Supplementary Material

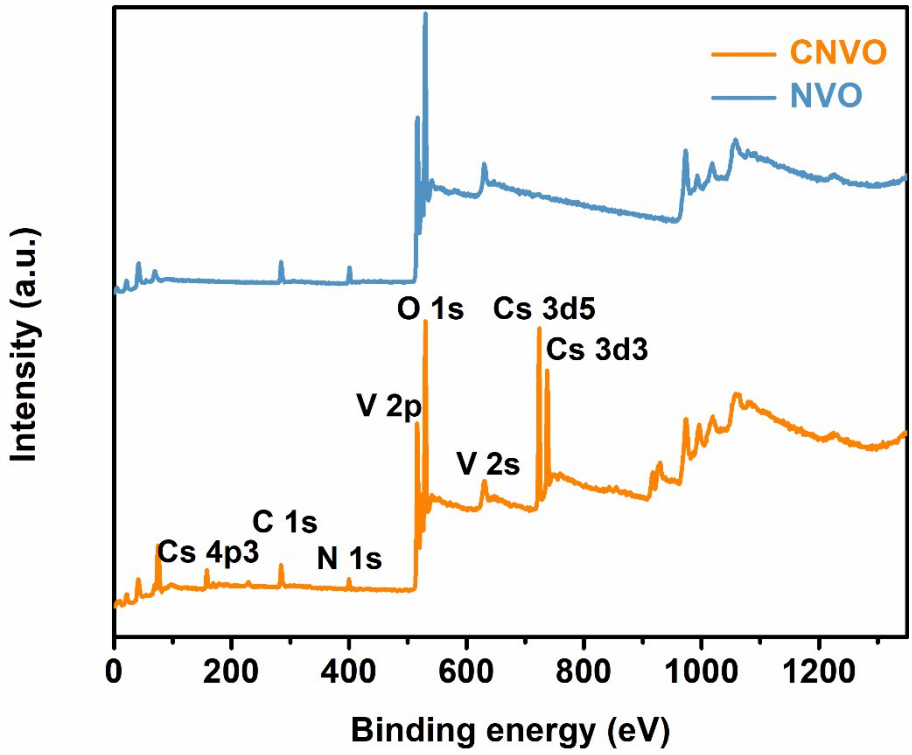

Fig. S1. XPS spectra of CNVO and NVO.

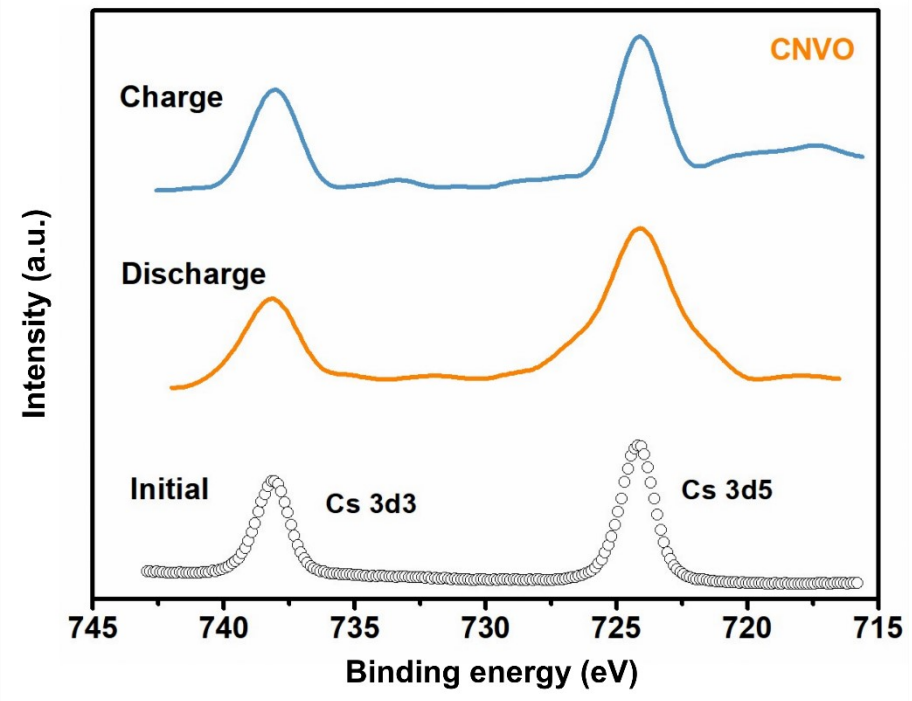

Fig. S2. XPS spectra of Cs 3d3 and Cs 3d5 of CNVO.

