Supporting information

Capacity enhanced and kinetic expedited zinc-ion storage ability in $Zn_3V_3O_8/VO_2$ cathode enabled by heterostructure design

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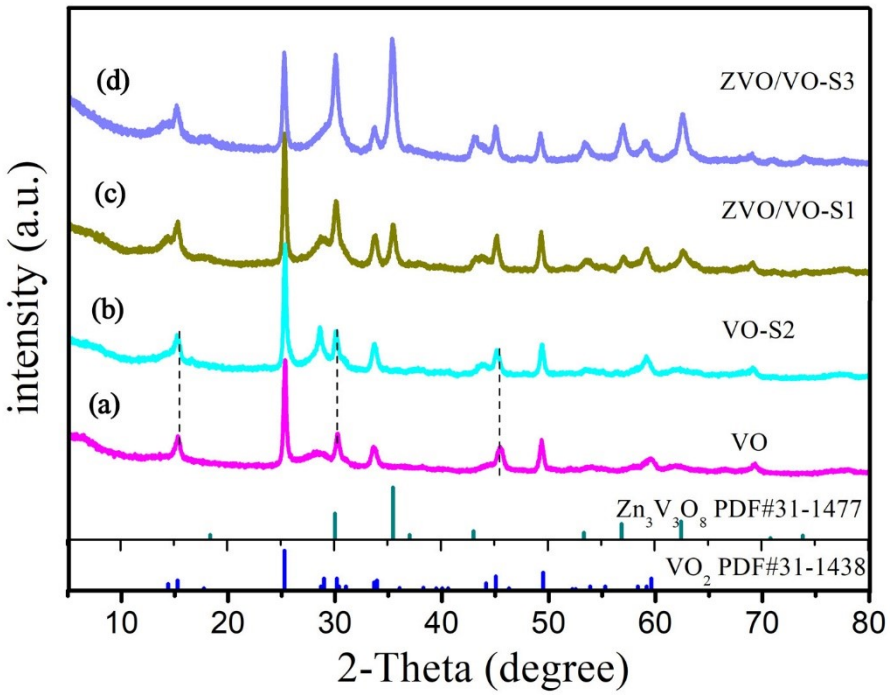

Figure S1. XRD pattern of (a)VO, (b) VO-S2, (c) ZVO/VO-S1, (d) ZVO/VO-S3.

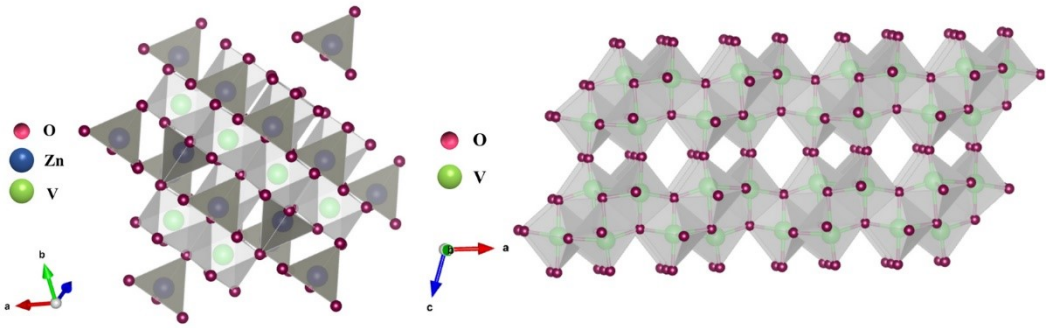

Figure S2. The crystal structure of (a) ZVO, and (b) VO.

