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High-capacity zinc vanadium oxides with long-term cyclability enabled by in-situ electrochemical oxidation for zinc-ion batteries

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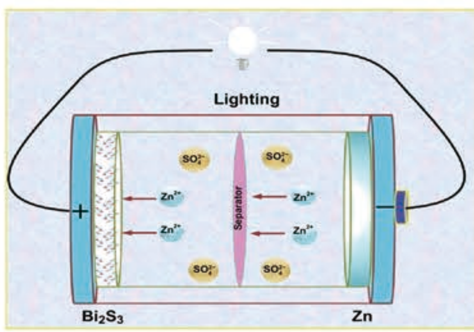
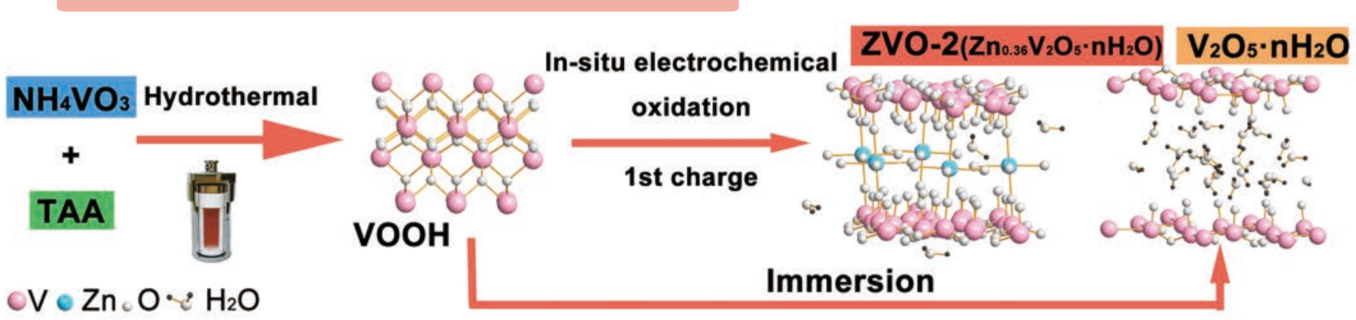
Introduction

- The rechargeable aqueous zinc ion batteries hold great promise but are extremely limited by the lack of suitable cathodes.
- The instability and poor conductivity of vanadide need to be solved.
- The introduction of metal ions act as “pillars” at interlayers of host materials is an effective modification strategy.
- This work obtained vanadium oxides with different interlayer zinc doping amount through in-situ electrochemical oxidation.



Experiment and Materials



Scheme 1. Schematic diagram of preparation of VOOH and conversion from VOOH to ZVO and $V_2O_5 \cdot nH_2O$.

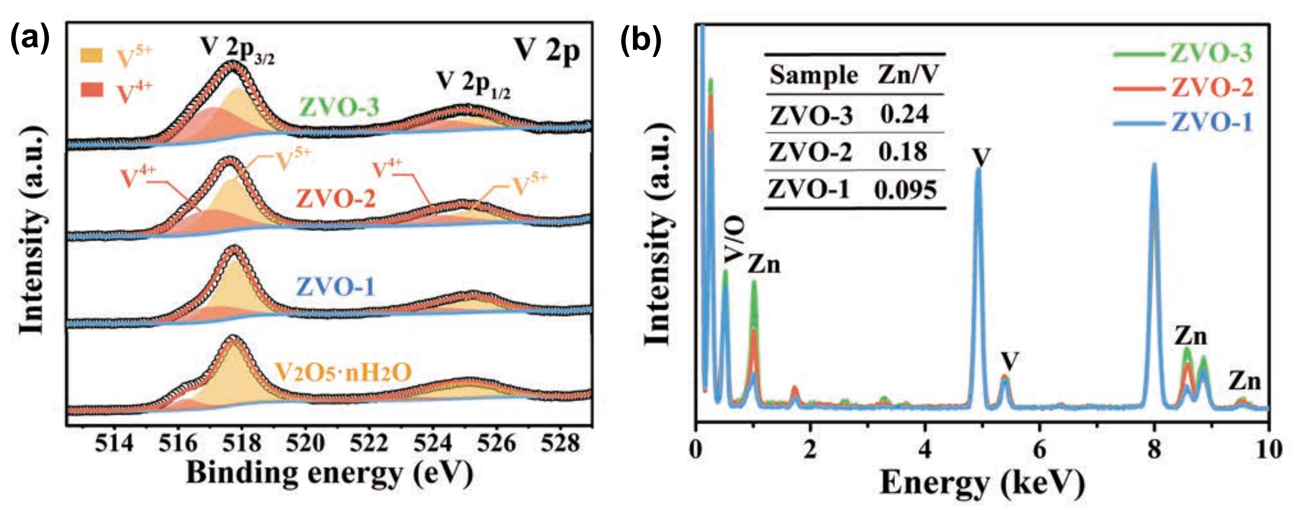


Fig 1. V 2p spectra of ZVO and $V_2O_5 \cdot nH_2O$ (a) and EDS spectra of ZVO (b).

