Electronic supplementary information

Controlled oxidation of V_2O_5/VO_2 hollow nanospheres as photocathodes for photo-rechargeable zinc ion batteries with an ultrahigh capacity enhancement

Hongran Yang,[a] Shilei Wu,[a] Akesh Manimendra Badalge,[c] Xinyu Li,[c] Qianjin Wang,[ab] Yu Lin Zhong,[c] and Ting Zhu[ab]*

[a] School of Physics and Electronic Information, Yunnan Normal University, 768 Juxian Street, Kunming 650500, China.

[b] Yunnan Key Laboratory of Optoelectronic Information Technology, School of Physics and Electronic Information, Yunnan Normal University, Kunming 650500, China.

[c] School of Environment and Science, Griffith University, Nathan, QLD 4111, Australia.

*Emails: zhut0002@ynnu.edu.cn (T. Zhu)

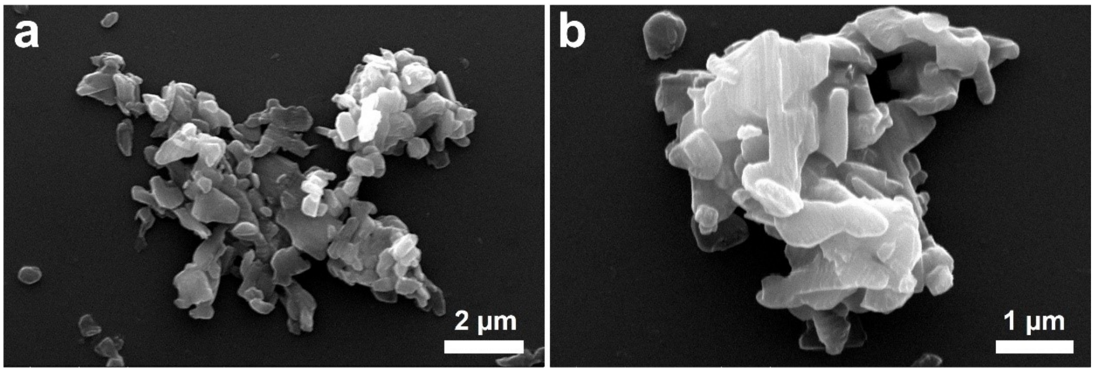

Fig. S1. SEM images of the starting commercial V_2O_5 particles.

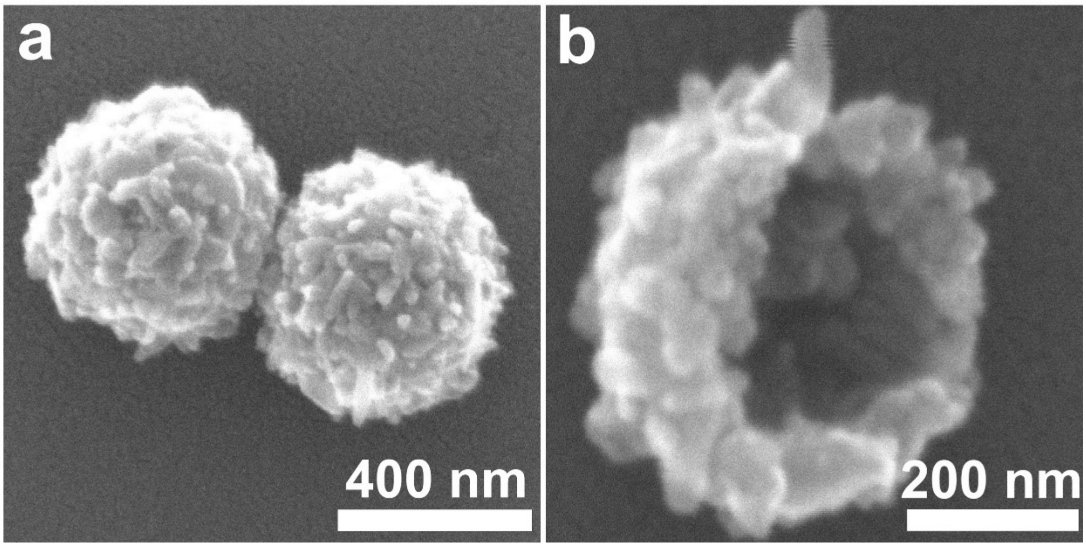

Fig. S2. SEM images of the intermediate VO_2 particles.