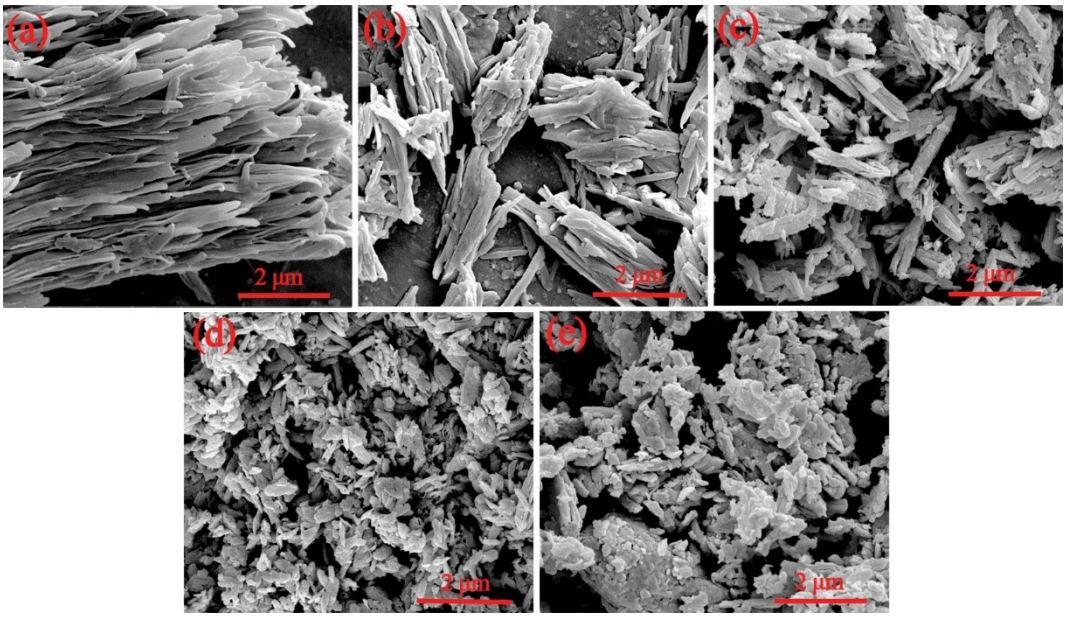

Figure S3. SEM images of (a)VO, (b) VO-S2, (c) ZVO/VO-S1, (d) ZVO/VO-S3 and (e) ZVO.

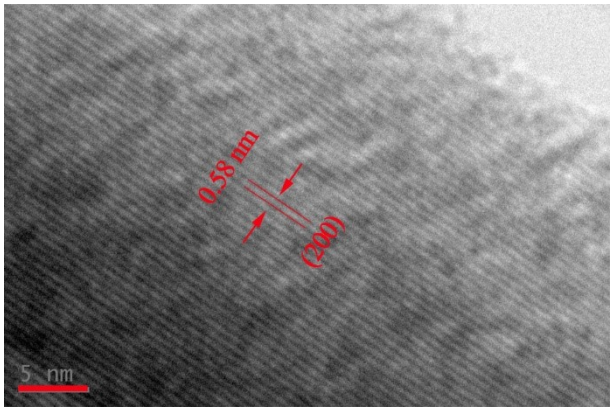

Figure S4. HRTEM of VO.