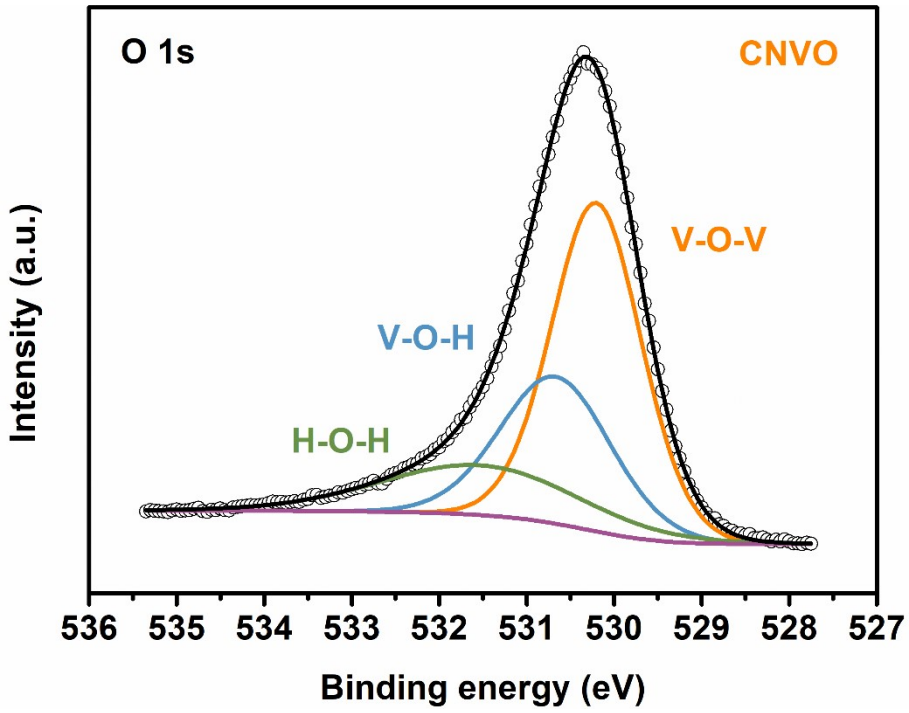

Fig. S3. XPS spectra of O 1s of CNVO.

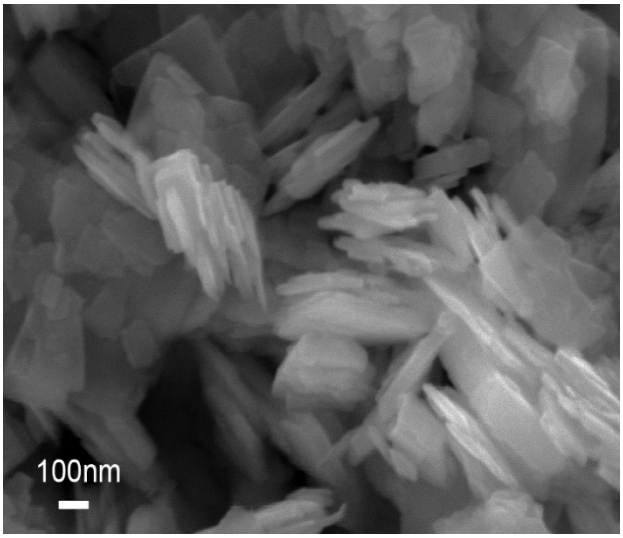

Fig. S4. Field Emission Scanning Electron Microscope (FE-SEM) image of CNVO.