Electrochemcial properties

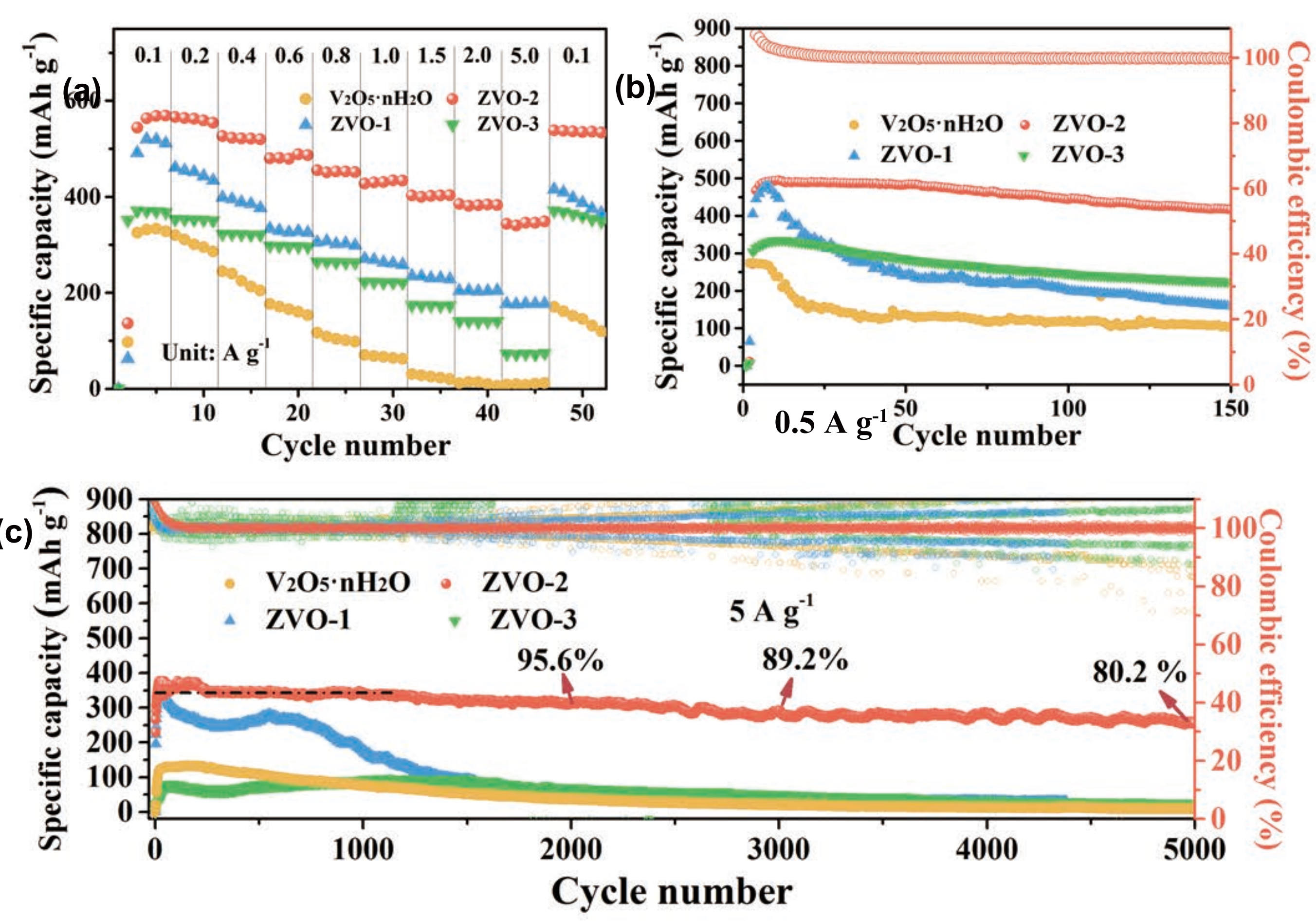


Fig 2. Electrochemical properties of ZVO and $V_2O_5 \cdot nH_2O$ (electrochemical chain: Zn foil|3 M $Zn(OTf)_2$|ZVO or $V_2O_5 \cdot nH_2O$). (a) Rate performance of ZVO and $V_2O_5 \cdot nH_2O$.(b) Cyclability of ZVO and $V_2O_5 \cdot nH_2O$ at 0.5 A g^{-1}. (c) Cyclability of ZVO and $V_2O_5 \cdot nH_2O$ at 5 A g^{-1}.