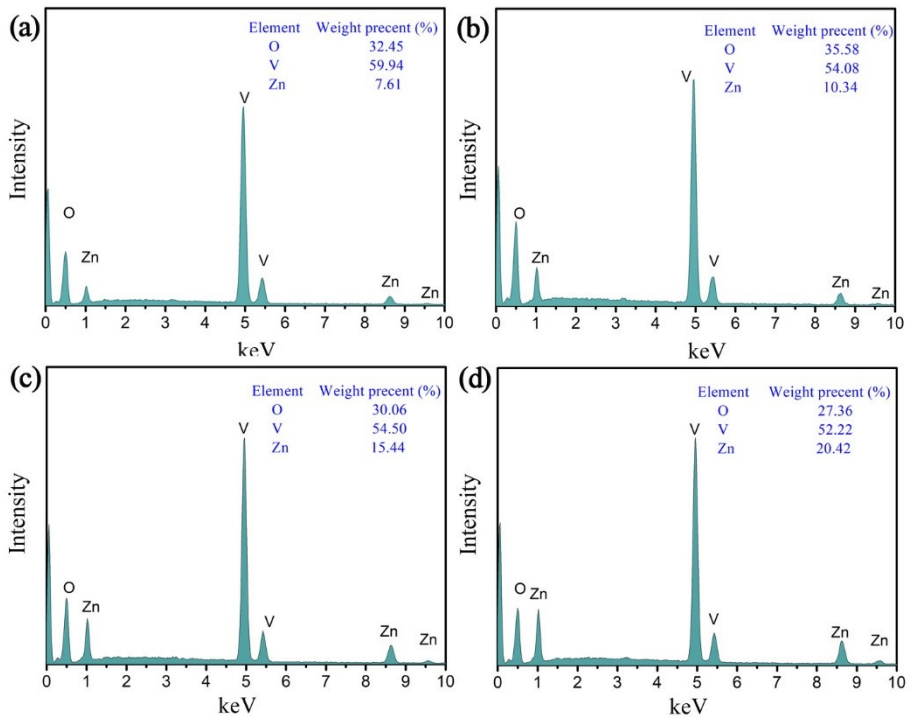

Figure S5. EDS of (a) VO-S2, (c) ZVO/VO-S1, (c) ZVO/VO-S2 and (d) ZVO/VO-S3.

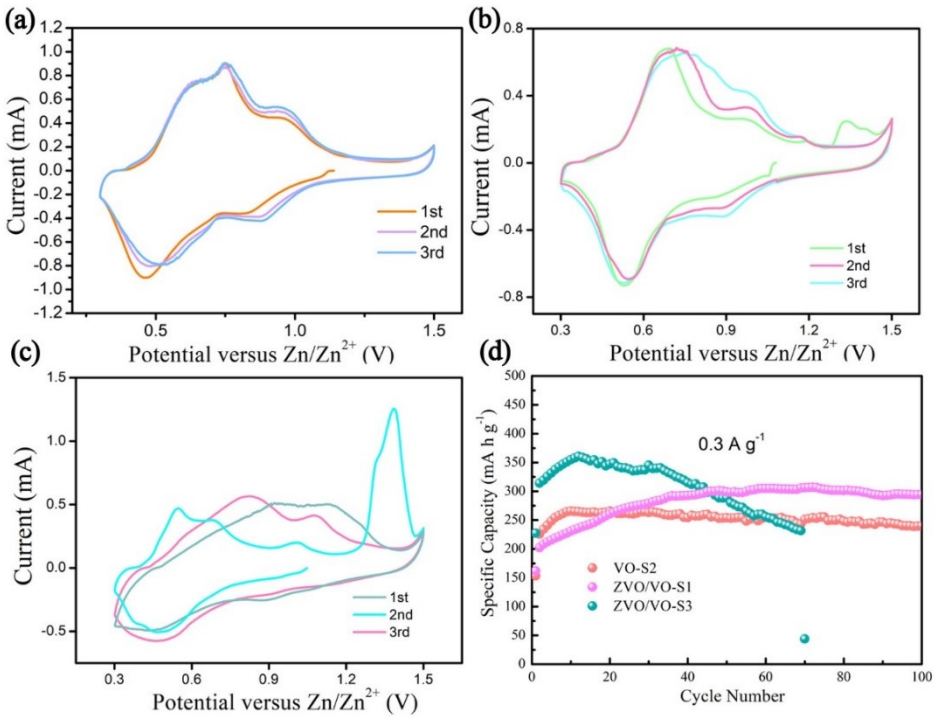

Figure S6. CV curves of (a) VO-S2, (b)ZVO/VO-S1, and (c) ZVO/VO-S3, (d) Cycling performance of VO-S2, ZVO/VO-S1, and ZVO/VO-S3 at 0.3 A g^{-1}.

