Materials Proceedings

Abstract

Phosphating constructed stable and high conductivity vanadium oxide enabling high-rate long-life aqueous zinc-ion battery

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Abstract: The phosphating process has been devoted to optimizing the electrochemical performance of vanadium oxide electrode for zinc-ion batteries. The $NH_4V_4O_{10}$ is modified by the interlayer phosphate groups and oxygen defects （P-NVO-2） through phosphating, which provide the electrode material with a stable structure, large interlayer spacing, and high conductivity. The phosphate groups and oxygen vacancies widen the interlayer spacing, cause lattice distortion and provide shortcuts for electrolytes, conducing to the ion diffusion kinetics. The phosphate groups immobilize the interlayer intrinsic ammonium ions and prevent the irreversible phase transition of P-NVO-2 during the cycle. Combined with the kinetics analysis, appropriate phosphate groups and oxygen defects reduce the migration barrier, improve the electronic conductivity and afford extra electrons. Besides, it is found that the cathode after phosphating exhibit intercalation pseudocapacitive behavior, thus resulting in superior performance. Therefore, P-NVO-2 electrode delivers an outstanding specific capacity of 433.7 mAh g^{-1} at 0.5 A g^{-1}, excellent rate performance of 300.9 mAh g^{-1} at 10 A g^{-1}, and high capacity retention of 95.1% after 7000 cycles at 10 A g^{-1}. In addition, P-NVO-2 also exhibits brilliant electrochemical performance when applied to the flexible soft-packaged battery, confirming the application potential. Therefore, the exploration of P-NVO-2 material with appropriate phosphate and oxygen vacancies supply a prospective approach for designing high-rate and long-cyclicality zinc-ion batteries.

Keywords: Phosphate groups; Oxygen vacancies; Vanadium oxides; Structural stability; Zinc-ion battery

Citation: Zhang , X. Phosphating constructed stable and high conductivity vanadium oxide enabling high-rate long-life aqueous zinc-ion battery. *Mater. Proc.* **2023**, *4*, x. https://doi.org/10.3390/xxxxx

Published: 5 March