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Anode Modification in Zn-Ion Batteries Using Non-Stoichiometric SnOx (1 x â‰¤ 1.2) and Its Manufacturing Method

SnO interlayers steer Zn to (101) texture, suppressing dendrites and HER for >86% utilization, long life, and high-density Zn-ion batteries.

Zinc-ion batteries (ZIBs) utilizing mild aqueous electrolytes are promising for grid-level energy storage due to their high capacity, large abundance of component materials, and eco-friendliness, but their practical use is limited by issues such as dendrite growth, hydrogen evolution reaction (HER), and corrosion, which reduce reversibility and lifespan. Achieving a high Zn utilization ratio of over 80% in a battery is critical to overcoming these challenges and ensuring competitive performance when compared to more traditional batteries such as the lithium-ion and sodium-ion batteries. A key characteristic of plated Zn are the various crystallographic facets (002), (100), and (101) that are correlated to Zn stripping/plating behavior as well as side reactions.

Purdue researchers have developed a method for selectively inducing the growth of the Zn (101) orientation utilizing a non-stochiometric underlying tin oxide (SnO) interlayer. The use of the Zn (101) provides various advantages, such as faster mass transfer, lower overpotential at the Zn plating/stripping step and the elimination of HER. The Zn (101) with SnO demonstrates excellent electrochemical performance in half-cell tests, showing stable cycling for over 600 hours with an overpotential of 72 mV, indicating high efficiency and performance retention. The developed technology showcases potential for the development of next-generation ZIBs due to the high-capacity retention (81.6% after 200 cycles) in an anode-free system and the increased energy density over traditional ZIBs.

Related Publications: Spontaneous passivation of selective Zn(101) plating via dangling bond saturation and electrostatic interaction regulation for high-utilization, fast-kinetics zinc anodes.
https://doi.org/10.1039/D4EE05498A

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Technology Validation:

- Cyclic voltammetry was used to determine the effects of the SnO interlayers on the electrochemical deposition of Zn

- Galvanostatic cycling performance of various Zn and SnO interlayers was performed to determine cell performance

Advantages:

- Enhanced Zn utilization ratio (> 86%)

- Improved cycle life

- Reduced dendrite formation

- Decreased hydrogen evolution reactions

Applications:

- Zn-ion batteries

TRL: 3

Intellectual Property:

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