Electronic Supplementary Material (ESI) for Journal of Materials Chemistry A.

Supporting information for

Porous V_2O_5 Yolk-Shell Microspheres for Zinc Ion Battery Cathode: Activation Responsible for Enhanced Capacity and Rate Performance

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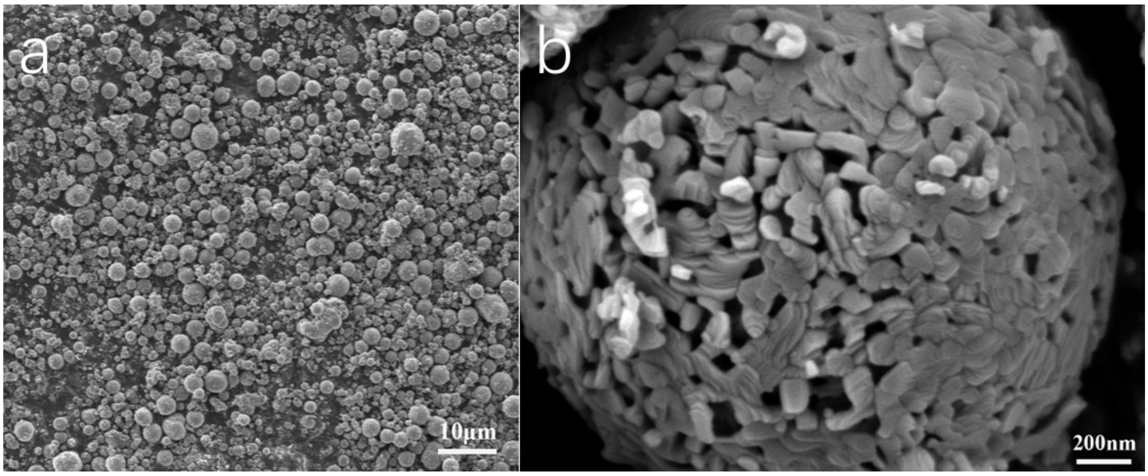

Figure S1. SEM images of V_2O_5-YS at a) low magnification and b) high magnification.

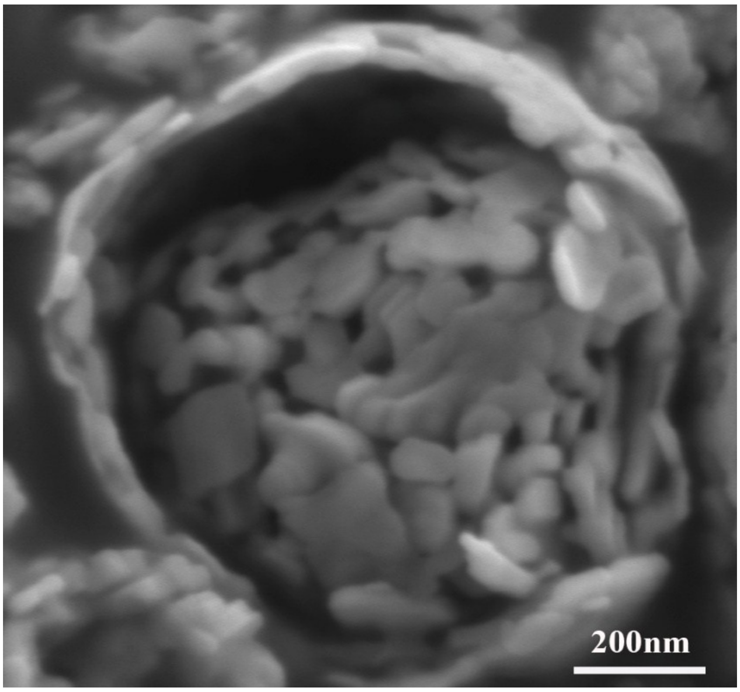

Figure S2. SEM image of broken microsphere.

