UNIVERSITY OF CALIFORNIA SANTA CRUZ OFFICE OF RESEARCH

Zinc-Iodine Battery with improved Coulombic efficiency

Tech ID: 33095 / UC Case 2021-583-0

BACKGROUND

Aqueous rechargeable zinc-based batteries (ARZBs) are promising candidates for next-generation grid storage and battery-buffered charging stations due to many characteristics. These include their relative safety, low cost, and high power density. Researchers have developed various ARZBs, including Zn-ion batteries, alkaline Zn-based batteries, and Zn-based redox flow batteries, among others. Zinc-iodine ($Zn\text{-}I_2$) redox flow batteries have generated the most interest. These use using ZnI_2 aqueous solution as an electrolyte and offer impressive theoretical capacity (211 mAh per gram of iodine, 820 mAh per gram of zinc) and energy density (322 Wh L_{-1}). This is thought to be due to the high solubility of ZnI_2 (up to 7 M) and multi-electron conversion reactions that occur during charge/discharge. During charging, metallic zinc is electrodeposited on the anode ($Zn^{2+} + 2e^- \rightarrow Zn$), while iodine is generated at the cathode and spontaneously transformed into highly soluble triiodide (I^{3-}) ions with the presence of iodide (I^-) ions ($2I^- \rightarrow I_2 + 2e^-$; $I_2 + I^- \rightarrow I_3^-$). The reverse reactions occur during discharge.

Static $Zn\text{-}I_2$ batteries (ZIBs) have been designed to overcome many hurdles of flow batteries. A remaining challenge is the self discharge caused by the shuttling of I_3^- ions to the zinc anode. This results in low Coulombic efficiency. Other strategies to address this challenge include physically blocking the I_3^- shuttling with an ion selective membrane (e.g. Nafion), but this increases the device cost and inner resistance. Another alternative is to encapsulate the I2 in microporous carbon and use another solution as an electrolyte. While this results in improved Coulombic efficiency, the total capacity and energy density are reduced.

TECHNOLOGY DESCRIPTION

The solution to the problem was a double layered cathode that includes a conductive layer serves as a cathodic current collector and an adsorptive layer.

During charging, the oxidation of I^- takes place at the interface between the conductive layer and the adsorptive layer. I^- in the solution transfer electrons to the conductive layer and spontaneously form adsorbed I_3^- ions at the absorptive layer interface. Adsorbed I_3^- ions can diffuse into the bulk structure of the adsorptive layer following the concentration gradient and reexpose the adsorptive layer/conductive layer interface to collect newly formed I_3^- ions.

During discharge, adsorbed I_3^- ions will be reduced to I^- ions at the interface between the conductive layer and the adsorptive layer.

So the presence of an adsorptive layer can suppress I_3^- shuttling and improve Coulombic efficiency without changing battery capacity.

In a proof of concept experiement, carbon cloth can be used as the conductive layer, while the adsorptive layer can be any of a number of materials including conducting polymers such as polypyrrole (PPy), polyaniline (PANi), and poly(3,4-ethylenedioxythiophene) (PEDOT) as well as metallic comipounds.

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OTHER INFORMATION

KEYWORDS

Zinc based battery, Rechargeable battery, Aqueous rechargeable zinc based battery, Zinc-iodine, Zinc-iodine battery, Zinc-iodine redox flow battery, Coulombic efficiency, Double layered cathode