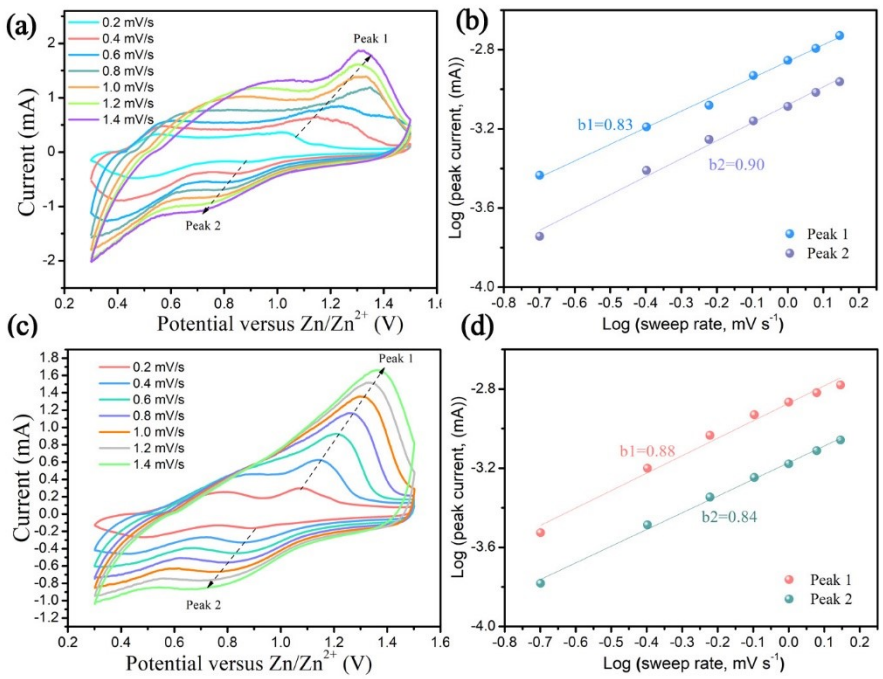

Figure S7. (a) CV profiles of the VO electrode from 0.2 to 1.4 mV s^{-1}, (b) *b* values calculated by the reduction and oxidation peaks in the CV curves at different scan rates, (c) CV profiles of the ZVO electrode from 0.2 to 1.4 mV s^{-1}, (d) *b* values calculated by the reduction and oxidation peaks in the CV curves at different scan rates.

Table S1. The electrochemical properties comparison between ZVO/VO and other reports.

Cathode materials	The range of voltage (V)	Capacity	Retention/cycles	Publish date
ZVO/VO	**0.3-1.5**	**328.4mA h g^{-1} (at 0.3 A g^{-1})**	**92.1%/200**	**This work**
		198.4 mA h g^{-1} (at 3 A g^{-1})	**90.5%/1000**	
$Zn_3V_3O_8$ [1]	**0.2-1.6**	**261.7 mA h g^{-1}(at 0.15 A g^{-1})**	**78.3%/60**	**2021**
		192 mA h g^{-1}(at 5 A g^{-1})	**72.6%/2000**	
$Zn_3V_3O_8$ [2]	**0.2-1.7**	**272 mA h g^{-1}(at 0.5 Ag^{-1})**	**73.8%/400**	**2021**
		170 mA h g^{-1}(at 2 A g^{-1})	**74.6%1200**	
VO_2 [3]	**0.2-1.4**	**Above 250 mA h g^{-1}(at 0.05 A g^{-1})**	**85%/100**	**2019**
		About 100 mA h g^{-1}(at 3 A g^{-1})	**86%/5000**	
VO_2-rG[4]	**0.2-1.6**	**466 mA h g^{-1}(0.1 A g^{-1})**	**94.3%/50**	**2020**
		267 mA h g^{-1}(at 10 A g^{-1})	**100%/5000**	
V_3O_7/V_2O_5 [5]	**0.2-1.6**	**225 mA h g^{-1}(at 2 A g^{-1})**	**96.2%/1120**	**2020**
		176 mA h g^{-1}(at 5 A g^{-1})	**82.6%/6500**	
NaV_6O_{15} /V_2O_5[6]	**0.2-1.8**	**390 mA h g^{-1}(at 0.3 A g^{-1})**	**82.8%/150**	**2021**
		267 mA h g^{-1}(at 5 A g^{-1})	**92.3%/3000**	