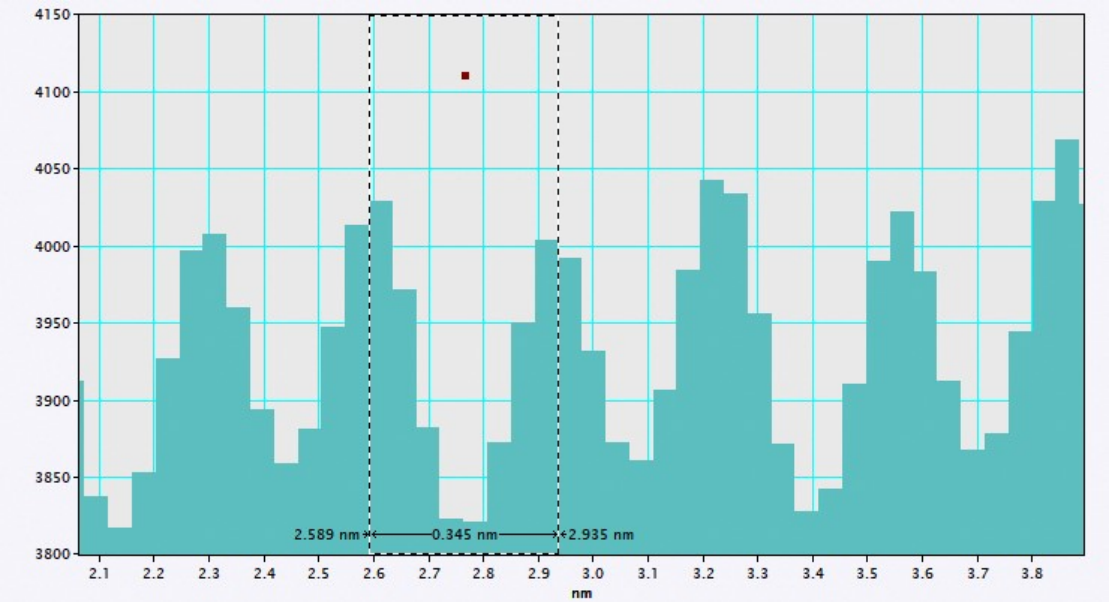

Fig.S5. Lattice diffraction stripe size of CNVO.

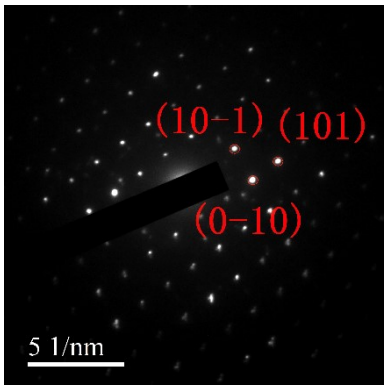

Fig. S6. SAED image of CNVO.

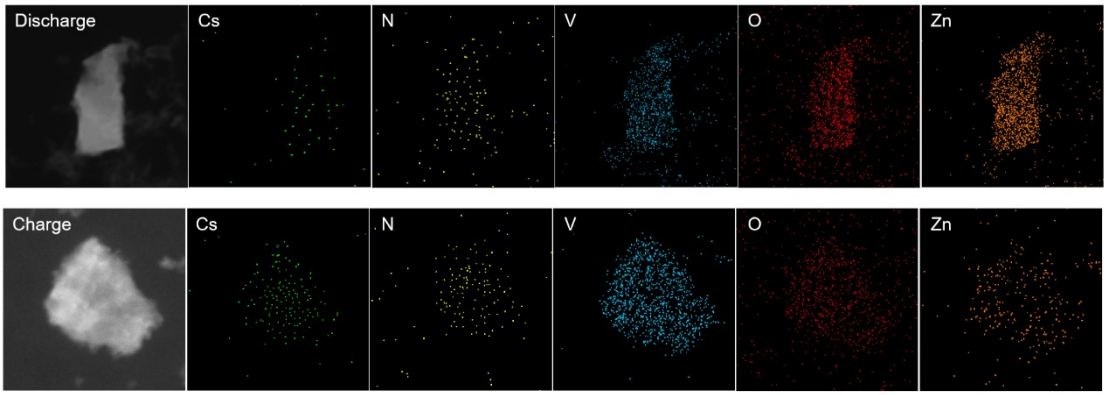

Fig.S7. EDS mapping images of CNVO in different charging and discharging states.