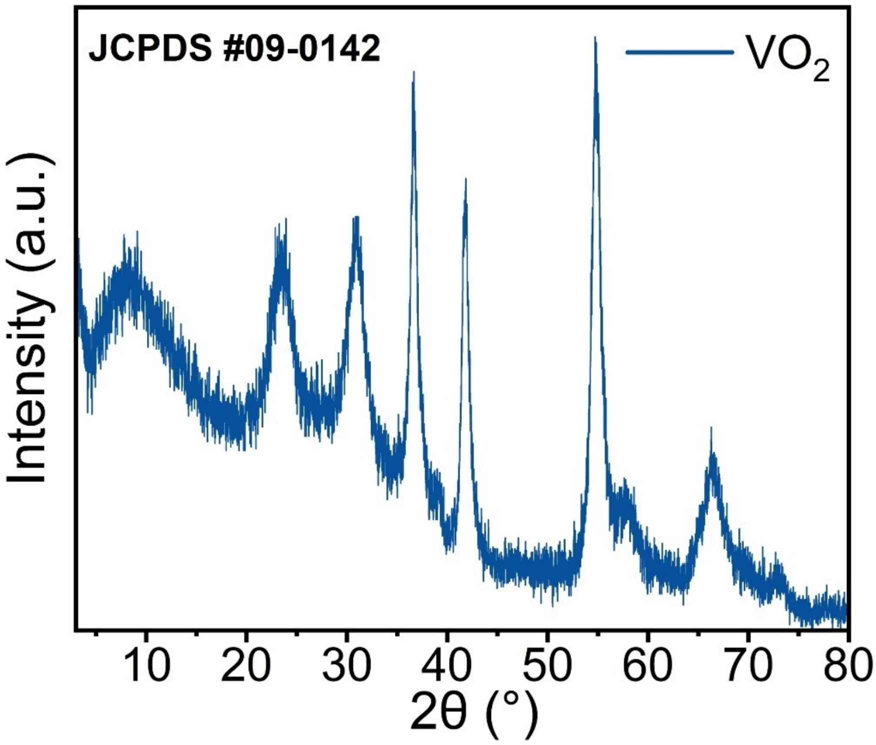

Fig. S3. XRD pattern of the intermediate VO_2 particles.

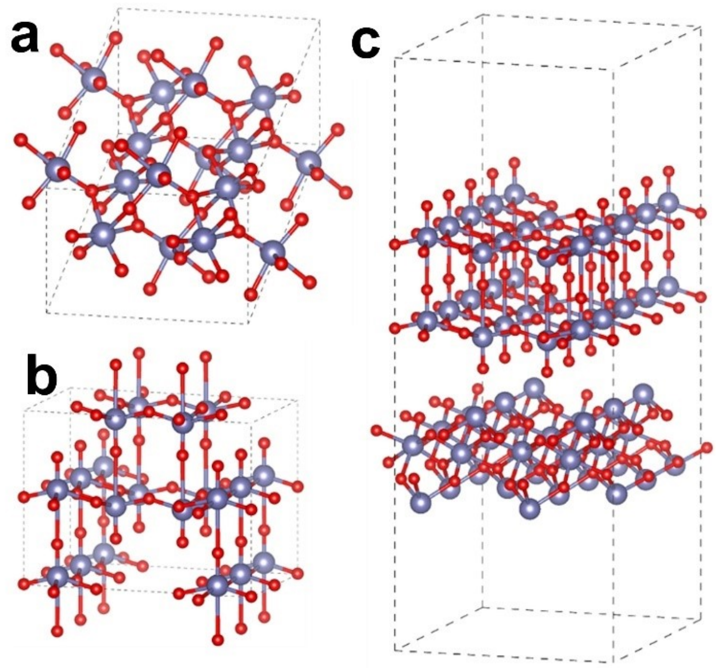

Fig. S4. The optimized models of VO_2 (a), V_2O_5 (b), and V_2O_5/VO_2 (c).

