Zn-Air Batteries for Long-Duration Energy Storage

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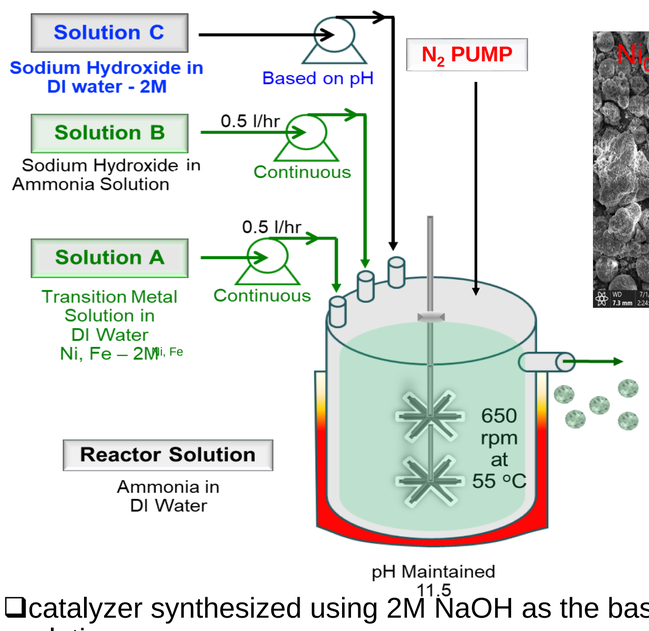
Motivation and Objectives

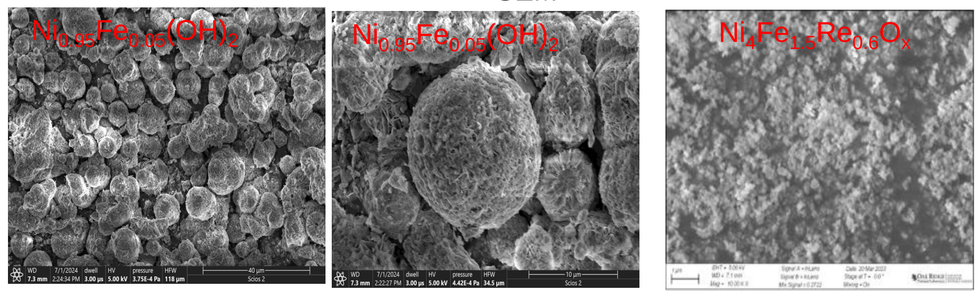
- Efficient use of renewable sources necessitates to develop a low-cost and sustainable energy storage technology.
- The proposed novel Zn-air battery (ZAB) system has a strong market demand because of its easily maintained supply chain, low-cost ($10 KW h), high-energy density (1086 Wh kg^{-1}).
- Major short comes of Zn-air battery are severely limited operating life and low round trip energy efficiency.
- Need to overcome key challenges related to material development, processing, electrode and electrolyte design, and cell engineering that hinder the practical applicability of these novel Zn-air batteries.
- Scale up the synthesis of low-cost PGM free bifunctional electrocatalysts.
- Developing a cross-linking composite polymer membrane that enables to minimize the water loss and keeps the high conductivity.
- The goal is to develop a low cost, critical material free, multifunctional ZAB prototype that can be integrated into renewable energy technology platforms to enable long duration energy storage.

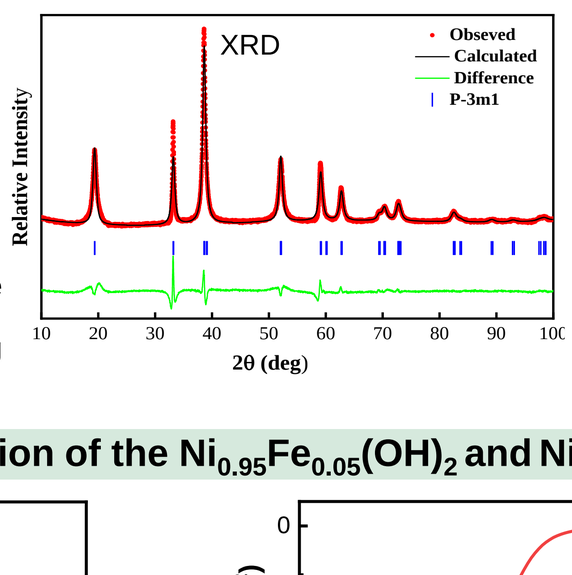
Synthesis of bifunction electrocatalysts