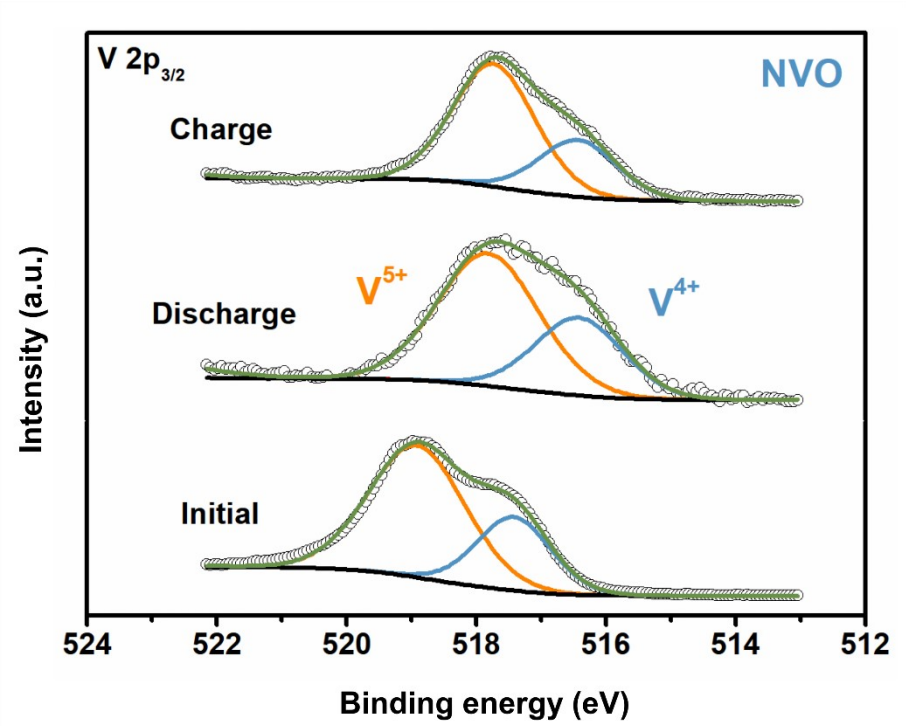

Fig. S8. XPS spectra of V $2p_{3/2}$ of NVO.

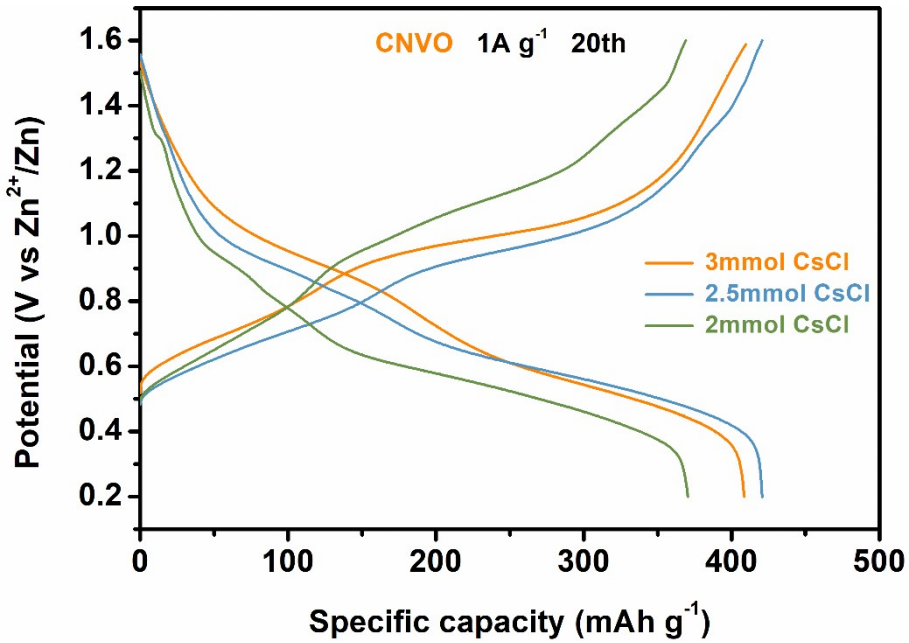

Fig. S9. 20th charge/discharge curves of CNVO with different Cs^+ molar ratios at 1A g^{-1} current density.