Mechanism analysis

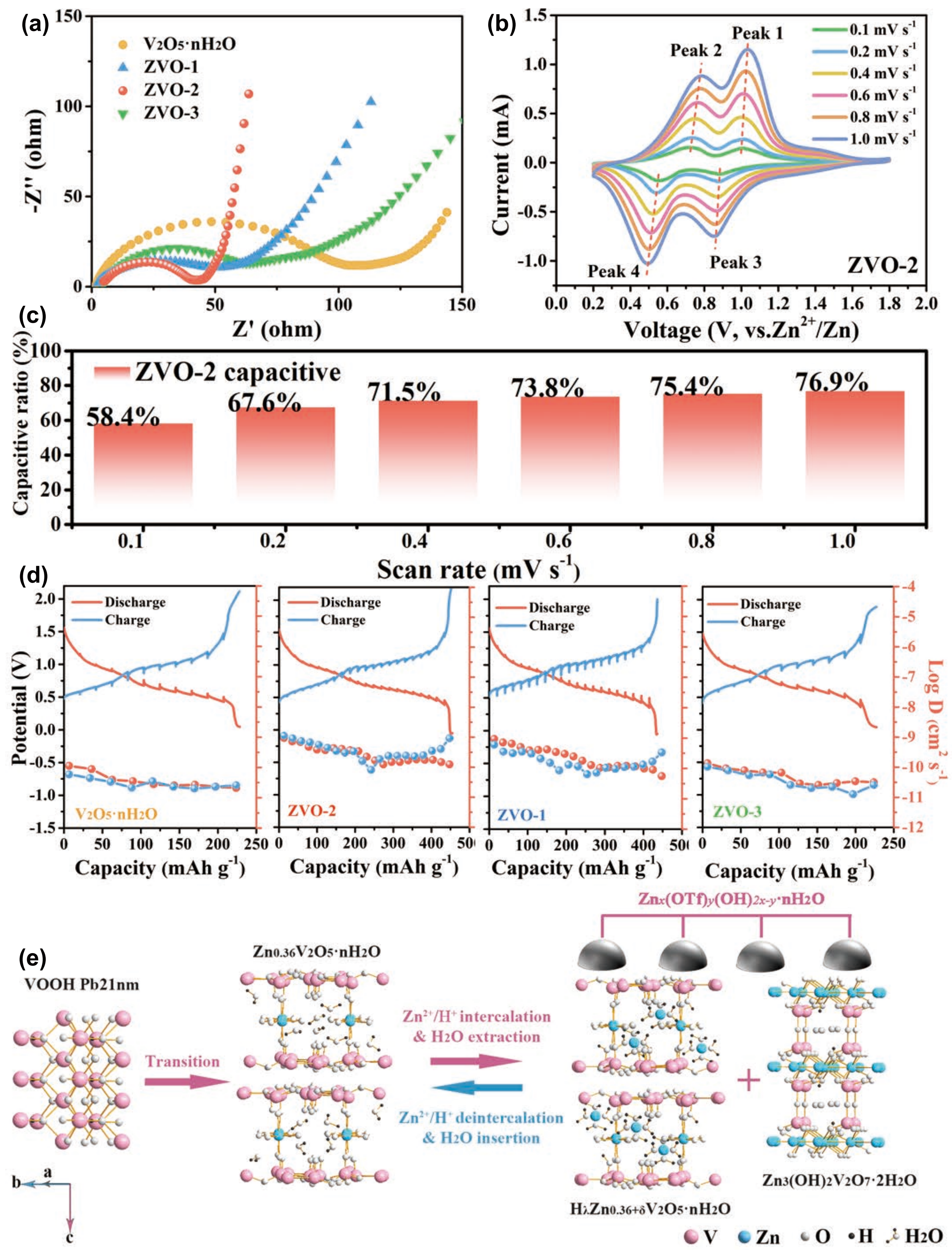


Fig 3. EIS patterns of all samples (a), CV profiles of ZVO-2 at different scan rates (b), the contribution ratio of capacitive capacities in ZVO-2.(c), GITT profiles and diffusion coefficients of all samples (d), Schematic diagram of the Zn^{2+}/H^+ insertion mechanism on ZVO-2 cathode (e).

Conclusions

- Zinc-inserted hydrated vanadium oxides are converted from VOOH in various phases through in-situ electrochemical oxidation.
- ZVO with appropriate zinc doping amount demonstrates best electrochemcial properties (508.3 mAh g^{-1} (0.5 A g^{-1}), 80% retention after 5000 cycles, 348.6 mAh g^{-1} at 5 A g^{-1}).
- The [ZnO] polyhedrons act as “interlayer pillars” to brace the entire structure and retain open channels for active Zn^{2+}.
- The robust structure restrains the consumption of active materials and the accumulation of undesired by-products.

Reference

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[2] D. Kundu, B. D. Adams, V. Duffort, S. H. Vajargah, L. F. Nazar, Nat. Energy 1 (2016) 16119.

Acknowledgments

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