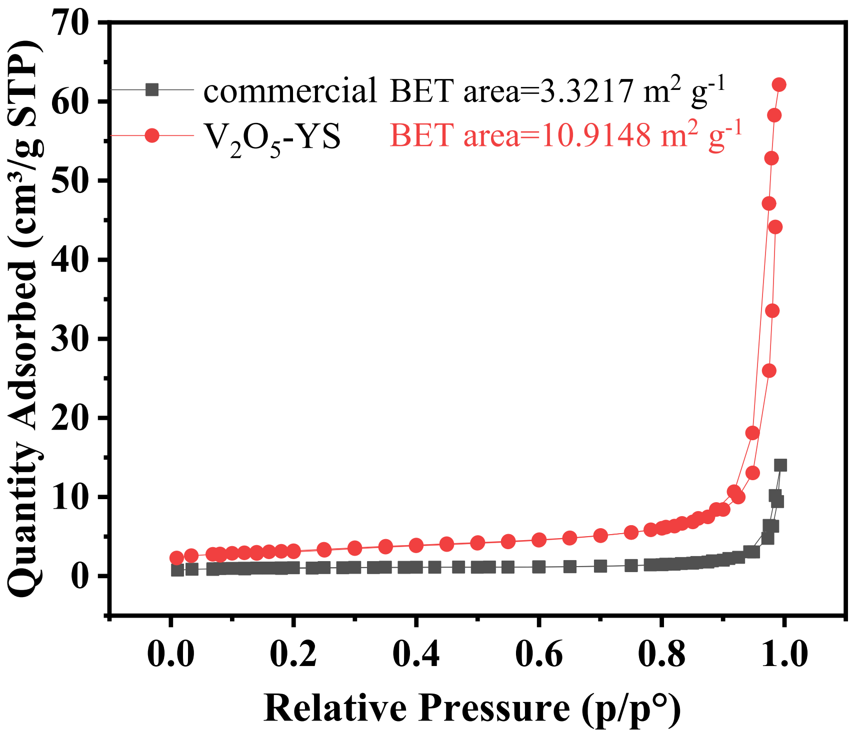

Figure S3. N_2 adsorption/desorption isotherms of commercial V_2O_5 and as-prepared V_2O_5-YS at 77K.

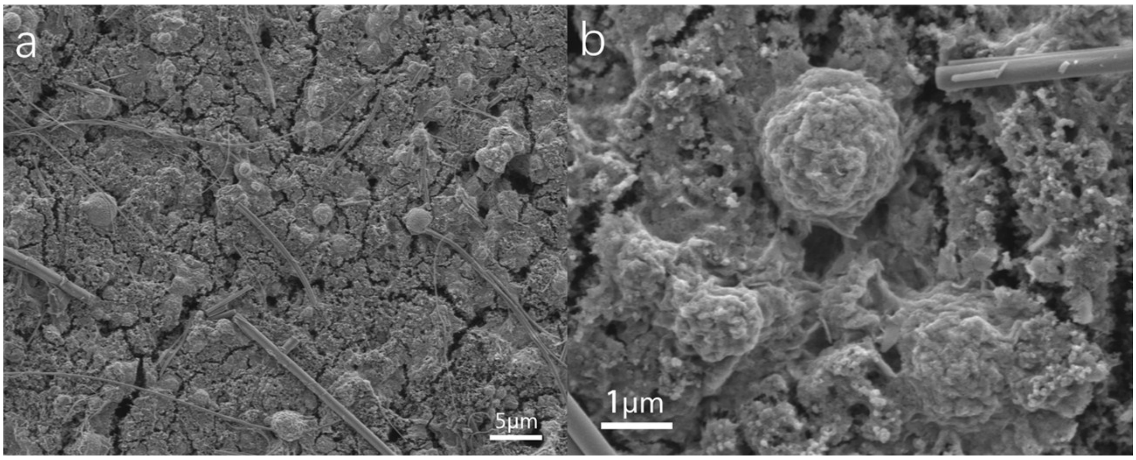

Figure S4. SEM Images of V_2O_5-YS cathode cycling for 100 cycles at the current density of 1.0 A g^{-1} at a) low magnification and b) high magnification, where nanofibers are fragments of glass fiber membrane.

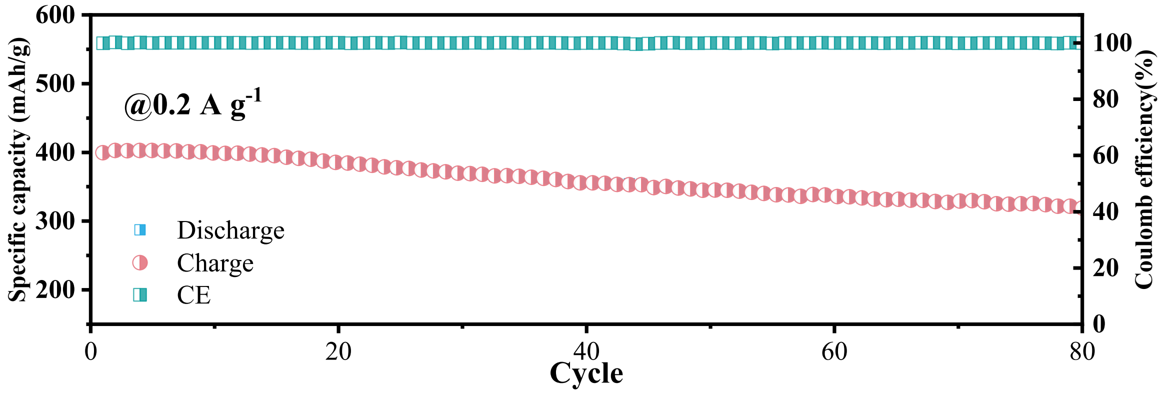

Figure S5. Cycling performance of the V_2O_5-YS cathode at current density of 0.2 A g^{-1}.