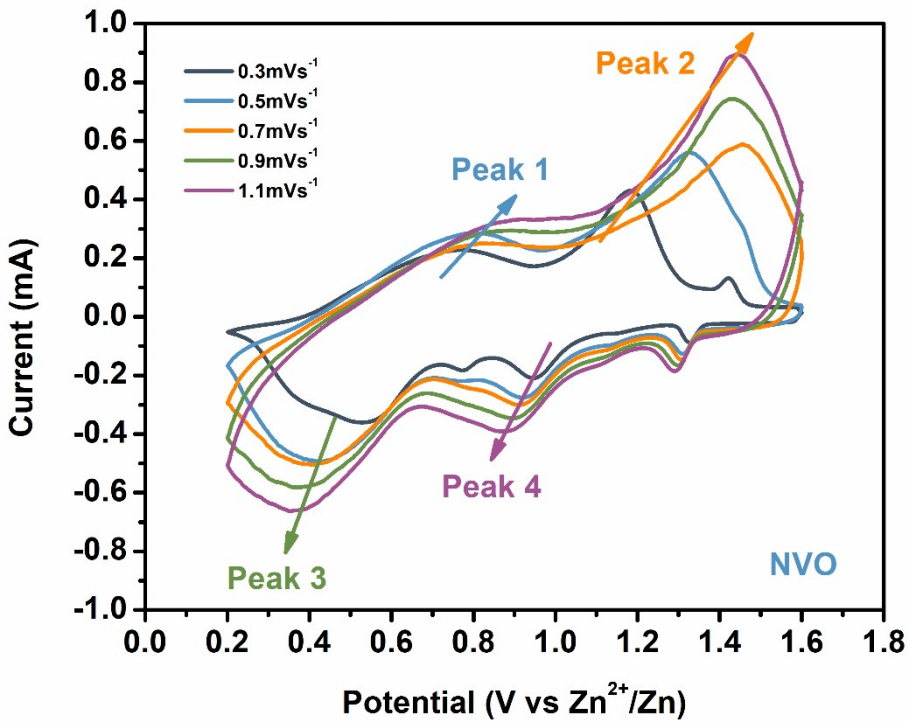

Fig. S10. CV curves of NVO at different scan rates.

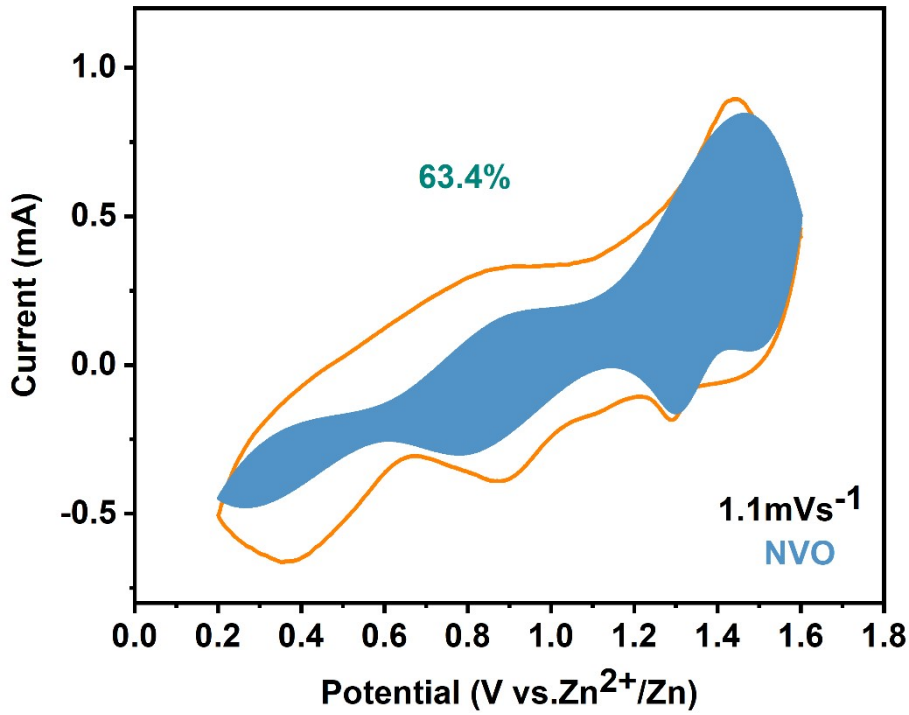

Fig. S11. Pseudocapacitance fitting results of CNVO at 1.1 mV s^{-1} scan rate.