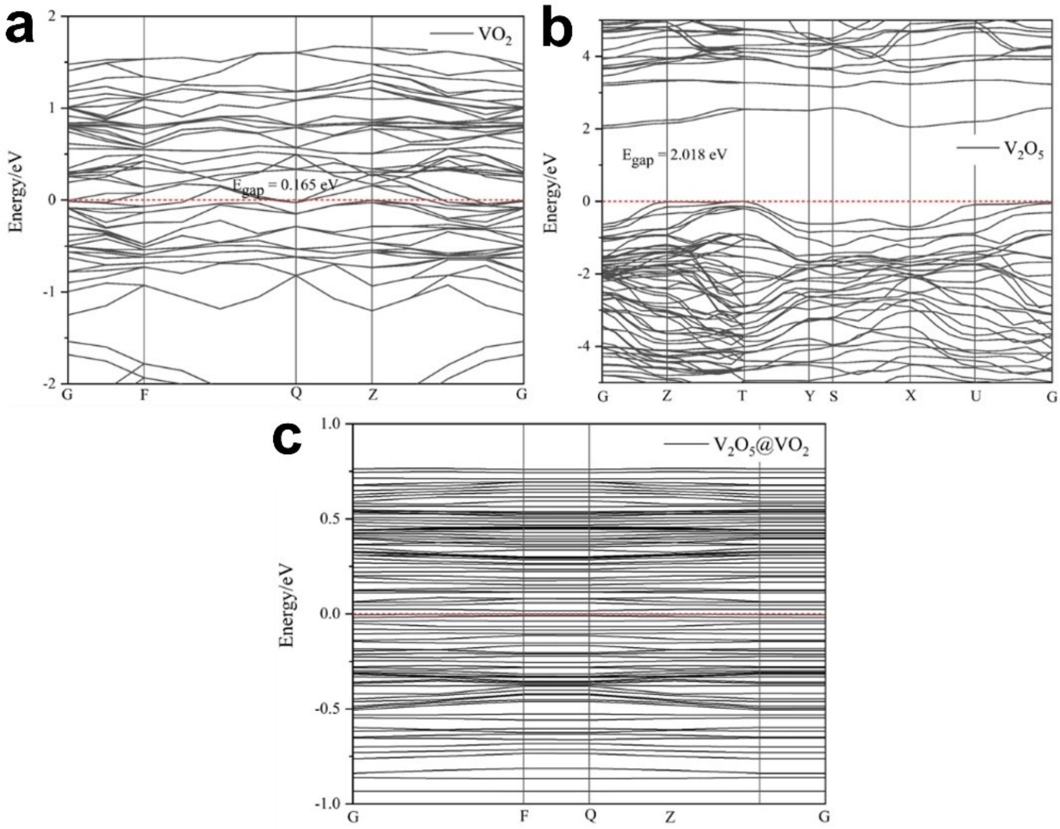

Fig. S5. The band structures of VO_2 (a), V_2O_5 (b), and V_2O_5/VO_2 (c).

