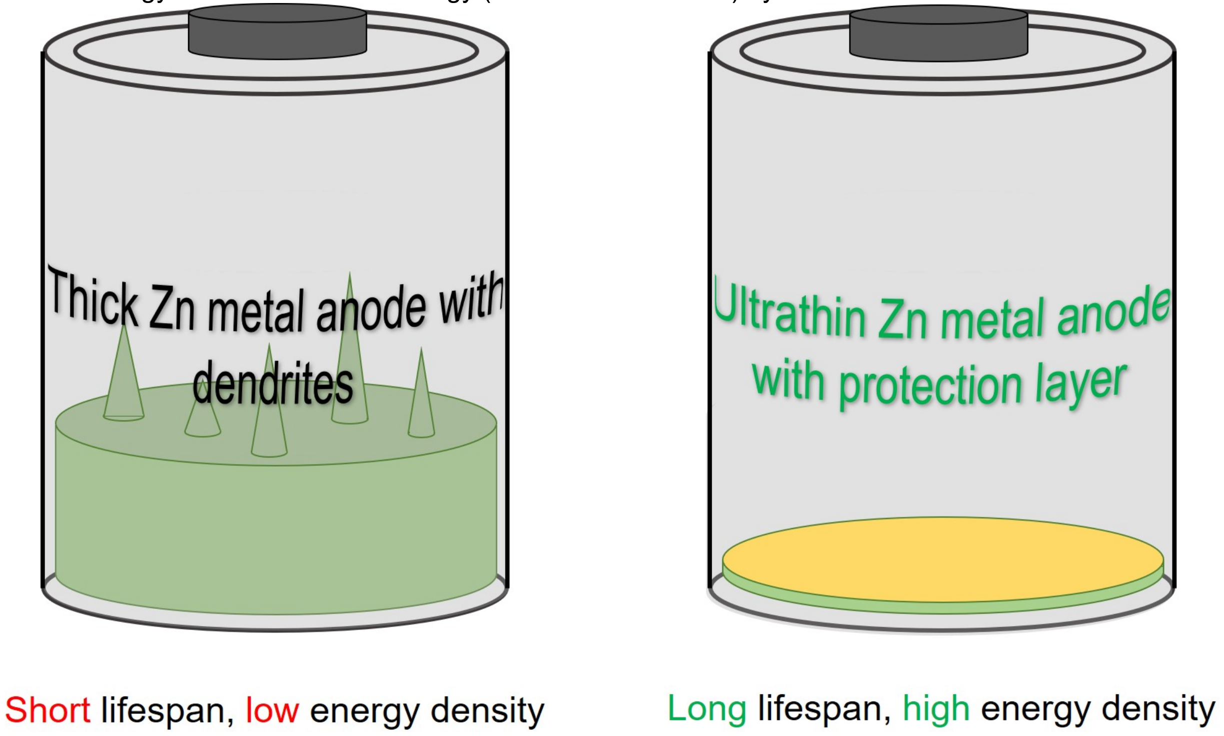


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