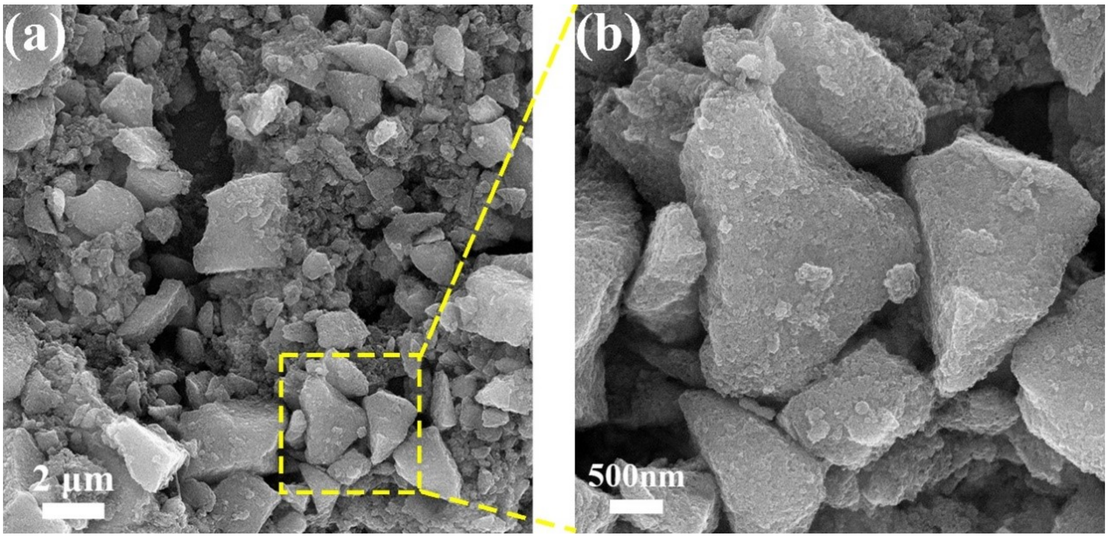
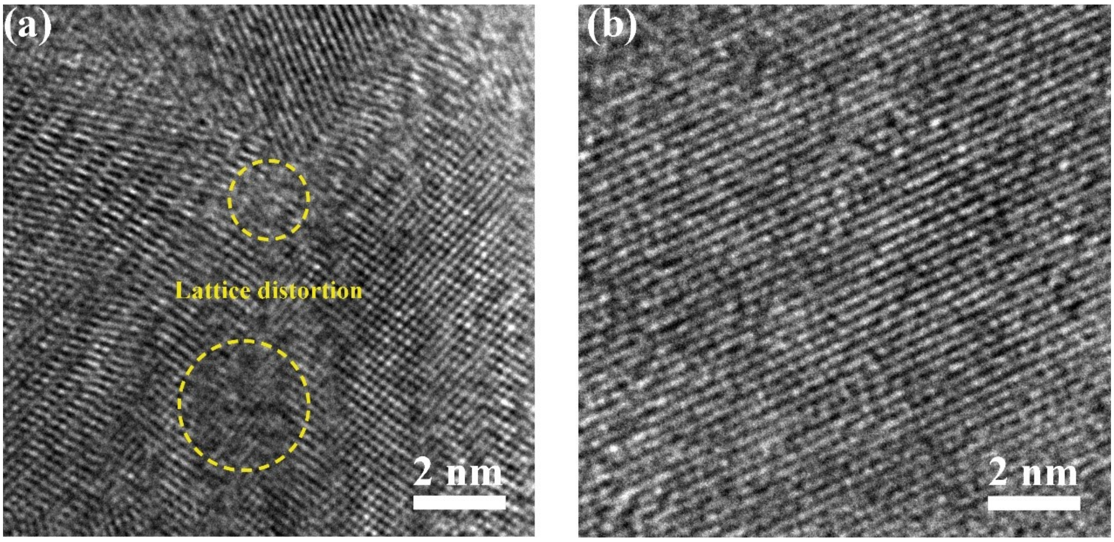
Supporting Information