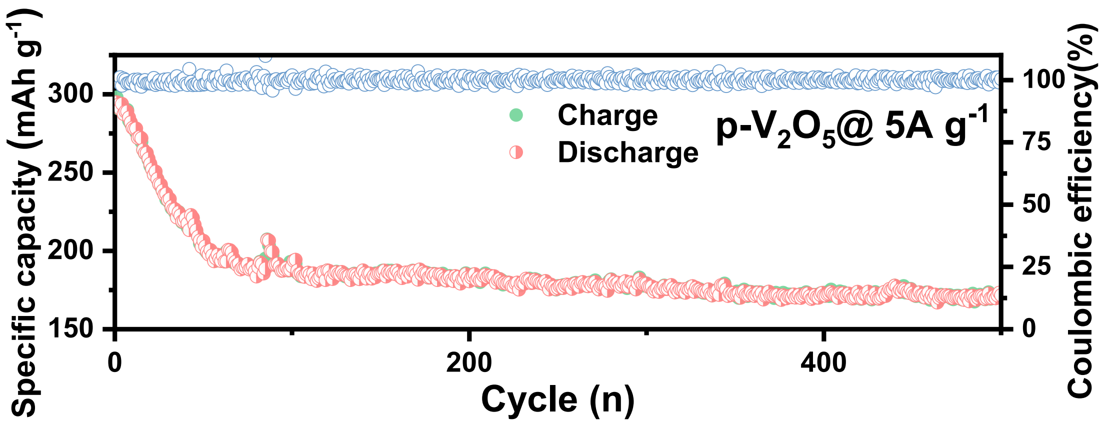

Figure S6. Cycling performance of the pristine V_2O_5 at current density of 5 A g^{-1}.

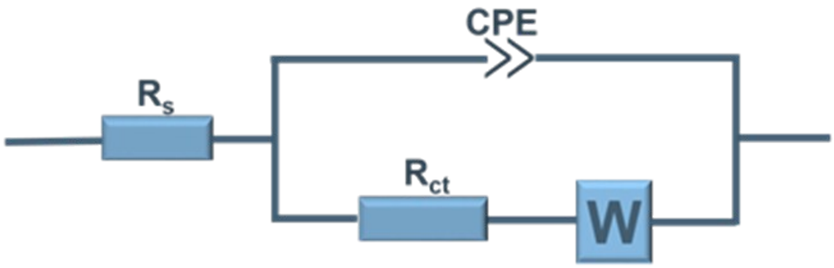

Figure S7. The equivalent circuit used for fitting the EIS curves of Figure 4c, where R_s = bulk resistance, R_{ct} = charge transfer resistance, CPE = constant phase element, W=Warburg impedance.

