Conductive metal organic framework intercalated vanadium oxide cathode with the dual energy-storage mechanism for high capacity and long lifespan aqueous zinc-ions batteries

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Introduction

Vanadium-based materials are promising cathodes for aqueous zinc-ion batteries (ZIBs), but their poor cycling stability and sluggish Zn^{2+} migration kinetics limit their electrochemical performance. Herein, a conductive metal-organic frameworks (MOFs) intercalated vanadium oxide cathode with a dual energy-storage mechanism is designed and prepared for high specific capacity and long lifespan ZIBs. The intercalated Ni-BTA (BTA: 1,2,4,5-benzenetetramine) can not only enlarge the interlayer spacing of vanadium to improve the Zn^{2+} migration kinetics, but also as the active materials to participate the storage of Zn^{2+}. This cathode material exhibits an improved specific capacity of 439.3 mAh g^{-1} at 0.2 A g^{-1} and excellent long cycle durability over 1000 cycles at 5 A g^{-1} with a capacity retention of 82.0%. This work of constructing a conductive MOF intercalated vanadium oxide cathode material with a dual energy-storage mechanism paves a novel way for high-energy secondary batteries.

Results & Discussion

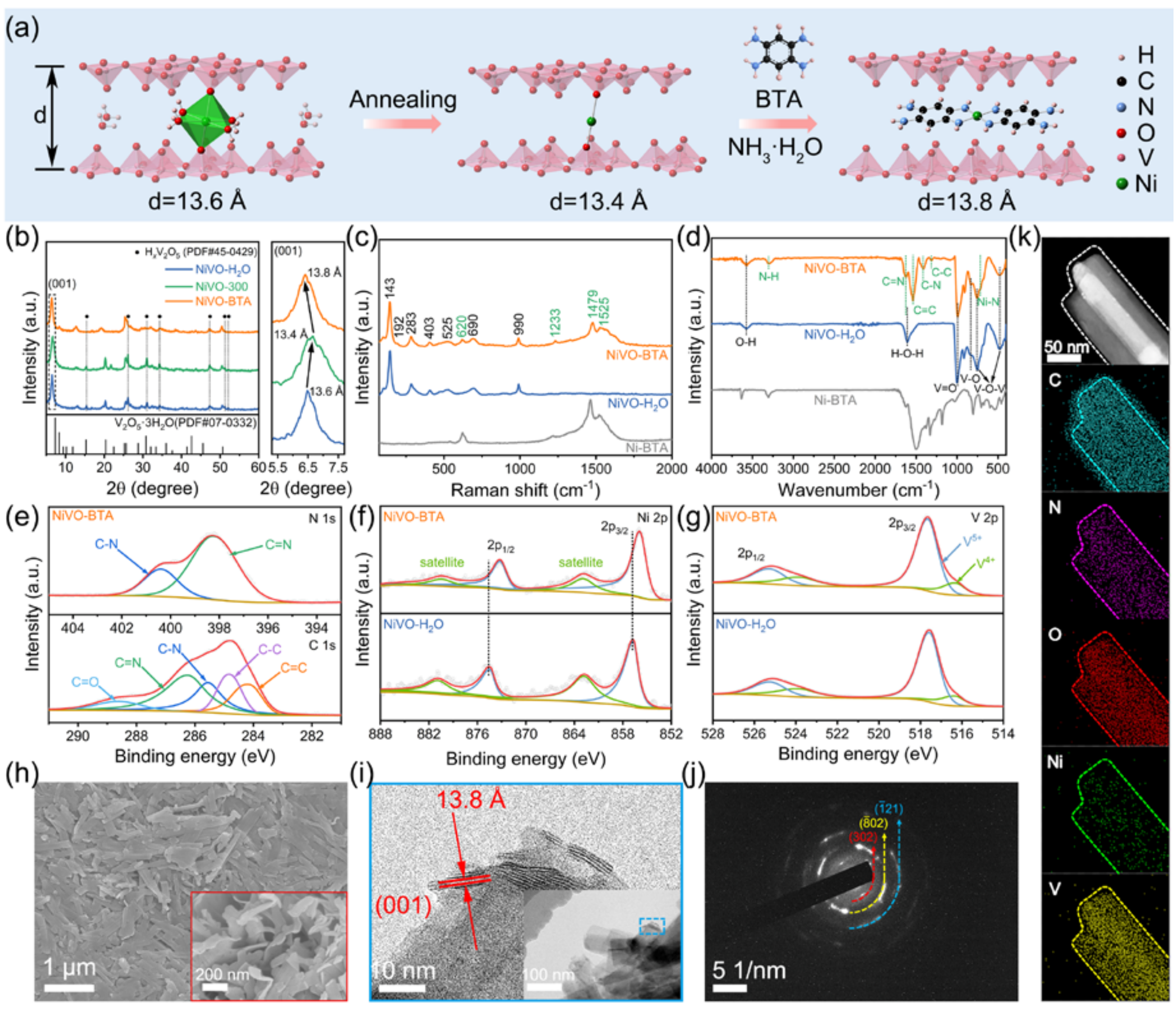

Fig. 1. Characterizations of NiVO-BTA and NiVO-H_2O materials.