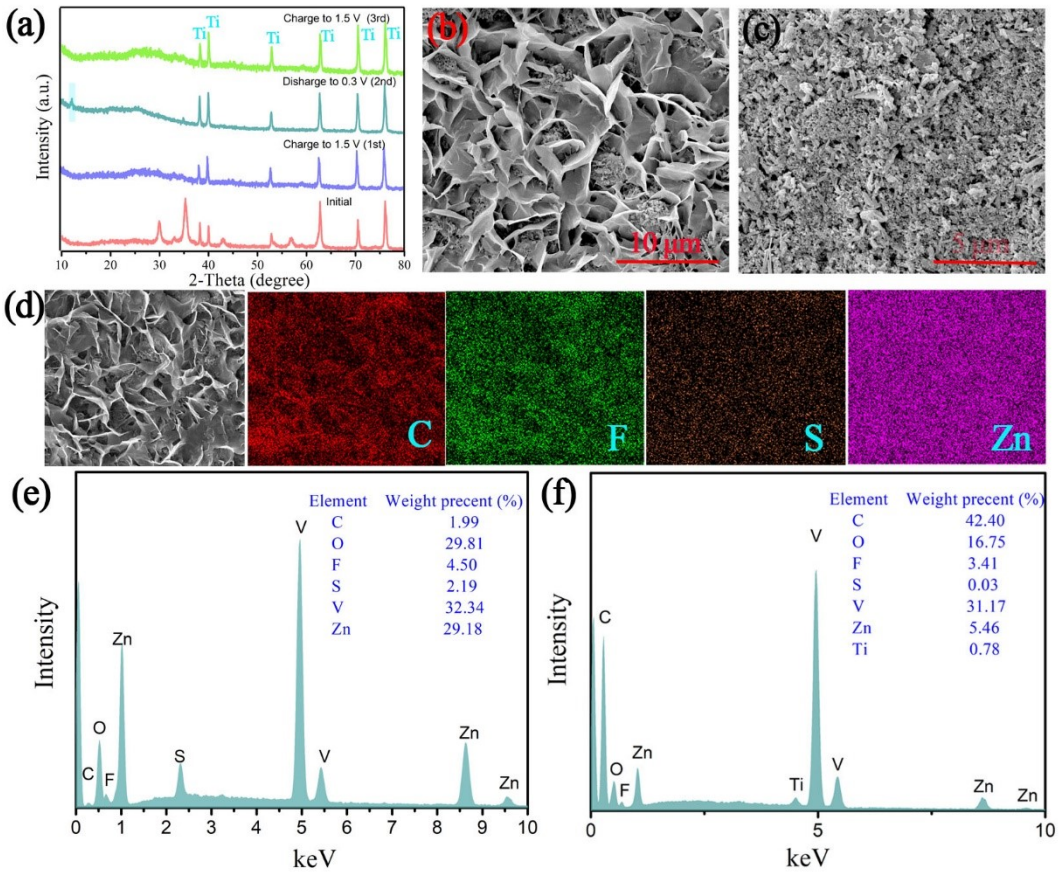

Figure S8. (a) Ex-situ XRD of the of ZVO electrode at different discharge/charge state, (b) and (c) SEM image of ZVO electrode discharged to 0.3 V and charged to 1.5 V, respectively. (d) EDS mapping of ZVO electrode discharged to 0.3 V, (e) and (f) EDS results of ZVO electrode discharged to 0.3 V and charged to 1.5 V, respectively.