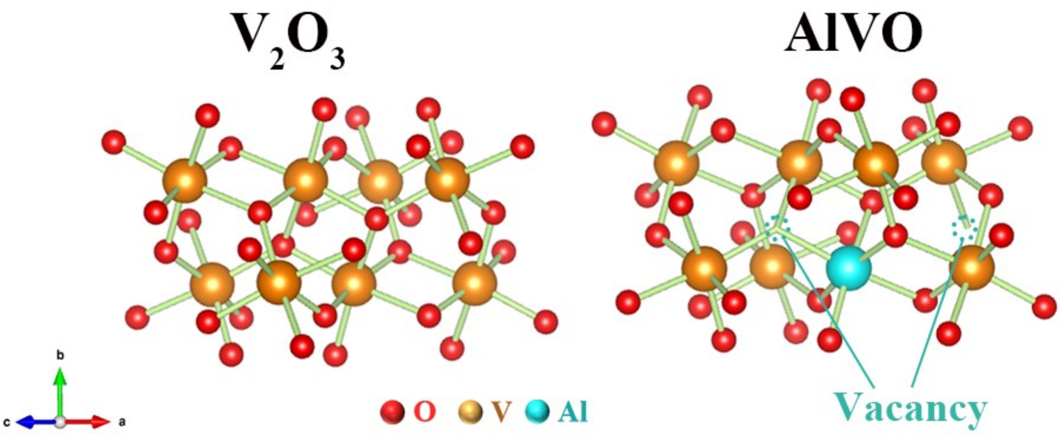
Al-induced fast phase transition constructing vanadium oxide cathode materials for high-performance aqueous zinc ion batteries



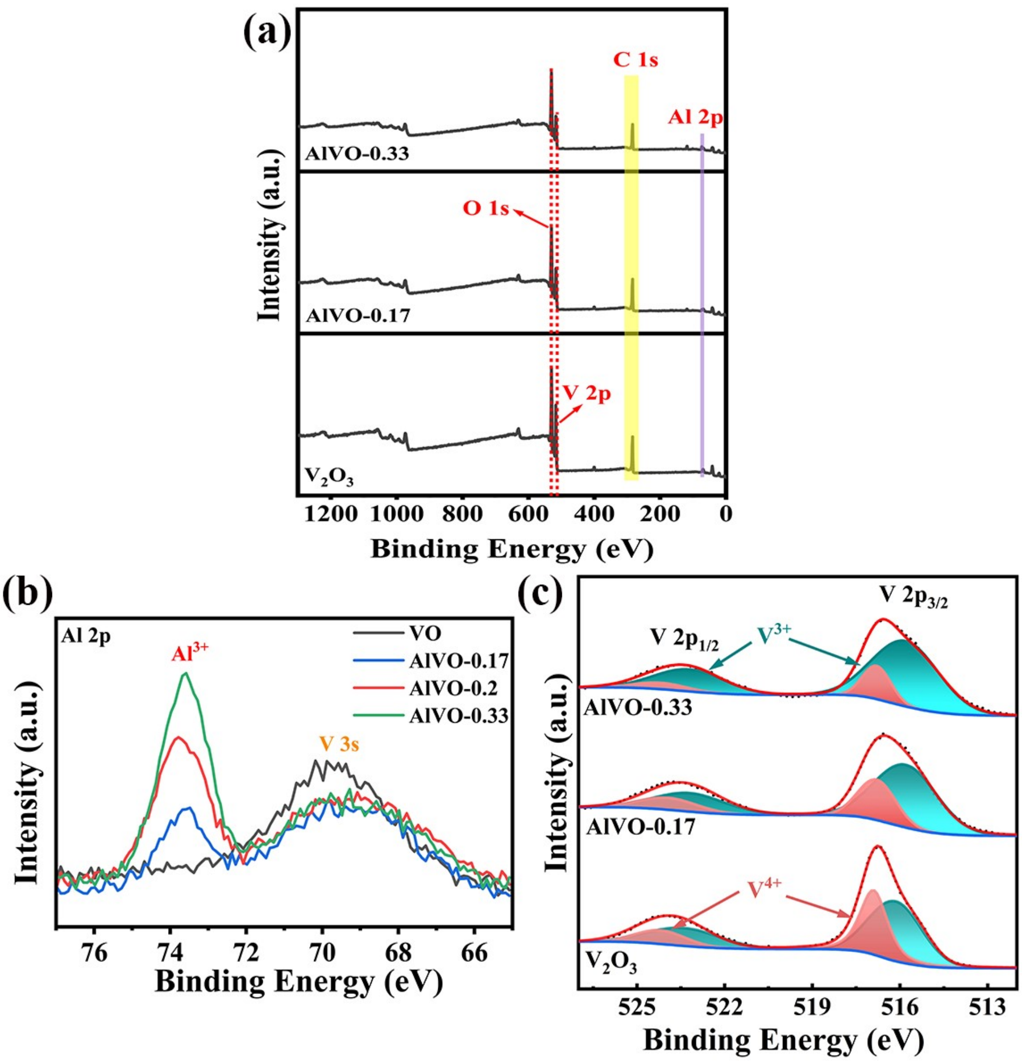
S1. Morphological characterization of V_2O_3.