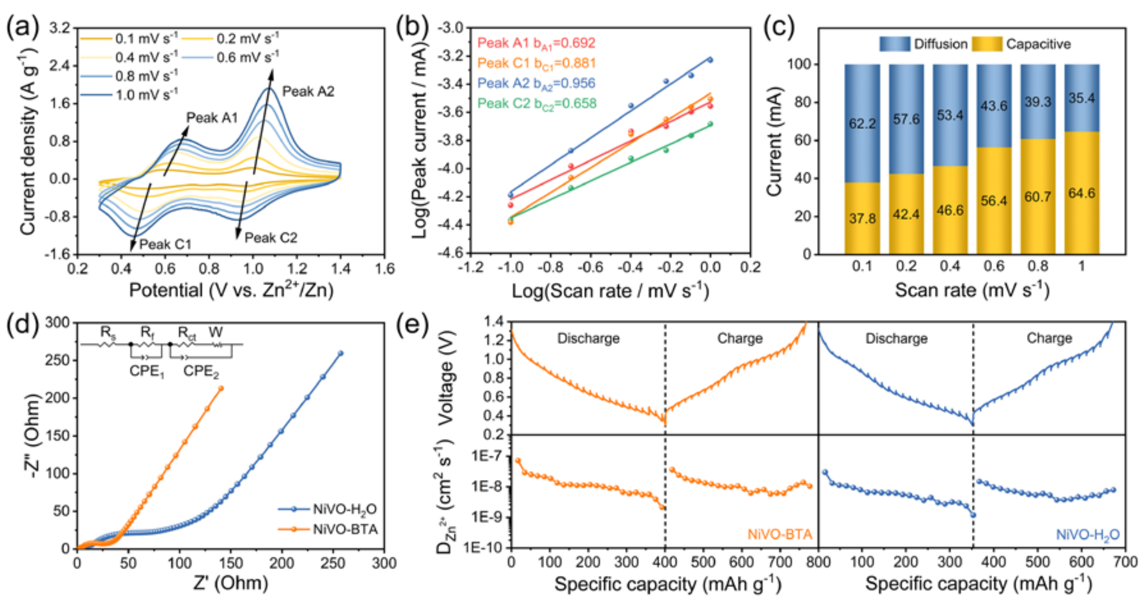

Fig. 3. Electrochemical kinetics analysis of the NiVO-BTA and NiVO-H_2O cathodes.