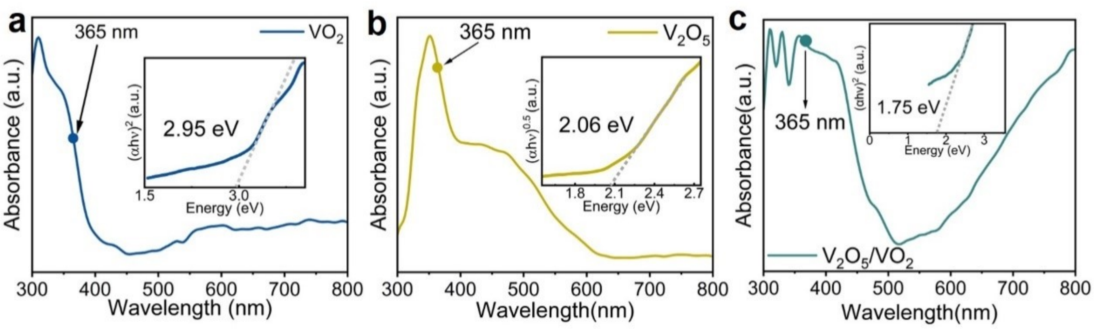

Fig. S6. UV-vis spectra of the intermediate VO_2 particles (a), V_2O_5 by a complete conversion from the intermediate VO_2 (b), and the final V_2O_5/VO_2 hollow nanospheres.

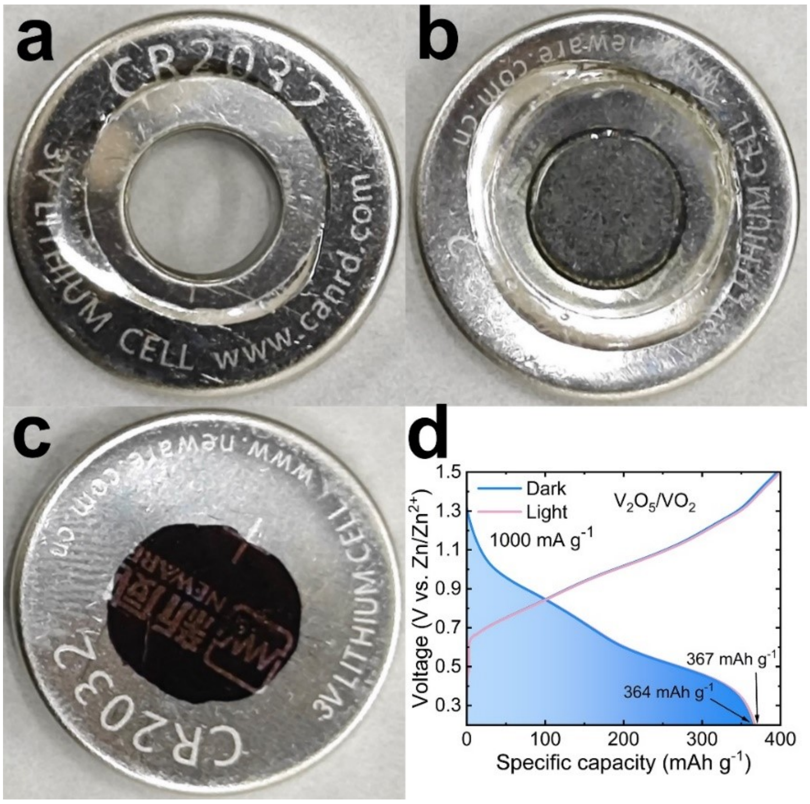

Fig. S7. The modified CR2032 coin cell with a PET transparent film in the punched hole (a), a ZIB full coin cell employing V_2O_5/VO_2 as cathode and Zn foil as anode (b), the ZIB coin cell with PET film filled in black using a mark pen (c), charge-discharge curves obtained with/without light irradiation of the ZIB coin cell in (c) to show the photothermal effect on electrochemical performances (d).