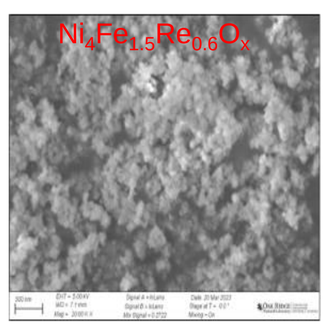
Synthesis of $Ni_{0.95}Fe_{0.05}(OH)_2$ and $Ni_4Fe_{1.5}Re_{0.6}O_x$ by coprecipitation and solution process



SEM

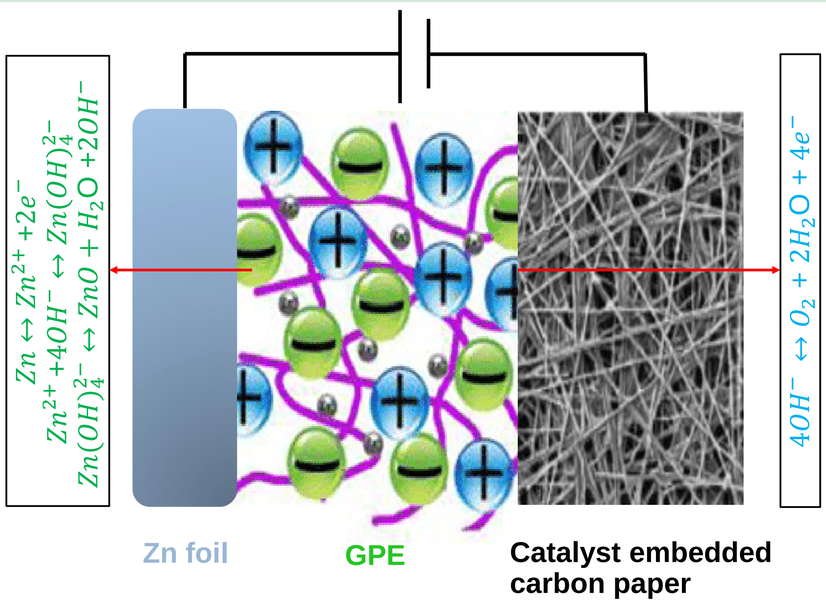




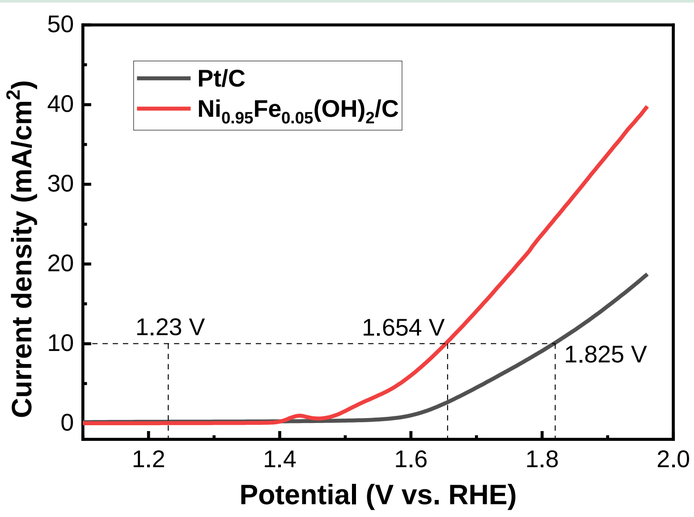


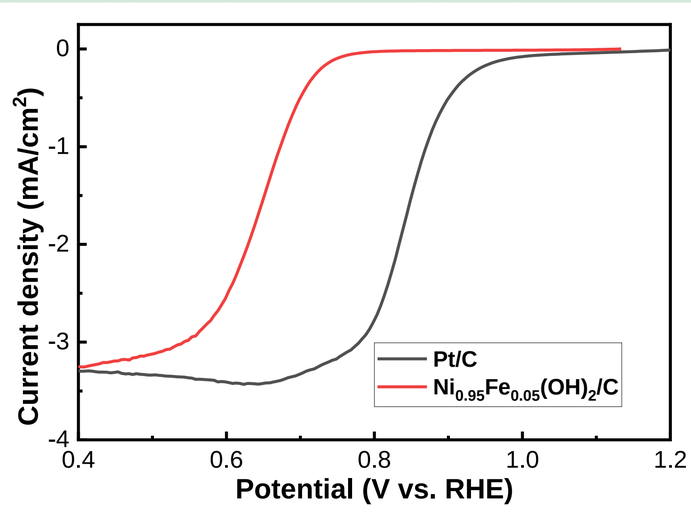
- ❑catalyzer synthesized using 2M NaOH as the base solution
- ❑N_2 gas pumped to avoid iron oxidation – Improving morphologies

Zn-air battery cell



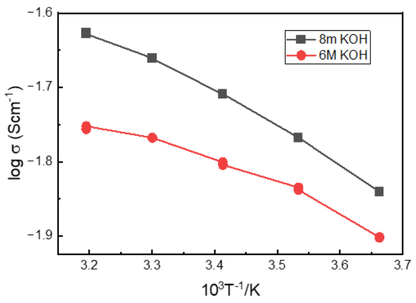
Electrochemical characterization of the $Ni_{0.95}Fe_{0.05}(OH)_2$ and $Ni_4Fe_{1.5}Re_{0.6}O_x$