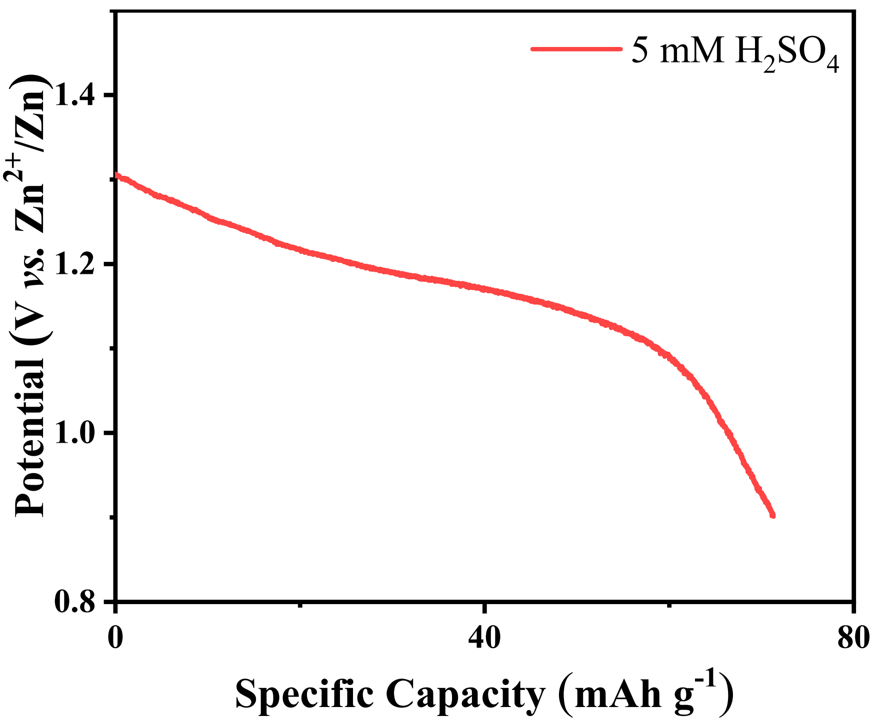

Figure S8. Galvanostatic discharge curve of the V_2O_5-YS cathode in a three-electrode cell in 5 mM H_2SO_4 electrolyte.

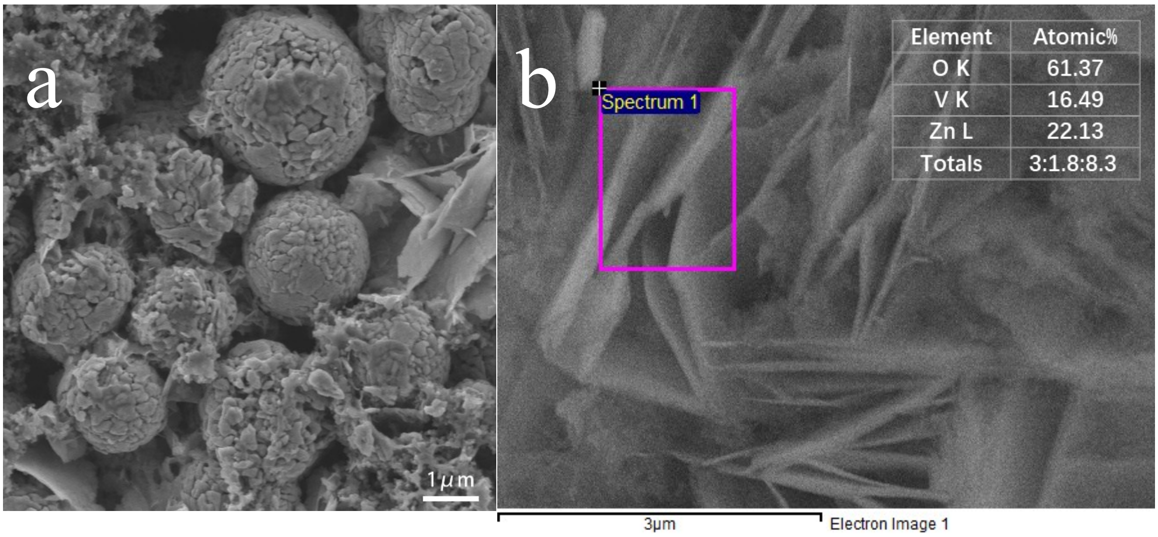

Figure S9. a) SEM image of V_2O_5-YS electrode soaked in aqueous electrolyte (nanoflakes: $Zn_3V_2O_7(OH)_2{\cdot}2H_2O$) b) Element quantification of nanoflakes and the ratio of Zn, V, O is accorded with $Zn_3V_2O_7(OH)_2{\cdot}2H_2O$.

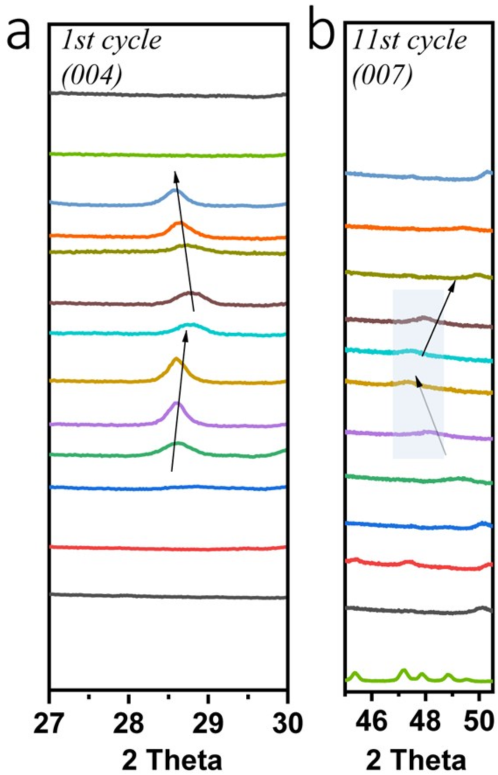

Figure S10. The magnified profile of a) (004) plane in the first cycle. b) (007) plane in the 11st cycle