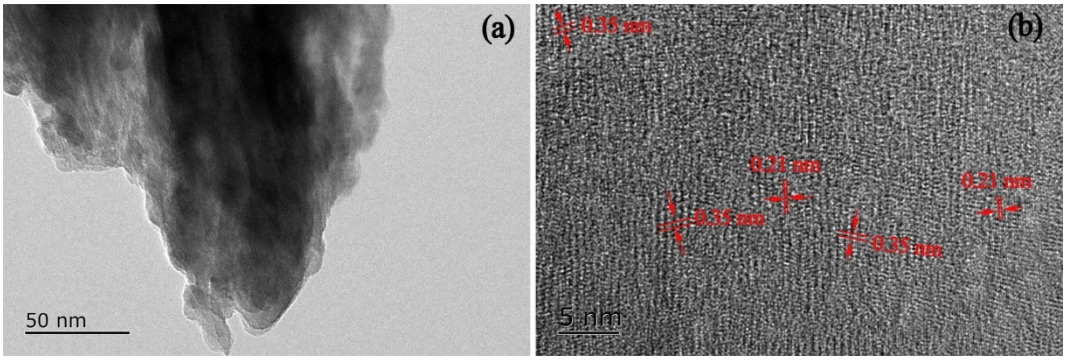

Figure S9. (a) Ex-situ TEM and (b) HRTEM images of ZVO electrode charged to 1.5 V.

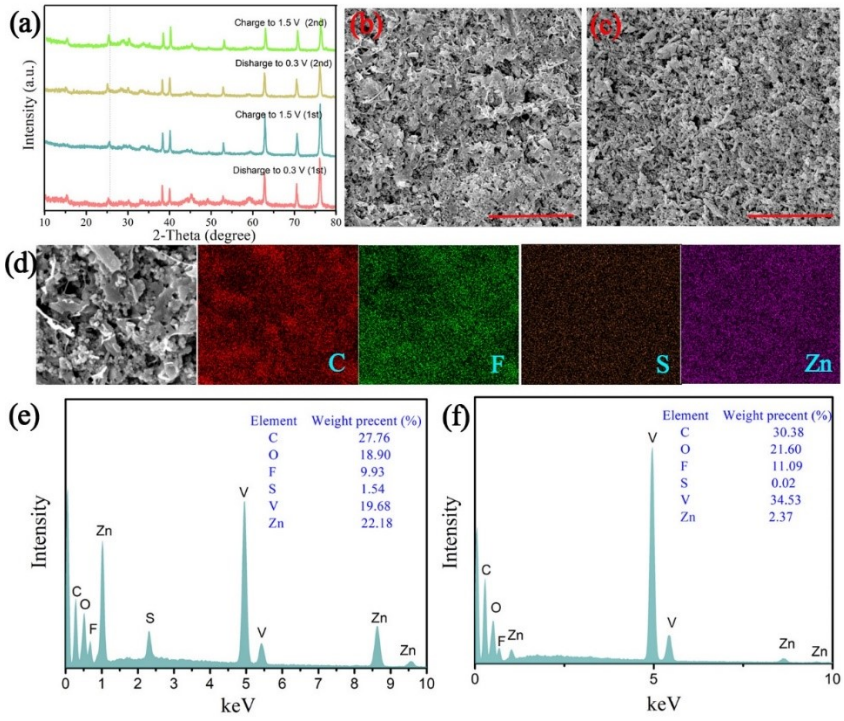

Figure S10. (a) Ex-situ XRD of the of VO electrode at different discharge/charge state, (b) and (c) SEM image of VO electrode discharged to 0.3 V and charged to 1.5 V, respectively. (d) EDS mapping of VO electrode discharged to 0.3 V, (e) and (f) EDS results of VO electrode discharged to 0.3 V and charged to 1.5 V, respectively.

Zn^{2+} diffusion coefficients (D_H) for VO, ZVO/VO-S1, and ZVO were measured by the GITT method, as present in Figs. 4(d-f). And the galvanostatic charge/discharge

pulses were each 5 min at 200 mA g^{-1}, and the relaxation time was 30 min. The Zn^{2+} diffusion coefficient can be calculated from equation as follows:

$$D_H = \frac{4}{\pi\tau} \times \left(\frac{m_B \times V_M}{M_B \times S}\right)^2 \times \left(\frac{\Delta E_S}{\Delta E_t}\right)^2, \quad \text{(S1)}$$

where τ is the charge/discharge time, V_m is the molar volume of active substance, m_B is the practical mass of active substance in one electrode piece, M_B is the relative molecular mass of VO, ZVO/VO-S1, and ZVO, S is the area of the pole piece, ΔE_s represents the change in steady state voltage during a constant current pulse, and ΔE_t represents the change in the total voltage during a constant current pulse.

Reference

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