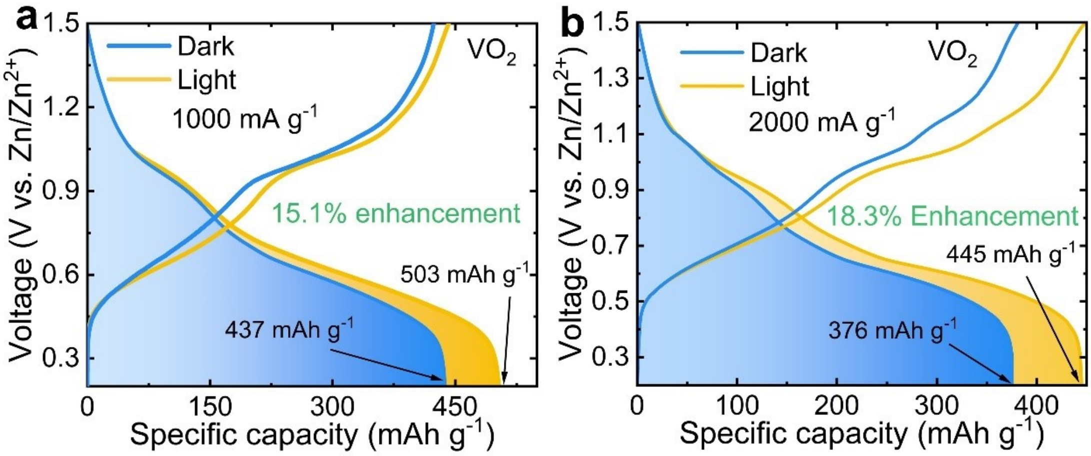

Fig. S8. Charge-discharge curves obtained with/without light irradiation at a current density of 1000 (a) and 2000 mA g^{-1} (b) of the intermediate VO_2 sample.

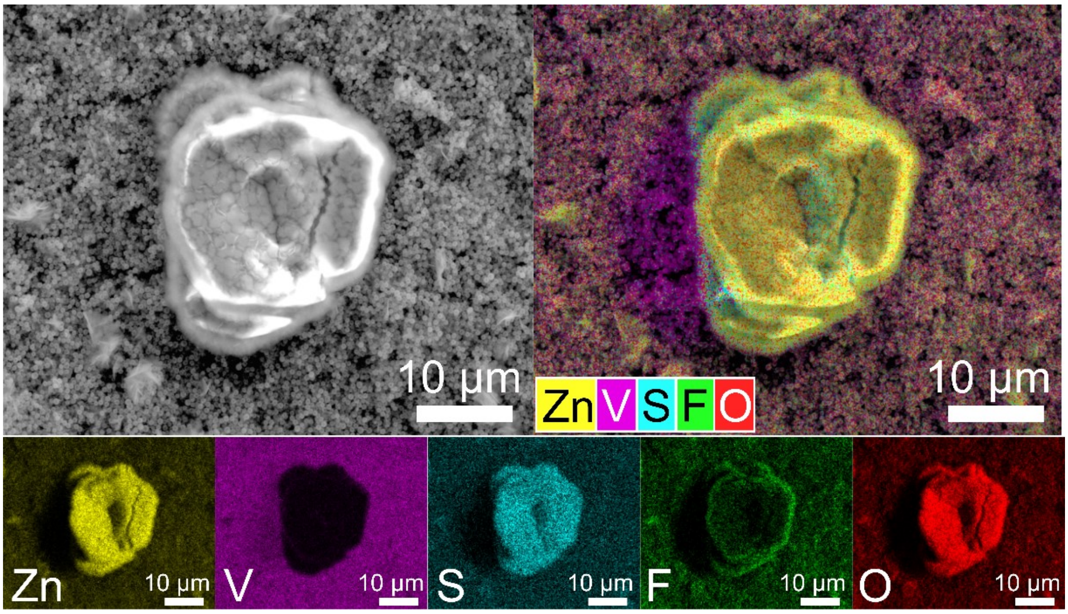

Fig. S9. SEM and EDX mapping of the V_2O_5/VO_2 cathode after 500 cycles at 5 A g^{-1}.