Table S1. Comparison of battery performance of V_2O_5-YS with other V_2O_5-based cathode materials

Materials	Capacity	Cycling performance	Reference
V_2O_5-YS	410mA h g^{-1} at 0.1A g^{-1} 182mA h g^{-1} at 20A g^{-1}	80% after 1000 cycles at 5A g^{-1}	This work
V_2O_5	224mA h g^{-1} at 0.1A g^{-1}	37% after 400 cycles at 1A g^{-1}	Chem. Commun., 2018, 54, 4457
V_2O_5	132mA h g^{-1} at 10A g^{-1}	82% after 6000 cycles at 10A g^{-1}	Electrochimica Acta 306 (2019) 307e316
V_2O_5	336mA h g^{-1} at 50mA g^{-1}	85% after 5000 cycles at 10A g^{-1}	Nano Energy 60 (2019) 171–178
V_2O_5-CNT	219mA h g^{-1} at 10A g^{-1}	80% after 500 cycles at 10A g^{-1}	Nano Energy 60 (2019) 752–759
$Mg_{0.34}V_2O_5{\cdot}nH_2O$	81mA h g^{-1} at 5A g^{-1}	97% after 2000 cycles at 5 A g^{-1}	ACS Energy Lett. 2018, 3, 2602−2609
$Zn_{0.25}V_2O_5{\cdot}nH_2O$	223mA h g^{-1} at 4.5A g^{-1}	82% after 1000 cycles at 4.5A g^{-1}	Nature Energy 2016, 1, 16119
Expanded $V_2O_5{\cdot}2.2H_2O$	222mA h g^{-1} at 10A g^{-1}	72% after 3000 cycles at 5A g^{-1}	Nano Energy 62 (2019) 94–102
$V_2O_5{\cdot}nH_2O$-Graphene	248 mA h g^{-1} at 30A g^{-1}	71% after 900 cycles at 6A g^{-1}	Adv. Mater. 2018, 30, 1703725
$Li_xV_2O_5{\cdot}nH_2O$	170 mA h g^{-1} at 10A g^{-1}	67% after 50 cycles at 1A g^{-1}	Energy Environ. Sci., 2018,11, 3157-3162
$Ag_{0.4}V_2O_5{\cdot}nH_2O$	180 mA h g^{-1} at 2A g^{-1}	74% after 1000cycles at 5A g^{-1}	Energy Storage Materials 18 (2019) 10–14
$K_2V_8O_{21}$	247mA h g^{-1} at 0.3A g^{-1}	90% after 300 cycles at 6A g^{-1}	Nano Energy 51 (2018) 579–587
$NH_4V_4O_{10}$	150 mA h g^{-1} at 10A g^{-1}	76% after 100 cycles at 1A g^{-1}	J. Mater. Chem. A,2019, 7, 940–945
$Ca_{0.67}V_8O_{20}{\cdot}3.5H_2O$	291mA h g^{-1} at 5A g^{-1}	74% after 2000 cycles at 5A g^{-1}	ACS Nano 2019, 13, 12, 14447-14458
$Ca_{0.25}V_2O_5{\cdot}nH_2O$	72mA h g^{-1} at 5.76A g^{-1}	96% after 3000 cycles at 5.76A g^{-1}	Angew. Chem. 10.1002/ange.201713291

Table S2. Simulated parameters from EIS curves in Figure 4c using equivalent circuit in Figure S7.

Cell	R_s (Ω)	CPE (μF)	R_{ct} (Ω)
Pristine	0.6	18.3	380.0
After activation	4.6	696.2	39.8

Supplementary Note1: Discussion of the Galvanostatic Intermittent Titration Technique (GITT)

GITT tests were employed to determine the kinetic behavior of materials by calculating the Zn2+ diffusion coefficient based on the following equation:

$$D = \frac{4L^2}{\pi\tau}(\frac{\Delta E_s}{\Delta E_t})^2$$

Where L is diffusion length (cm) of Zn^{2+} ,which is approximate to thickness of electrode here, τ is the relaxation time (s), and ΔE_s is the steady-state voltage change (V) by the current pulse. ΔE_t is the voltage change (V) during the constant current pulse after eliminating the iR drop. All of the parameters are illustrated as follows.