Title : Development of Zinc Powder Anode for Liquid Zinc-Air Batteries Using Polyvinyl Alcohol as a Binder

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ABSTRACT

This research aims to enhance the mechanical stability and electrochemical performance of zinc powder anodes for liquid-electrolyte zinc-air batteries by employing polyvinyl alcohol (PVA) as a binder. The study initially involved physical characterization to determine the particle size of the zinc powder. Subsequently, anodes were fabricated using pure zinc powder and zinc-PVA composites at varying ratios (0, 0.025, 0.050, 0.075, and 0.100). The mixture was molded into 3 x 3 cm^2 electrodes using a hydraulic press at 800 psi. The mechanical integrity was evaluated via a three-point bending test, complemented by an analysis of the electrochemical properties to assess practical application feasibility. Morphological analysis using optical microscopy (OM) and scanning electron microscopy (SEM) revealed that increasing PVA content significantly improved zinc powder distribution and reduced inter-particle porosity. Samples PVA0.075 and PVA0.1 exhibited high surface continuity as the polymer film effectively coated and bonded the gaps between zinc particles. This modification directly influenced fracture behavior; while the binder-free sample (PVA0) demonstrated distinct brittle fracture and powder delamination, the PVA-enhanced samples inhibited crack propagation through a polymeric bridging mechanism. This mechanism effectively maintained the structural

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integrity of the anode. Electrochemical testing indicated that higher PVA ratios led to an increase in open-circuit voltage (OCV) and improved efficiency in maintaining voltage and capacity during charge-discharge cycles, thereby extending battery lifespan. However, a decrease in power density was observed with higher binder content. All ratios yielded a consistent specific capacity of approximately 819 mAh/g. In conclusion, PVA serves as an effective binder that enhances both the mechanical robustness and electrochemical stability of zinc-air batteries, offering a promising pathway for high-performance battery development.

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