High-Voltage Aqueous Zinc-Hybrid Batteries

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Introduction

- Aqueous battery systems are beneficial above conventional Lithium-Ion Batteries in terms of safety, environmental impact and production requirements
- Hybrid-Ion Batteries can utilize the full electrochemical stability window of advanced gel or “water-in-salt” electrolyte concepts
- Hybrid-Ion concept → Different cations are involved in anode and cathode reaction

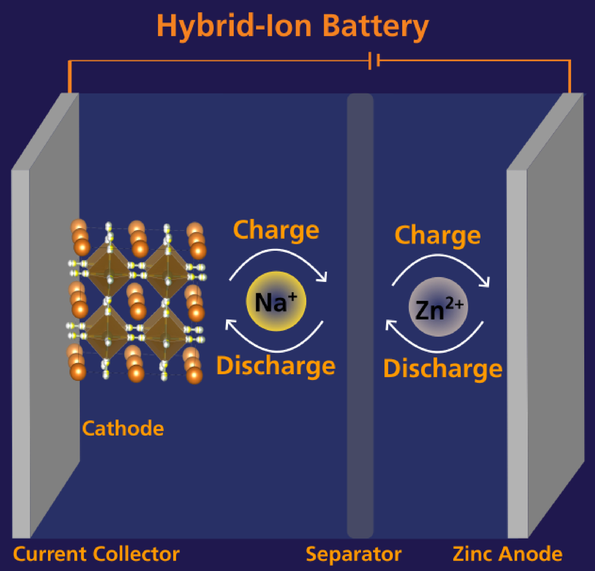
Objectives

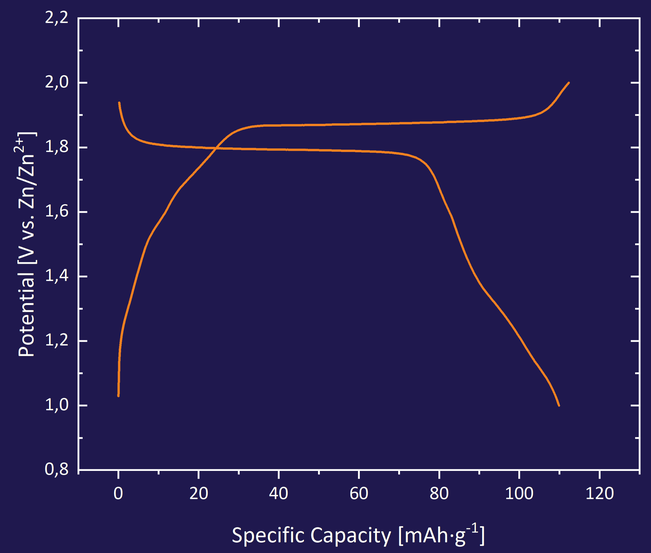
- Design of electrolytes that withstand potential above the stability window of water (1.23 V)
- Exploring cell chemistries that allow high potentials in a Hybrid-Zinc Ion Battery

Challenges

- Dendrite growth on the Zinc Anode limits the lifetime of traditional Zinc Ion batteries
- Corrosive nature of the electrolyte must be respected for selection of current collector and cell design

Hybrid-Ion Batteries utilize earth abundant materials **for** low-cost **energy storage.**





Hofmeister Series

$CO_3^{2-} > SO_4^{2-} > S_2O_3^{2-} > H_2PO_4^- > F^- > Cl^- > Br^- > NO_3^- > I^- > ClO_4^- > SCN^-$

Water structure maker: Kosmotropics — **Water structure breaker: Caotropics**

$N(CH_3)_4^+ > NH_4^+ > Cs^+ > Rb^+ > K^+ > Na^+ > Li^+ > Ca^{2+} > Mg^{2+} > Zn^{2+} > Ba^{2+}$

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Cathode Material

Prussian White: $Na_2MnFe[CN]_6$

- Very good ionic diffusion
- Abundant Materials
- Low environmental impact
- High Potential vs Zinc
- Simple Synthesis

Zinc Anode

- Abundant Material
- High capacity (820 $mAh \cdot g^{-1}$)
- Compatibility with aqueous electrolytes (SHE: -0.76 V SHE)

Electrolyte

- Utilization of aqueous electrolytes provide higher conductivity compared to organic electrolytes
- Caotropic anions increase the electrochemical stability window of the electrolyte
- Hybrid Electrolyte containing Na/Zn is needed for Hybrid Ion Batteries
- Implementation of gel or “water-in-salt” concepts for an improved electrolyte and anode stability

Research Focus

- Probe the intercalation mechanism → co-intercalation of Zn^{2+} / Na^+ in the cathode?
- Explore electrochemical storage mechanisms of aqueous hybrid ion systems

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