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RESEARCH ARTICLE

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A dendrite free Zn-Fe hybrid redox flow battery for renewable energy storage

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Abstract

About two thirds of global greenhouse emissions is caused by burning of fossil fuels for energy purposes and this has spurred great research interest to develop renewable energy technologies based on wind, solar power, and so on. Redox flow batteries (RFB) are receiving wide attention as scalable energy-storage systems to address the intermittency issues of renewable energy sources. However, for widespread commercialization, the redox flow batteries should be economically viable and environmentally friendly. Zinc based batteries are good choice for energy storage devices because zinc is earth abundant and zinc metal has a moderate specific capacity of 820 mA hg^{-1} and high volumetric capacity of 5851 mA h cm^{-3}. We herein report a zinc-iron (Zn-Fe) hybrid RFB employing Zn/Zn(II) and Fe(II)/Fe(III) redox couples as positive and negative redox systems, respectively, separated by a self-made anion exchange membrane (AEM). The battery delivers a good discharge voltage of approximately 1.34 V at 25 mA cm^{-2}, with a coulombic efficiency (CE) of 92%, voltage efficiency (VE) of 85% and energy efficiency (EE) of ~78% for 30 charge-discharge cycles. Repeated galvanostatic charge/discharge cycles show no degradation in performance, confirming the excellent stability of the system. A key advancement in the present Zn-Fe hybrid redox flow battery with AEM separator is that no dendrite growth was observed on zinc electrode on repeated charge-discharge cycles, which was the serious drawback of many previously reported zinc based redox flow batteries.

KEYWORDS

anion-exchange membrane, dendrite growth suppression, energy storage, redox flow battery, renewable energy, zinc deposition

1 | INTRODUCTION

Global climate change resulting from greenhouse emissions is causing increasingly severe risks for ecosystems, human safety and health. This combined with the large-scale demand for electricity expected during the coming decades has aroused great interest in the development of new technologies for energy production from renewable energy sources, such as wind, solar, and so on. However, these renewable energy sources are intermittent in nature and hence the success of these new renewable energy harvesting technologies needs to be associated with the introduction of competitive energy storage devices for grid scale energy storage. Unlike traditional batteries, the