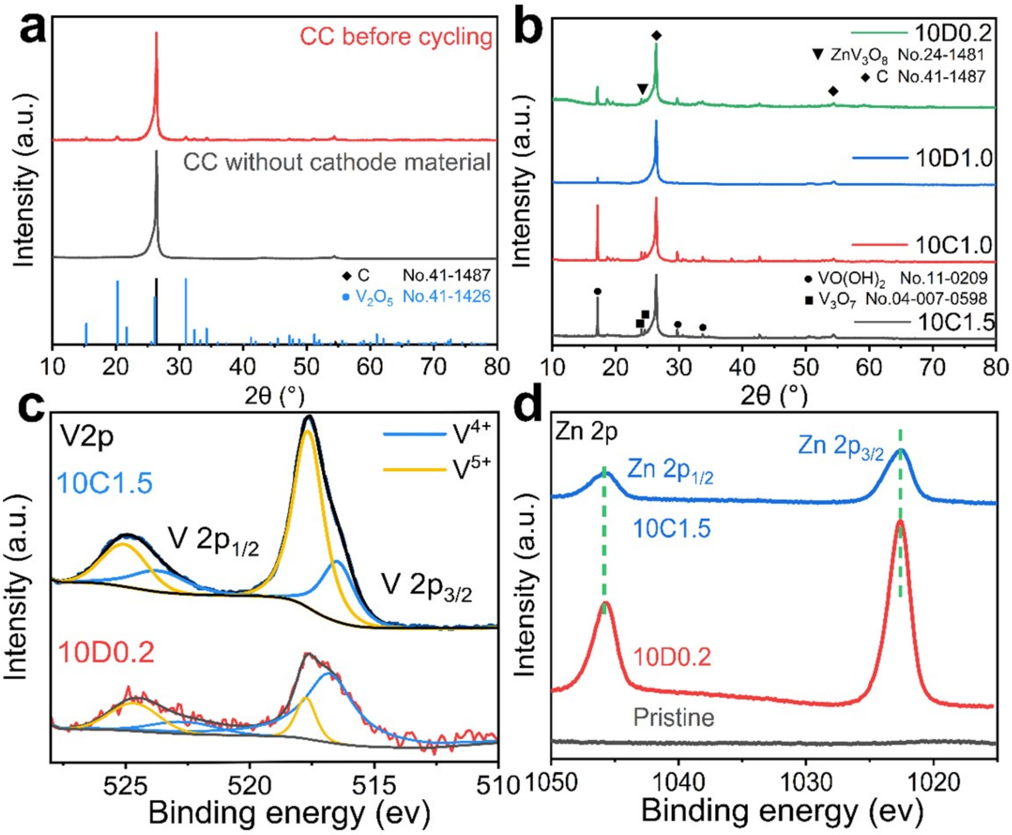

Fig. S10. XRD patterns (a and b) and XPS spectra (c and d) of the CC and the V_2O_5/VO_2 loaded CC electrodes before cycling (a), V_2O_5/VO_2 loaded CC electrodes cycled for 10 times, at which the ZIB cells were discharged to 1 V and 0.2 V, and re-charged to 1V and 1.5 V, respectively (b), V 2p (c) and Zn 2p (d) spectra of the V_2O_5/VO_2 loaded CC cycled for 10 times, at which the ZIB cells were charged to 1.5 V and discharged to 0.2 V, respectively.