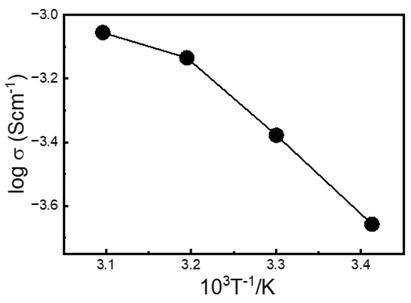


OER overpotential value for $Ni_{0.95}Fe_{0.05}(OH)_2$/C: 424 mV and Pt/C: 595 mV at 10 mA/cm², respectively.
ORR performance were evaluated in O_2 saturated 0.1 M KOH, showing $E_{1/2}$ at 0.645 V and 0.852 V.

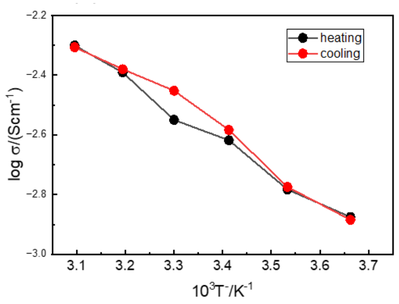
Conductivity and electrochemical stability of fabricated composite gel polymer electrolyte (GPE)



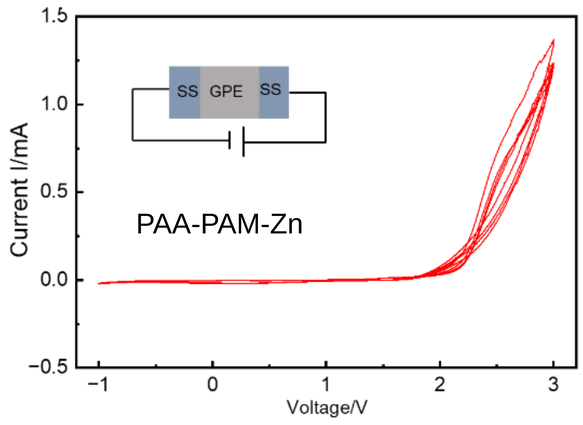
Conductivity of PAA with 8M KOH solution and higher water content