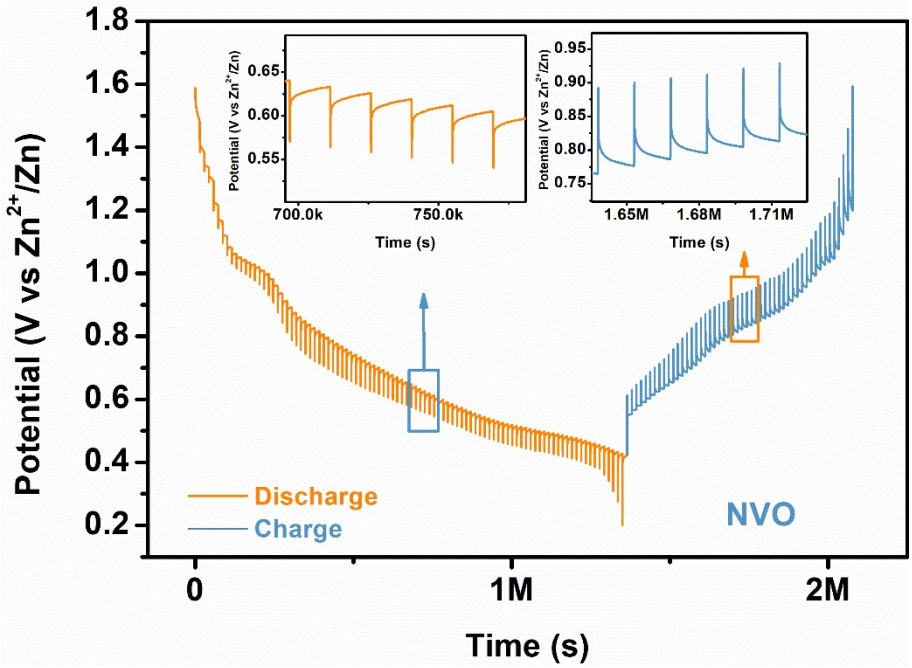

Fig. S12. GITT curves of NVO.

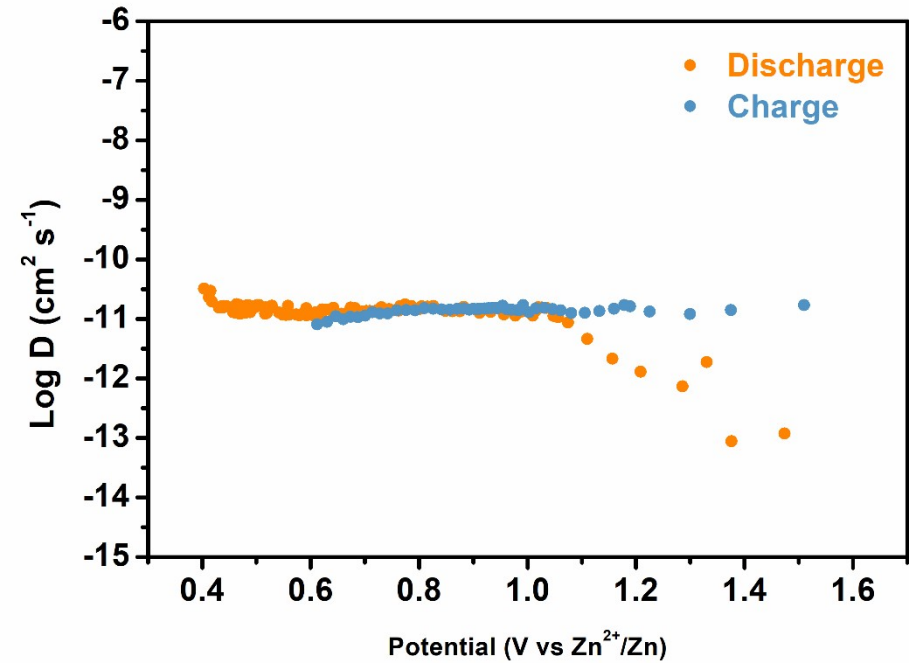

Fig. S13. Calculated diffusion coefficients of NVO.

