Supporting information for

Low crystallinity VOOH hollow microspheres as outstanding high-rate and long-life cathode for sodium ion batteries

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Experimental details

Synthesis of VOOH and V_2O_5 hollow microspheres: The $V(OH)_2NH_2$ solid precursors were first prepared according to the method reported in literature with minor modification.[30] Briefly, 2 mmol of NH_4VO_3 and 1 mL of HCl (1 $mol \cdot L^{-1}$) were dissolved in 45 mL of H_2O to obtain a yellow transparent solution. Subsequently, 3 mL of hydrazine ($N_2H_4 \cdot H_2O$) was introduced into the above solution dropwise, which was further stirred at room temperature for 30 min. The yellow transparent solution became gray and turbid. At last, the $V(OH)_2NH_2$-containing suspensions were directly transferred into an autoclave and hydrothermally treated at 120^{o}C for 4h. The VOOH precipitate was collected by centrifuging and washing. High crystalline V_2O_5 hollow microspheres were obtained via calcination of VOOH at 350^{o}C in air for 3h.

Characterization methods: The morphology, microstructure, and composition of the materials were investigated by FE-SEM (Hitachi SU8000), TEM (Philips EM 420), XRD (Bruker D4), XPS (VG ESCA 2000), and FTIR (Nicolet 730).

Electrochemical testing: The working electrode slurry was prepared by dispersing the

mixture of VOOH or V_2O_5, Super P-Li, and poly(vinylidene fluoride) (PVDF) binder with a weight ratio of 7/2/1 in N-methylpyrrolidone. The slurry was spread onto aluminum foil disks and dried in a vacuum oven at 120 ^oC overnight. The mass loading of active material on each electrode is about 1mg cm^{-2}. Na foil as the counter and reference electrodes, and 1 mol L^{-1} $NaClO_4$ dissolved in propylene carbonate (PC) solvent as the electrolyte, Celgard 2500 as the separator, were used to assemble a CR2032 coin cell. Galvanostatic discharge and charge tests were performed with a cycle tester from LAND Electronic Co. The cyclic voltammograms were obtained using ZAHNER Electrochemical Workstation IM6.

Supplementary figures

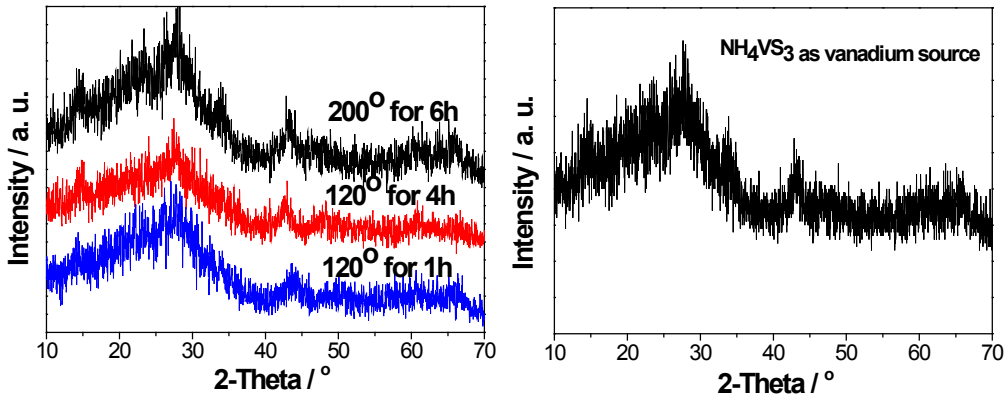

Figure S1 XRD patterns of VOOH hollow microspheres prepared at different hydrothermal conditions or using different vanadium sources.

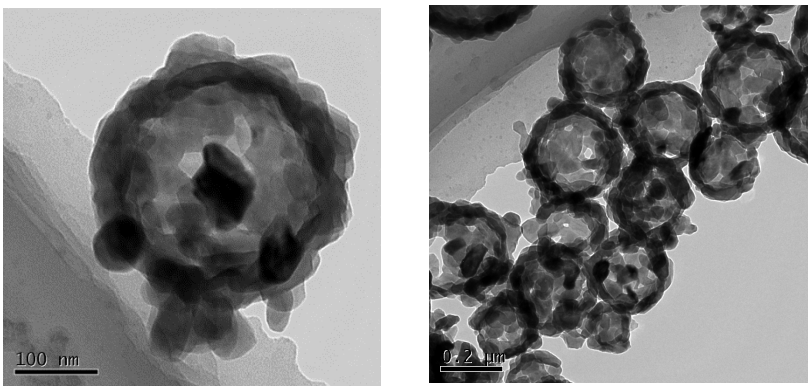

Figure S2 TEM images of high crystallinity V_2O_5 hollow microspheres.

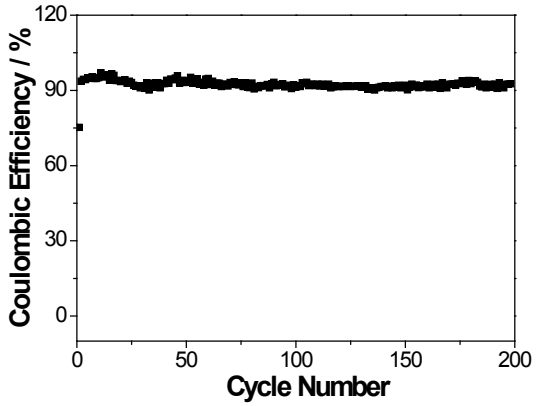

Figure S3 Coulombic efficiency of the VOOH microspheres electrode during long-term cycles.

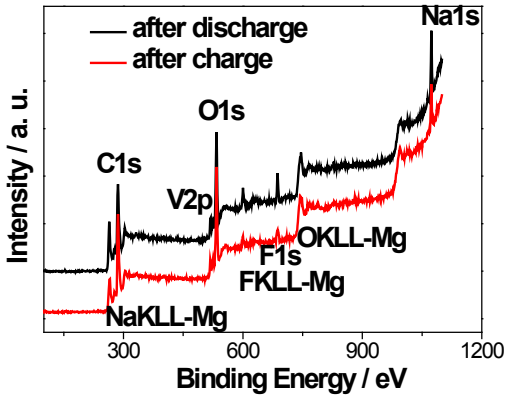

Figure S4 Survey XPS spectra of VOOH electrodes after cycling.