CATEGORIZED AS

- **Energy**
  - Storage/Battery

RELATED CASES

2021-583-0

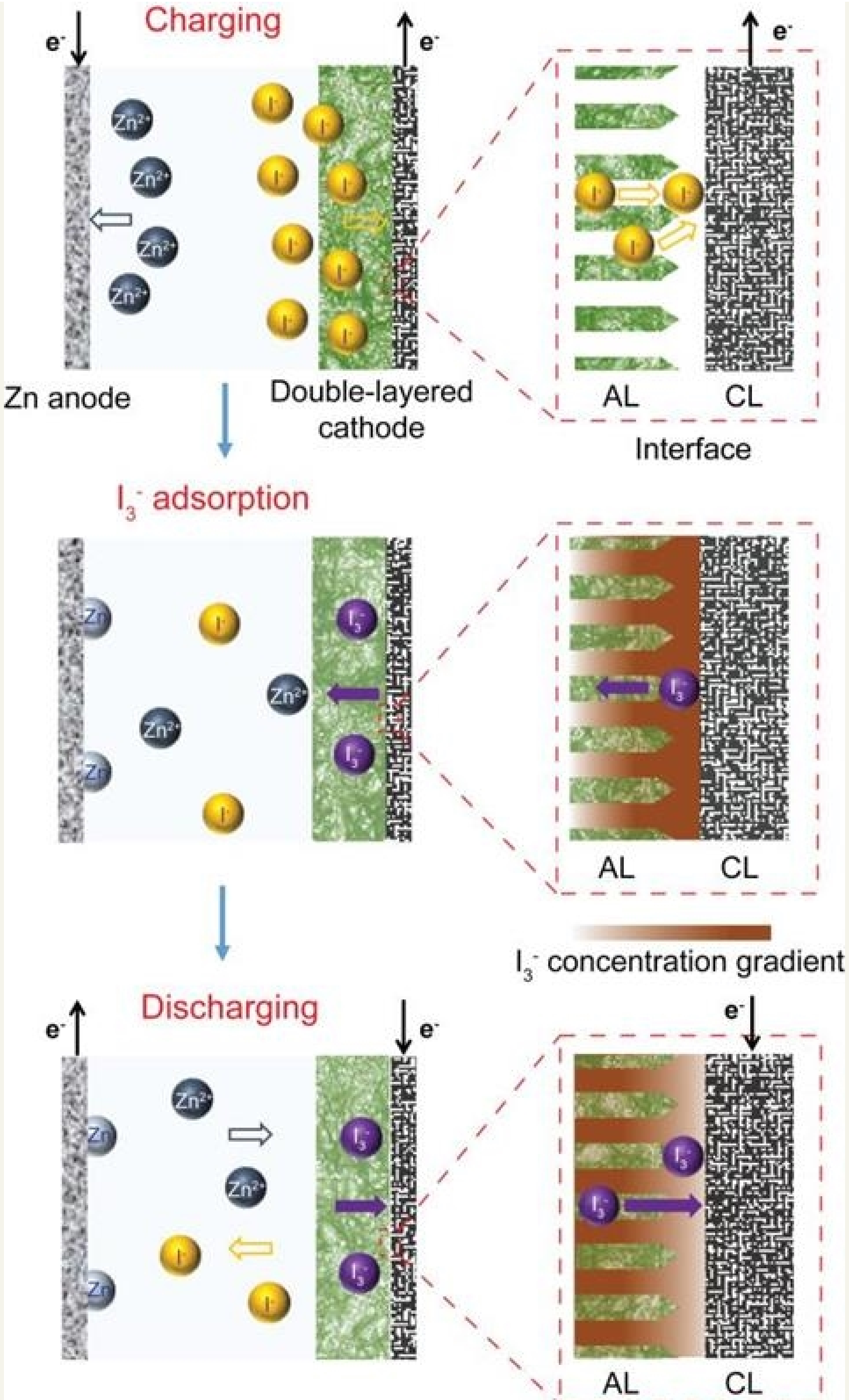

Figure 1

APPLICATIONS

Rechargeable batteries

Energy storage

Grid storage

ADVANTAGES

Improved Coulombic efficiency without loss of capacity

INTELLECTUAL PROPERTY INFORMATION

Country	Type	Number	Dated	Case
United States Of America	Published Application	20220336866	10/20/2022	2021-583

Additional Patent Pending

RELATED MATERIALS

- Prototypical Study of Double-Layered Cathodes for Aqueous Rechargeable Static Zn–I2 Batteries - 05/03/2021

ADDITIONAL TECHNOLOGIES BY THESE INVENTORS

- Carbon-Doped NiO Catalyst For Hydrogen Evolution Reaction
- Z-Scheme Microbial Photoelectrochemical System (Mps) For Wastewater-To-Chemical Fuel Conversion
- Hydrogen-Treated Semiconductor Metal Oxides For Photoelectrochemical (PEC) Water Splitting
- Self-Biased and Sustainable Microbial Electrohydrogenesis Device
- Three-Dimensional Hierarchical Porous Carbon Foams For Supercapcitors

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