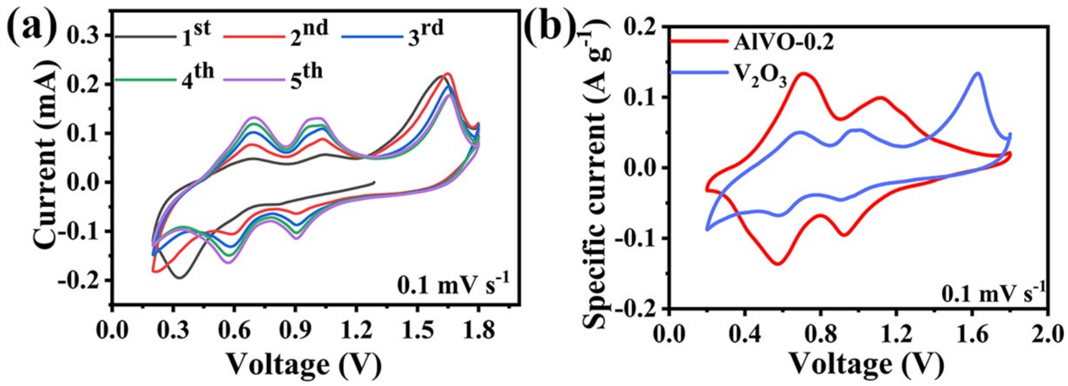
S2. HRTEM image of AlVO-0.2 and undoped-V_2O_3.



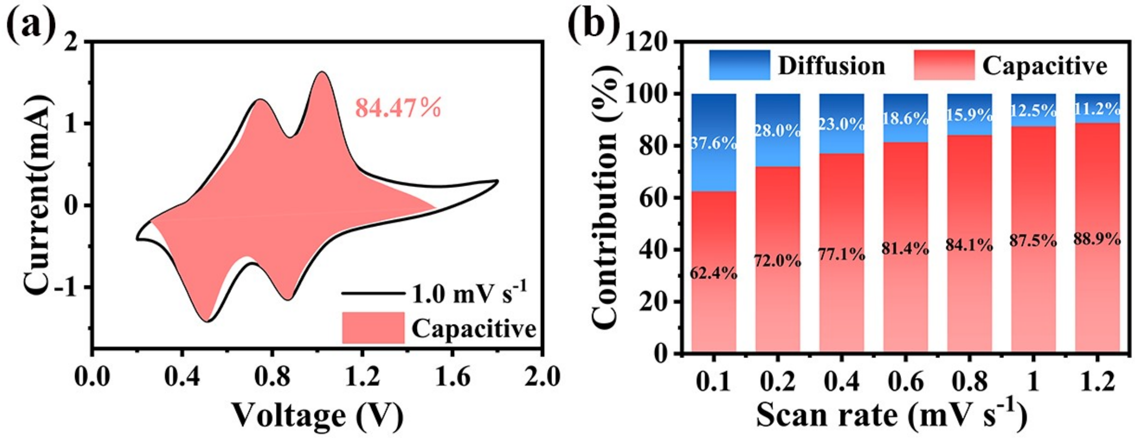
S3. Crystal structure schematic of pure V_2O_3 and AlVO.