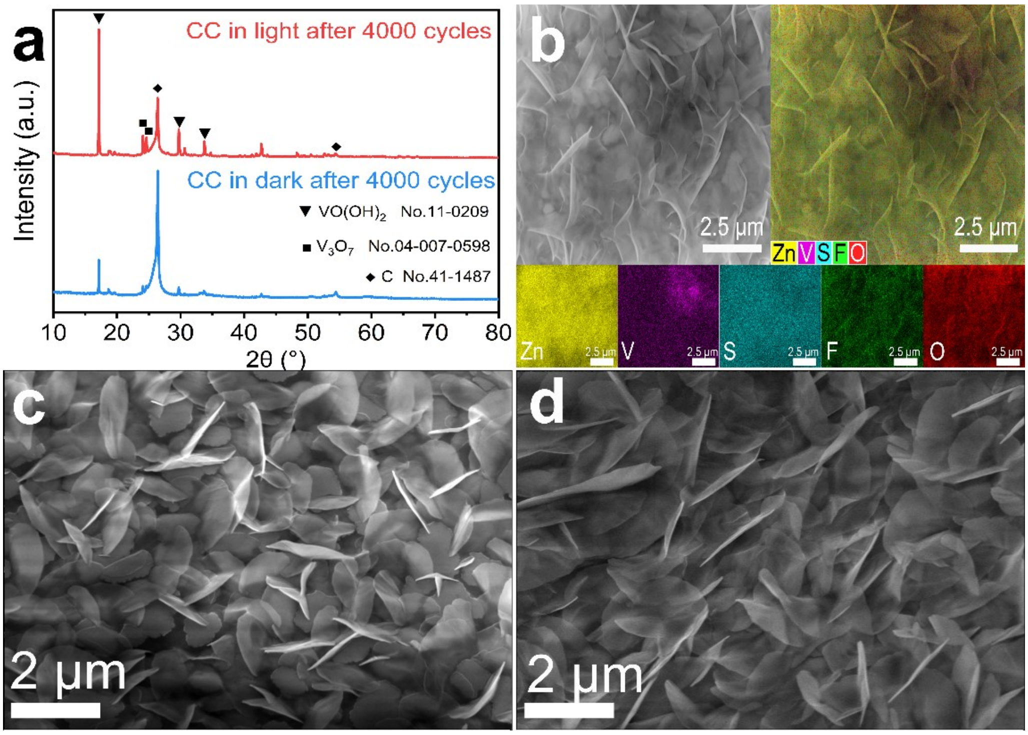

Fig. S11. XRD patterns (a), SEM and EDX images (b-d) of the V_2O_5/VO_2 loaded CC cathodes after 4000 cycles under dark and light conditions, respectively.

Table S1. A summary of the important parameters and performance of the recently

Cathode materials	Battery system	Current density /mA g^{-1}	Discharge capacity (dark)/mAh g^{-1}	Light enhancement	Cycling performance	Light source	Conversion efficiency (ŋ)
This work	ZIBs	200	441.8	77.8%	200 mA g^{-1} for 500 cycles /84.6%	365 nm	4.3%
VO_2/ZnO[1]	ZIBs	200	367	17.7%	200 mA g^{-1} for 500 cycles /73%	455 nm	0.51%
VO_2/rGO[2]	ZIBs	200	282	11.7%	1000 mA g^{-1} for 1000 cycles /90.0%	455 nm	0.18%
V_2O_5/P3HT/rGO[3]	ZIBs	1000	103	33.0%	/	455 nm	1.2%
MoS_2/ZnO[4]	ZIBs	100	245	38.7%	500 mA g^{-1} for 200 cycles /82%	455 nm	1.8%
MoS_2/C-NT[5]	ZIBs	100	254	39.7%	500 mA g^{-1} for 1000 cycles /70%	1 sun	0.98%
MoS_2/SnO_2[6]	ZIBs	100	190	92.6%	/	1 sun	2.7%
V_2O_5[7]	ZIBs	100	281	68.5%	5000 mA g^{-1} for 4000 cycles /89.3%	450 nm	5.2%
SnO_2/MnO_2[8]	ZIBs	200	333	56.4%	1000 mA g^{-1} for 500 cycles /90.0%	1 sun	1.2%
TiO_2/CuTPP /Cu:V_2O_5[9]	ZIBs	100	210	27.6%	/	1 sun	5.51%
V_2O_5/P3HT/rGO[10]	LIBs	200	118	36.4%	/	455 nm /1 sun	2.6% /0.22%
V_2O_3@CSs[11]	ZIBs	500	305	51.8%	2000 mA g^{-1} for 300 cycles /90%	550nm	0.354%
$MoSe_2$-V_{Se}[12]	ZIBs	100	186.2	26.0%	500 mA g^{-1} for 100 cycles /63.0%	1 sun	0.58%

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