$H_2V_3O_8$ Nanowire/Graphene Electrodes for Aqueous Zinc-ion Batteries with Ultrahigh Rate Capability and Large Capacity

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Zinc metal has some significant advantages such as low price, rich global distribution, high stability, relatively low redox potential and high theoretic capacity. It has been directly used as the anode material for aqueous zinc ion batteries (ZIBs).[1] However, lack of suitable cathode materials is one of the biggest hindrances of aqueous ZIBs because of the large atomic mass and poor transport kinetics of Zn^{2+}. In this work, we developed a composite material comprised of $H_2V_3O_8$ nanowires (NWs) wrapped by graphene sheets and used it as the cathode material for aqueous ZIBs. The $H_2V_3O_8$ NW/graphene was synthesized through a simple hydrothermal reaction. The as-synthesized $H_2V_3O_8$ NWs exhibited high crystallinity, uniform size distribution and a large aspect ratio with length of 3-5 μm and diameter of 50-100 nm. Graphene sheets were well blended within the randomly oriented NWs forming a homogeneous mixture. Owing to the synergistic merits of desirable structural features of $H_2V_3O_8$ NWs and high conductivity of graphene network, the $H_2V_3O_8$ NW/graphene composite exhibited superior Zn^{2+} storage performances including large specific capacity of 394 mAh g^{-1} at 1/3C rate, high rate capability of 270 mAh g^{-1} at 20C rate and excellent cycling stability of up to 2000 cycles with a capacity retention of 87%. The material offered a high energy density of 168 Wh kg^{-1} and a high power density of 2215 W kg^{-1}. Systematic structural and elemental characterizations confirmed reversible Zn^{2+} and water co-intercalation into the $H_2V_3O_8$ NWs. This work brought a new prospect of designing high-performance aqueous ZIBs for grid-scale energy storage.

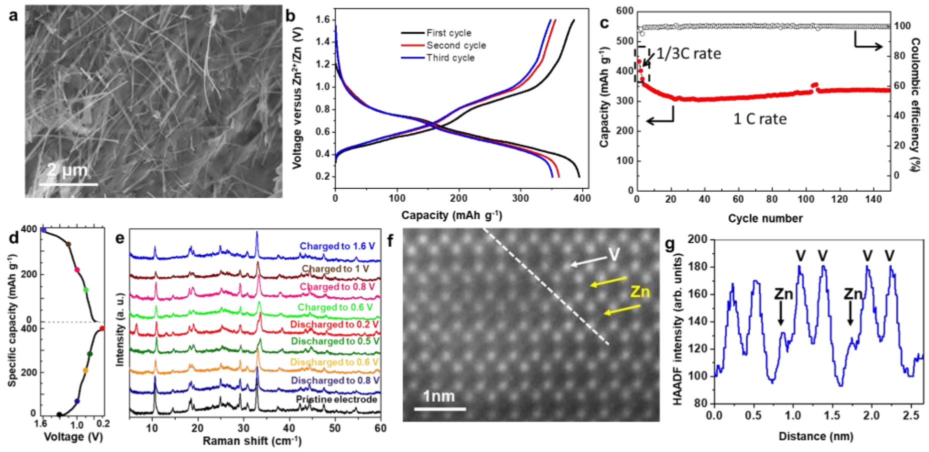

Fig. 1. (a) SEM image of the $H_2V_3O_8$/graphene composite; (b) Charge-discharge profiles of the the $H_2V_3O_8$/graphene at 1/3C rate; (c) Cycling performance at 1C rate; (d) Charge/discharge curves of the first cycle and sampling points for XRD characterization; (e) Ex-situ XRD patterns during the first cycle; (f) High-precision HAADF STEM image of a $H_2V_3O_8$ NW discharged to 0.2 V; (g) Intensity line scan along the white dashed line in the HAADF image.

References:

[1] D. Kundu, B.D. Adams, V. Duffort, S.H. Vajargah, L.F. Nazar, *Nat. Energy* 1 (2016) 16119.