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Electrochemical performance of V_2O_5 cathodes in zinc (2+)-containing aqueous electrolytes

Veniamin V. Kondratiev[1*], Alexey I. Volkov[1], Andrey S. Sharlaev[2], Olga Ya. Berezina[2]

[1] *Saint Petersburg State University, Institute of Chemistry, 7/9 Universitetskaya nab., Saint Petersburg, Russia, 199034*
[2] *Petrozavodsk State University, Lenin Street 33, Petrozavodsk, Russia, 185910*

Aqueous Zn-ion batteries (AZIBs) are considerd as one of the promising energy storage devices due to their intrinsic safety, environmental frend less, and the Zn abudance. The main bottleneck is at the choice of accepatable cathode materials for Zn ion because of their unsatisfactory charging property, low energy density and poor cycling stability. Vanadium pentaoxide has been consurered as a promising cathode material for AZIBs, due to its unique layered structure with high interlayer distance providing possibility to reversibly intercalate Zn^{2+} ions, abundant resources and relatively high theoretical capacity.

In this work, the $V_2O_5 \cdot nH_2O$ was obtained by the sol-gel method and then, vanadium pentoxide nanofibers have been manufactured by the electrospinning method followed by thermal treatment in air. The morphology and structural characterization was performed by an optical and scanning electron microscopy, energy-dispersive X-ray elemental analysis, X-ray diffraction. XRD pattern of V_2O_5 demonstrated its high purity and good crystallinity and obtained data are in agreement with card ICDD № 01–077–2418. V_2O_5 has a layered structure, were each layer of phase is built by edge- and corner-sharing VO_5 pyramids and the large interlayer distance is beneficial for Zn^{2+} ions insertion/extraction.

The electrochemical properties of V_2O_5 based electrodes were investigated by cycling voltammetry and galvanistatic cherge-discharge curves both in standard three-electrode cells and CR2016-type cells with aqueous solution of 3M $ZnSO_4$. Cyclic voltammograms recorded for initial several cycles show the gradual redox peaks redistribution which is related to the phase transformation and it agrres with results commonly reported for V_2O_5. After first cycles of "activation" CVs in the stabilized form shows two pair of peaks at 1,0 and 0,7 V.

These peaks are attributed to formation of new Zn-containing phases of $Zn_xV_2O_5$. The specific capacity and rate performance of the Zn/V_2O_5 system were tested by galvanostatic charge and discharge curves at different current density. It was found that the V_2O_5 electrodes deliveres of max capaicity 357 $mAh \cdot g^{-1}$ at currents densities of 0.05 $A \cdot g^{-1}$, 303 $mAh \cdot g^{-1}$ at currents densities of 0.1 $A \cdot g^{-1}$ and 190 $mAh \cdot g^{-1}$ at currents densities of 2 $A \cdot g^{-1}$, respectively. The results showed a high reversible capacity of electrode, good rate capability and enhanced cycle performance.

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