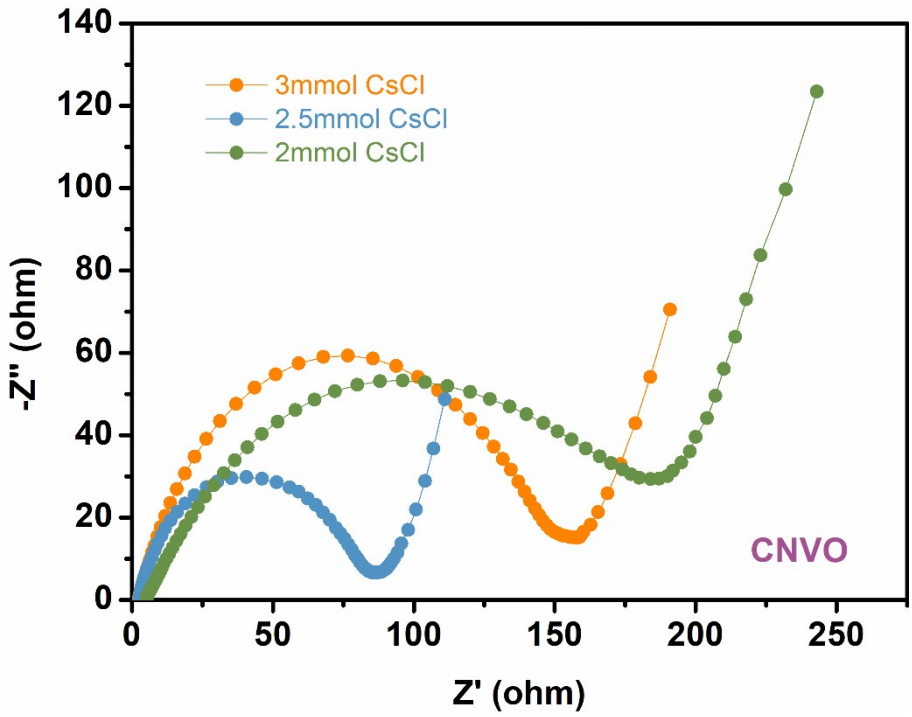

Fig. S14. EIS curves of CNVO with different Cs^{+} molar ratios.

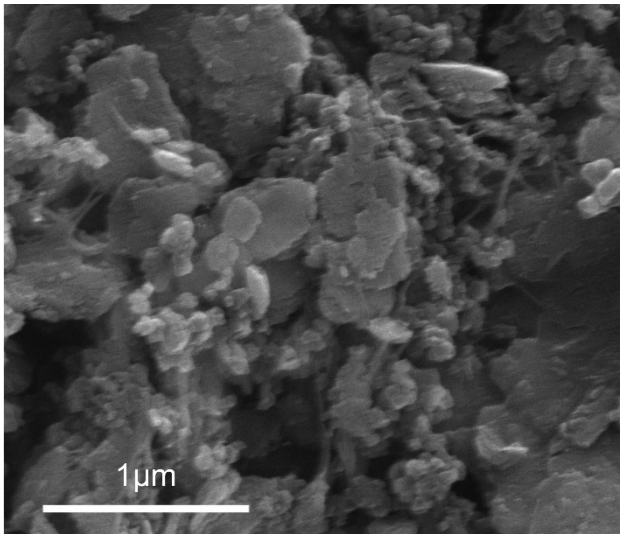

Fig. S15. SEM image of CNVO cathode material charged to 1.6 V for the 20th time.

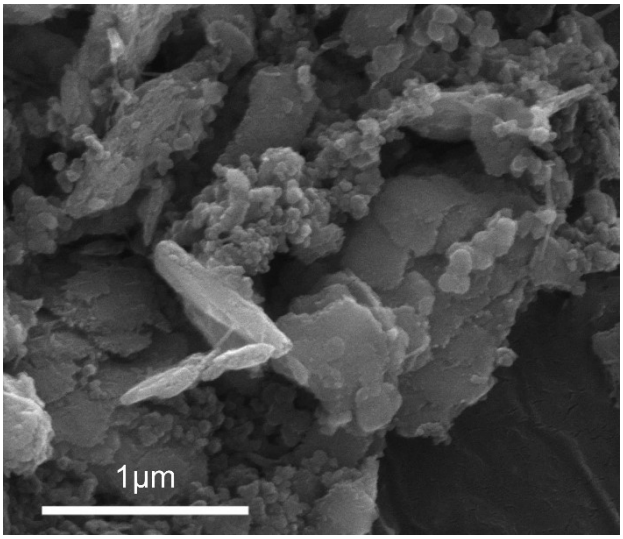

Fig. S16. SEM image of CNVO cathode material charged to 1.6 V for the 50th time.

