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Freestanding graphene/VO_2 composite films for highly stable aqueous Zn-ion batteries with superior rate performance

Aqueous Zn-ion batteries (ZIBs) are promising energy storage systems owing to their high safety and low cost.[1] However, their unsatisfactory energy and power densities as well as the cycling performance have hindered their practical application. Herein, we demonstrate a highly reversible zinc/vanadium dioxide system, where freestanding reduced graphene oxide/vanadium dioxide (RGO/VO_2) composite films are used as the cathodes. Owing to the synergistic effects from continuously porous network of RGO[2] and the robust structure of VO_2, RGO/VO_2 composite films not only enhance the transport of electrons and ions, but also accommodate the considerable deformations caused by Zn^{2+} extraction/insertion. Therefore, the Zn/VO_2 batteries exhibit an energy density of 65 Wh kg^{-1} even at a high power density of 7.8 kW kg^{-1}. More impressively, they deliver excellent capacity retention of 99% after 1000 cycles. In addition, the RGO/VO_2 composite films can serve as the electrodes of flexible ZIBs. Flexible soft-packaged Zn/VO_2 batteries demonstrated stable electrochemical performance at various bending states. Therefore, the rechargeable Zn/VO_2 battery can bridge the gap between conventional batteries and supercapacitors, opening new opportunities for powering portable electronic devices and hybrid electric vehicles.

References

[1] Fang Wan, Linlin Zhang, Xi Dai, Xinyu Wang, Zhiqiang Niu & Jun Chen. Nat. Commun. 1 (2018).
[2] Zhiqiang Niu, Lili Liu, Li Zhang, Qi Shao, Weiya Zhou, Xiaodong Chen, Sishen Xie. Adv. Mater. 22 (2014).

Figure

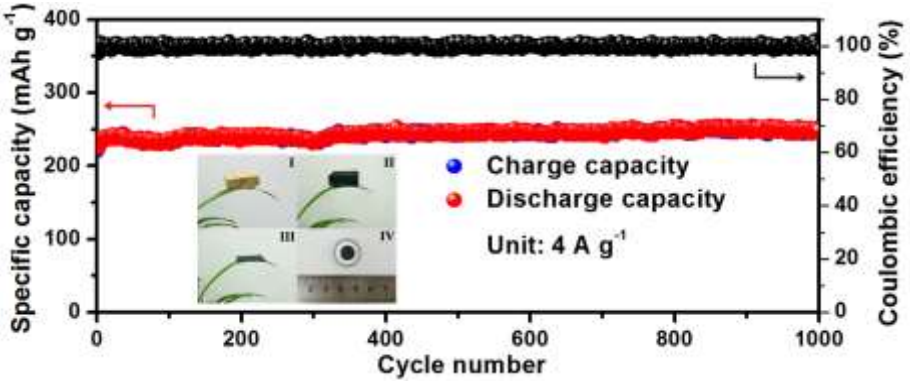

Figure: Long-term cycling performance with Coulombic efficiency of the RGO/VO_2 composite film at 4 A g^{-1}. The inset shows the optical images of corresponding samples. I: NH_3VO_4/GO foam through freeze-drying; II: RGO/VO_2 foam via calcination; III: freestanding RGO/VO_2 electrode film after mechanical compression; IV: the desirable piece of RGO/VO_2 composite film electrode for ZIBs.