Sustainable Self-Charging Aqueous Zinc-Ion Battery Using CaVO Nanostructures Prepared From Recycled Mortar

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The escalating global energy demand necessitates innovative and efficient storage solutions. However, conventional energy storage devices often require external charging, which can be problematic in remote locations, during emergencies, or in applications demanding continuous, autonomous operation. Developing self-charging batteries not only enhances operational independence but also contributes to a more sustainable energy ecosystem by reducing reliance on external power grids. The purpose of this study is to develop a sustainable aqueous zinc-ion battery (AZIB) incorporating recycled mortar and evaluate its self-charging capabilities through redox reactions and its electrochemical performance. This research employed a sustainable method, extracting calcium hydroxide from recycled mortar using a water-soluble process. The extracted calcium hydroxide and vanadium pentoxide were then synthesized into $CaV_6O_{16}•2.8H_2O$ (CaVO) nanostructures cathode material via a one-step hydrothermal reaction. The resulting materials structure and morphology were thoroughly characterized. Electrochemical testing demonstrated the battery's self-charging capability, driven by inherent redox reactions between oxygen and vanadium species. Galvanostatic charge-discharge (GCD) and cyclic voltammetry (CV) analyses revealed a significant enhancement in performance compared to traditional CaVO derived from unsustainable means. Specifically, the developed battery achieved a discharge capacity of 155 mAh/g, a 36% increase, while maintaining a 99% Coulombic efficiency over extended cycling. This research showcases the potential of utilizing construction waste to create high-performance, self-charging AZIBs, offering a sustainable and efficient solution for advanced energy storage applications

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