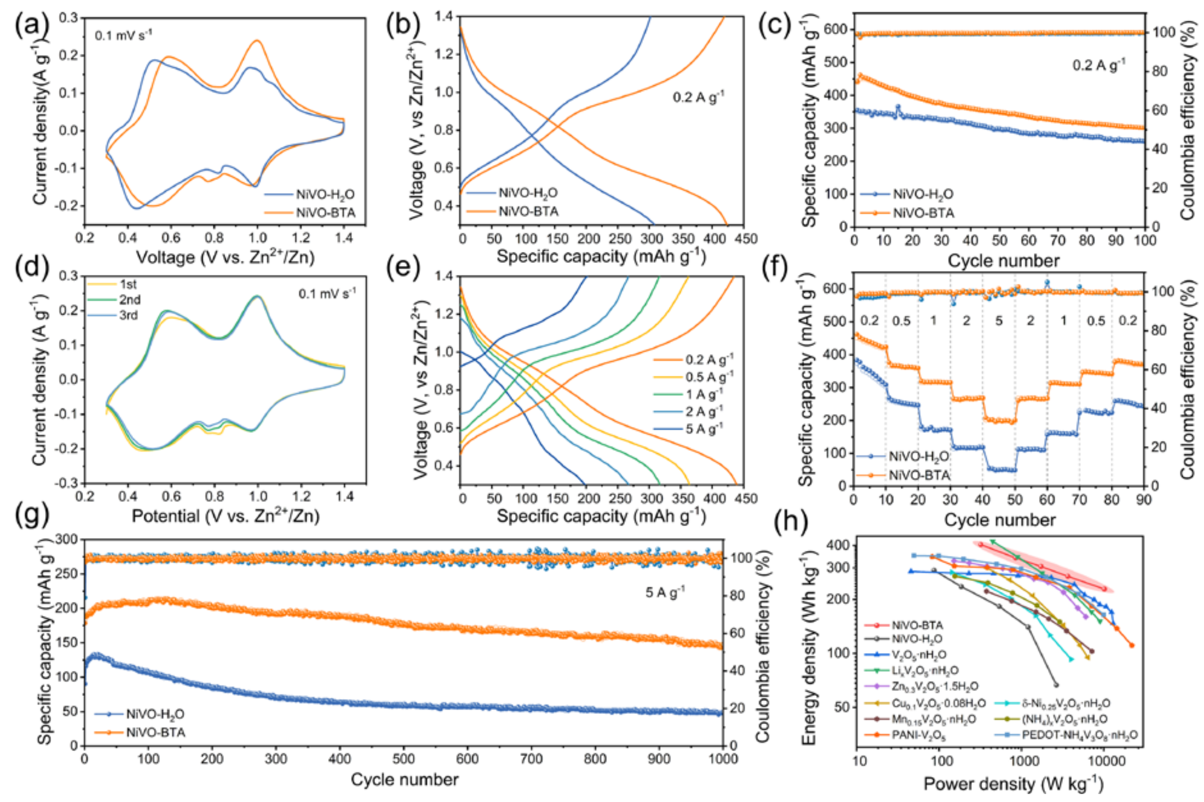

Fig. 2. Electrochemical Zn-ion storage performance using NiVO-BTA and NiVO-H_2O cathodes.

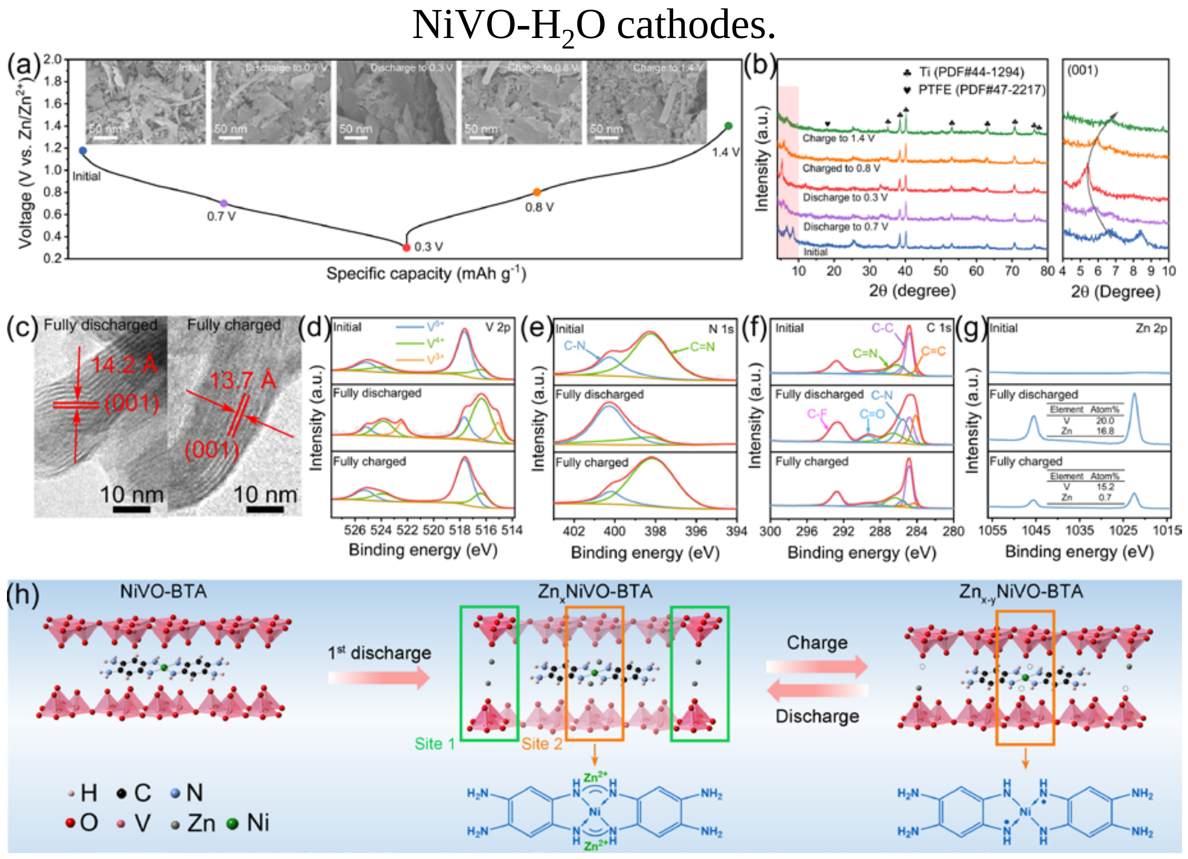

Fig. 4. Zinc-storage mechanism investigations in the NiVO-BTA cathode.

Conclusions

- The precisely intercalation of conductive MOFs into vanadium oxide nanosheets is achieved by pre-inserting metal ions into the vanadium oxide to trap organic ligand molecules.
- The intercalated conductive MOFs (Ni-BTA) can not only facilitate the rapid Zn^{2+} migration kinetics in the vanadium oxide layered structure by increasing the interlayer spacing, but also participate in the storage of Zn-ions to provide extra electrochemical capacity.
- The stable NiVO-BTA structure guarantees the remaining capacity of 146.4 mAh g^{-1} at 5 A g^{-1} with the capacity retention of 82.0 % over 1000 cycles

References

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[3] J. Guo, W. Ma, Z. Sang, *et al.* Chem. Eng. J. 2022, 428: 132644.