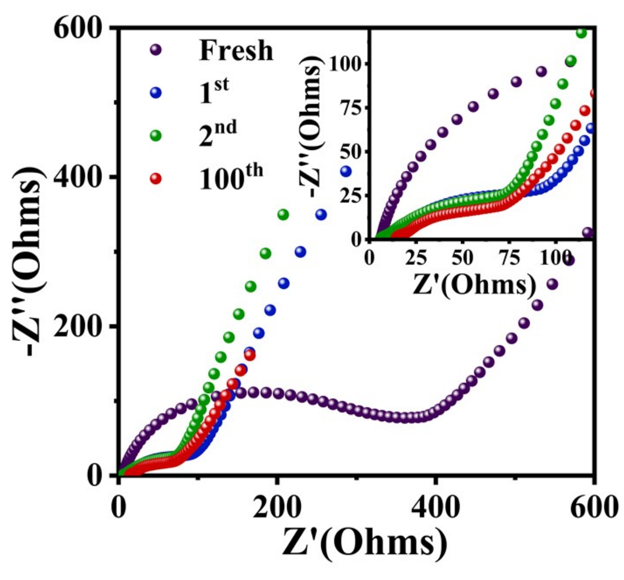
S4. (a) XPS full survey spectra, (b) Al 2p and (c) V 2p of V_2O_3, AlVO-0.17 and AlVO-0.33 samples.



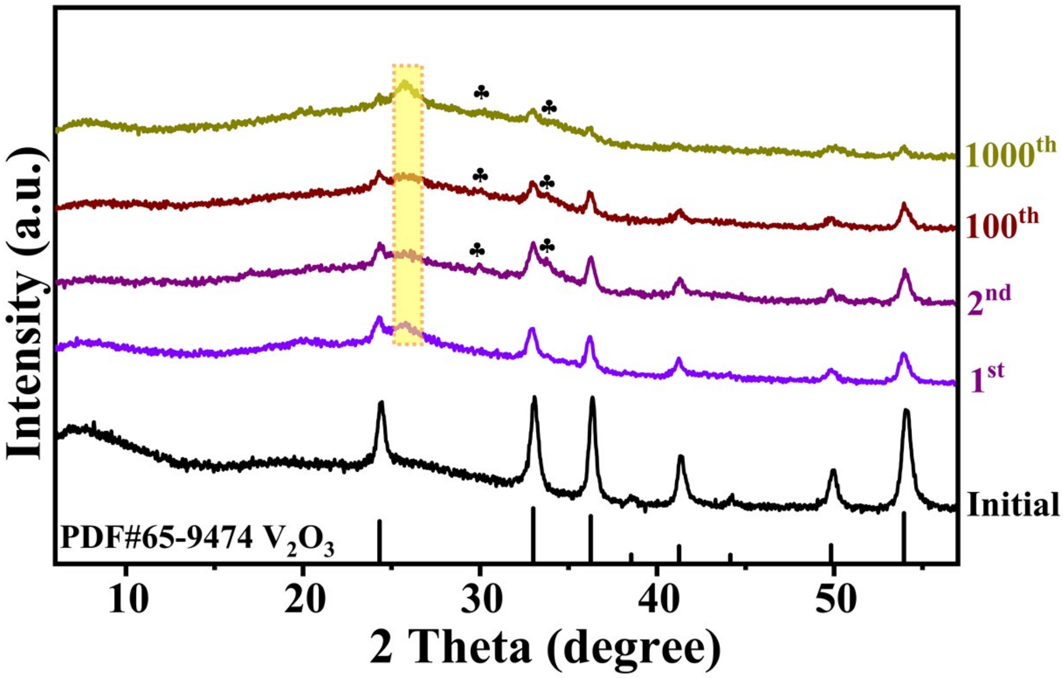
S5. (a)CV curves of V_2O_3 at 0.1 mV s^{-1}, (b) Comparison of CV curves of V_2O_3 and AlVO-0.2 at 0.1mV s^{-1}.



S6. (a) Pseudocapacitance contribution ratio at the current density of 1.0 mV s^{-1}. (b) Capacitance contribution at different scan rates of V_2O_3 cathode.



S7. EIS plots of V_2O_3 cathode in different stages.



