Influence of Polyvinyl Pyrrolidone (PVP) on Vanadium-based Compound Composite Performances for Aqueous Zinc-Ion Batteries

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Aqueous zinc-ion rechargeable batteries are potential candidates that are widely used in large-scale energy storage fields owing to their high safety, acceptable energy density, and low cost. However, the strong electrostatic interaction between divalent Zn^{2+} and the host lattice leads to slow reaction kinetics and poor reversibility of Zn^{2+} insertion/extraction. In this study, vanadium-based compound composites with the main phase of $\text{Zn}_2\text{V}_2\text{O}_7$ consisting of ZnV_2O_6 and ZnV_2O_4 was synthesised by a simple hydrothermal method using polyvinyl pyrrolidone (PVP) as a surfactant to adjust the morphology. Meanwhile, PVP molecules cause a change in the coordination environment of atoms in the crystal lattice of the samples and reduce the high-valence state of V to the low-valence state, forming a hybrid valence, which is beneficial to the multi-step reaction of vanadium. As expected, the vanadium-based compound composite displays an initial discharge capacity of 386 mA h g^{-1} at 300 mA g^{-1} and a discharge capacity of 114 mA h g^{-1} at 3 A g^{-1} with 64% reversible capacity after 4000 cycles, exhibiting good long-term cycle life. The excellent electrochemical performance of vanadium-based compounds is due to the good dispersion and hybrid valence, which contributes to the high ion-diffusion coefficient as well as to the deep insertion and extraction of Zn^{2+} .

Keywords: vanadium-based compounds composite; cathode; aqueous zinc-ion batteries; electrochemical performance

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