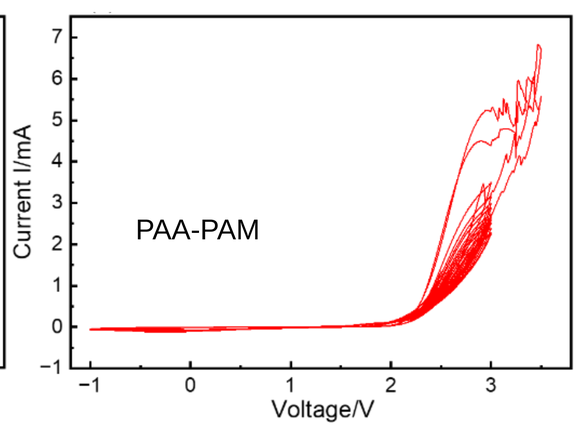


Conductivity of PAA with 8M KOH solution minimum water content

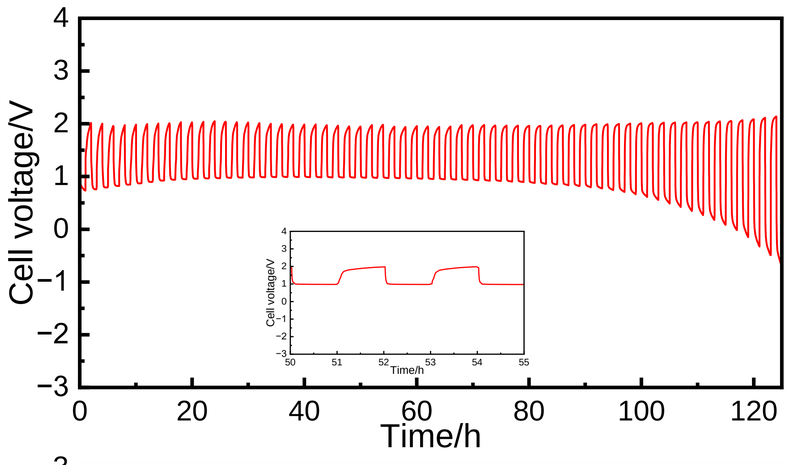


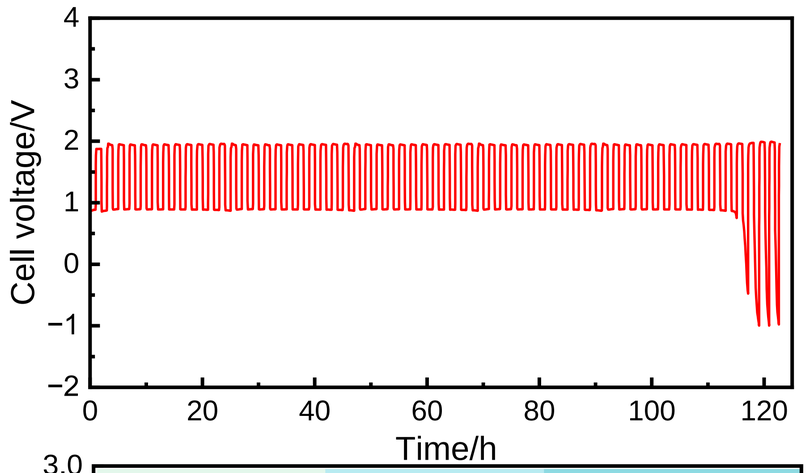
PAA + PAM and 5% $ZnCl_2$ with minimum water content