Table. S1. Inductively coupled plasma-optical emission spectroscopy of CNVO samples.

Sample Quality (g)	Fixed volume V_0 (ml)	Test elements	Test element concentration C_0 (mg/L)	Dilution times f	The elemental concentration of digestion solution/original sample solution C_1 (mg/L)	Sample elemental content C_x (mg/kg)	Sample elemental content W (%)
0.1264	25.00	Cs	0.04	1000	35.80	7080.70	0.7081%
0.1264	25.00	V	2.08	1000	2080.83	411557.04	41.1557%
0.0125	25.00	N	21.96	1	21.96	43922.00	4.3922%

Table. S2. Comparison of the electrochemical performance of CNVO with other reported zinc-ion batteries.

Cathode	Electrolyte	Specific capacity	Rate performance	Cycling stability	Ref.
$(NH_4)_2V_4O_9{\cdot}0.5H_2O$	2 M $ZnSO_4$ aqueous solution	374.3 mAh g^{-1} at 0.2 A g^{-1}	101 mAh g^{-1} at 15 A g^{-1}	84% after 1000 cycles at 5 A g^{-1}	[1]
$Mg_{0.34}V_2O_5{\cdot}0.84H_2O$	3 M $Zn(CF_3SO_3)_2$	352 mA h g^{-1} at 100 mA g^{-1}	264 mA h g^{-1} at 1000 mA g^{-1}	~97 % capacity retention for at least 2000 cycles at 5000 mA g^{-1}	[2]
δ-$Ni_{0.25}V_2O_5.nH_2O$	___	402 mAh g^{-1} at 0.2 A g^{-1}	225 mAh g^{-1} at 5 A g^{-1}	98 % over 1200 cycles at 5 A g^{-1}	[3]
$NaCa_{0.6}V_6O_{16}{\cdot}3H_2O$	3 M $Zn(CF_3SO_3)_2$	347 mAh g^{-1} at 0.1 A g^{-1}	154 mAh g^{-1} at 5 A g^{-1}	94% after 2,000 cycles at 2 A g^{-1}	[4]
V_6O_{13}@CC	3 M $ZnSO_4$	431 mAh g^{-1} at 0.2 A g^{-1}	227 mAh g^{-1} at 9 A g^{-1}	nearly 99% after 1000 cycles at 9 A g^{-1}	[5]
Al-doped $V_{10}O_{24}{\cdot}12H_2O$	3 M $Zn(CF_3SO_3)_2$	290 mAh g^{-1} at 0.375 A g^{-1}	294.5 mAh g^{-1} at 5 A g^{-1}	98% capacity retention after 3000 cycles	[6]

References

1 R. Wei, X. Wang, B. Xi, Z. Feng, H. Li, W. Chen, Y. Jia, J. Feng, & S. Xiong, *ACS Appl. Energy Mater.*, 2020, **3**, 5343–5352.

2 F. Ming, H. Liang, Y. Lei, S. Kandambeth, M. Eddaoudi, & H. N. Alshareef, *ACS Energy Lett.*, 2018, **3**, 2602–2609.

3 J. Li, K. McColl, X. Lu, S. Sathasivam, H. Dong, L. Kang, Z. Li, S. Zhao, A. G. Kafizas, R. Wang, D. J. L. Brett, P. R. Shearing, F. Cora, G. He, C. J. Carmalt, & I. P. Parkin, *Adv. Energy Mater.*, 2020 **10**, 2000058.

4 K. Zhu, T. Wu, & K. Huang, *Adv. Energy Mater.*, 2019, **9**, 1901968.

5 M. Tamilselvan, T. V. M. Sreekanth, K. Yoo, & J. Kim, *Appl. Surf. Sci.*, 2020, **529**, 147077.

6 Q. li, T. Wei, K. Ma, G. Yang, & C. Wang, *ACS Appl. Mater. Interfaces*, 2019, **11**, 20888–20894.