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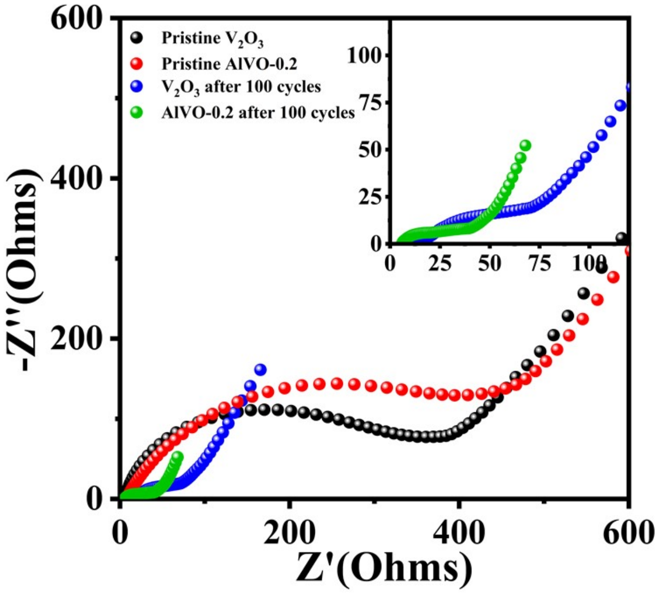
8. Ex situ XRD analysis of the V_2O_3 cathode at various states



S9. EIS plots of V_2O_3 and AlVO-0.2 cathode before and after cycle.

Table SI. Differences in lattice parameters of V_2O_3 and AlVO.

Sample name	Lattice parameters (Å)	
V_2O_3	a = 4.945	c = 14.003
AlVO-0.14	a = 4.993	c = 13.867
AlVO-0.2	a = 4.984	c = 13.949
AlVO-0.33	a = 4.989	c = 13.991
PDF # 65-9474	a = 4.951	c = 14.003

Table SII. Comparison of electrochemical properties of different vanadium oxide applied to AZIBs.

Cathode materials	Specific capacity (capacity @ current density [$mAh\ g^{-1}$ @ $A\ g^{-1}$])	Remain capacity (current density, cycles)	Reference
AlVO-0.2	383.5@0.1	282.8 (3.0 $A\ g^{-1}$, 1000)	This work
VO_2	280.9@0.1	220 (1.0 $A\ g^{-1}$, 200)	[1]
V_2O_3	207@0.1	110 (3.0 $A\ g^{-1}$, 2500)	[2]
V_2O_3@C	392@1.0	207 (5.0 $A\ g^{-1}$, 2000)	[3]
V_2O_3@N–C	342.5@0.1	274.6 (5.0 $A\ g^{-1}$, 2000)	[4]
$Al_xV_2O_5 \cdot nH_2O$/rGO	365@0.1	175(4.0 $A\ g^{-1}$, 1300)	[5]
Al-doped HV_6O_{13}	351@0.1	224(10.0 $A\ g^{-1}$, 1000)	[6]

Reference

1. Deng W, Li C, Zou W, Xu Y, Chen Y, Li R. Understanding the Super-Theoretical Capacity Behavior of VO_2 in Aqueous Zn Batteries. Small. 2023:2309527.
2. Deng L, Chen H, Wu J, Yang Z, Rong Y, Fu Z. V_2O_3 as cathode of zinc ion battery with high stability and long cycling life. Ionics. 2021;27(8):3393-3402.
3. Wang D, Liang W, He X, Yang Y, Wang S, Li J, Wang J, Jin H. V_2O_3@C Microspheres as the High-Performance Cathode Materials for Advanced Aqueous Zinc-Ion Storage. ACS Applied Materials & Interfaces. 2023;15(17):20876-20884.
4. Ren H-Z, Zhang J, Wang B, Luo H, Jin F, Zhang T-R, Ding A, Cong B-W, Wang D-L. A V_2O_3@N–C cathode material for aqueous zinc-ion batteries with boosted zinc-ion storage performance. Rare Metals. 2022;41(5):1605-1615.
5. Feng Z, Zhang Y, Yu X, Yu Y, Huang C, Meng C. Aluminum-ion intercalation and reduced graphene oxide wrapping enable the electrochemical properties of hydrated V_2O_5 for Zn-ion storage. Colloids and Surfaces A: Physicochemical and Engineering Aspects. 2022;641:128473.
6. Liu C, Zhang G, Ma T, Su Y, Dai J, Su X, Yue X, Cong C, Zhou W. Al-doped hydrated V_6O_{13} cathode materials with enhanced rate and cycling properties for aqueous zinc-ion batteries. Next Energy. 2024;2:100089.