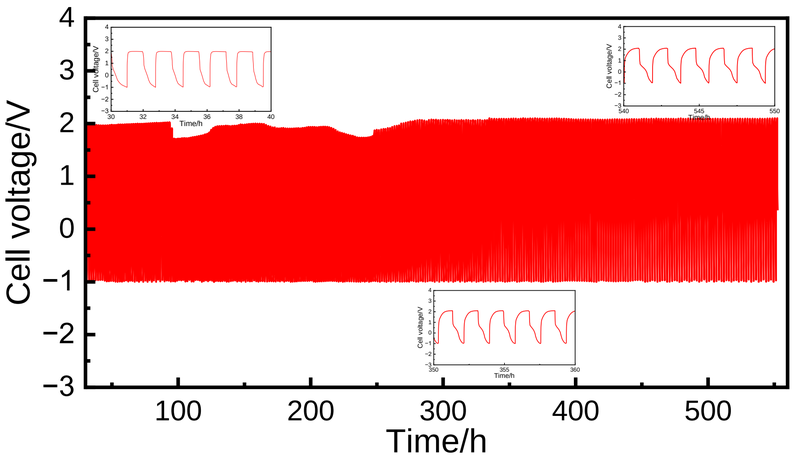


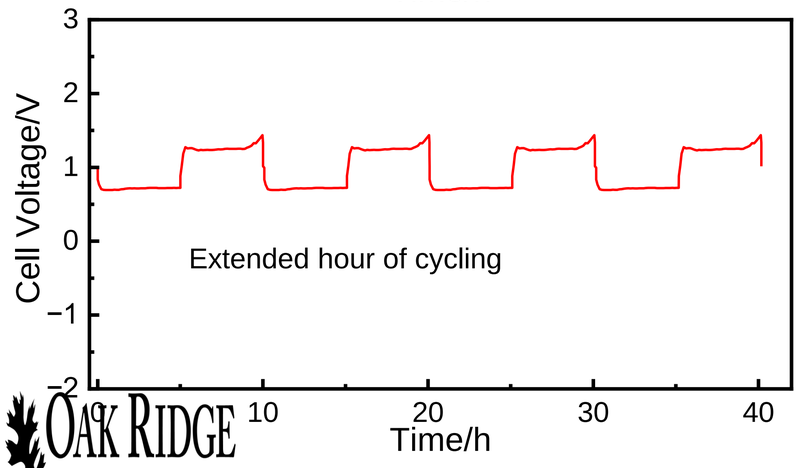


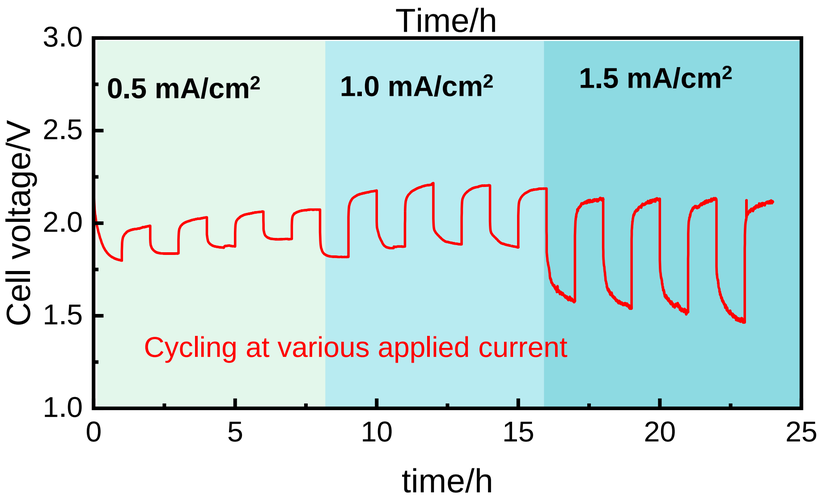
Electrochemical cycling performance of Zn-air battery using $Ni_{0.95}Fe_{0.05}(OH)_2$ as a catalyst and PAA-PAM with 5% $ZnCl_2$ GPE











- ❖ Both $Ni_{0.95}Fe_{0.05}(OH)_2$ and $Ni_4Fe_{1.5}Re_{0.6}O_x$ exhibit similar catalytic activity for OER and ORR.
- ❖ Cross linking composite gel polymer electrolyte shows better performance due to higher water retention ability.
- ❖ Better cycling performance is obtained for composite GPE and $Ni_{0.95}Fe_{0.05}(OH)_2$ catalyst.
- ❖ Two voltage steps slope is appeared due to the new interphase formation.

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