УФИМСКИЙ ИНСТИТУТ ХИМИИ
УФИМСКОГО ФЕДЕРАЛЬНОГО ИССЛЕДОВАТЕЛЬСКОГО ЦЕНТРА
РОССИЙСКОЙ АКАДЕМИИ НАУК

ИНСТИТУТ ФИЗИЧЕСКОЙ ХИМИИ И ЭЛЕКТРОХИМИИ
ИМЕНИ А.Н. ФРУМКИНА РАН

МОСКОВСКИЙ ГОСУДАРСТВЕННЫЙ УНИВЕРСИТЕТ
ИМЕНИ М.В. ЛОМОНОСОВА

АКТУАЛЬНЫЕ ПРОБЛЕМЫ ПРЕОБРАЗОВАНИЯ ЭНЕРГИИ В ЛИТИЕВЫХ ЭЛЕКТРОХИМИЧЕСКИХ СИСТЕМАХ

Материалы XVI Международной конференции
20 – 24 сентября 2021 года

Ответственный редактор
профессор Колосницын В.С.

УФА, Россия

2021

V_2O_5@PEDOT as high-performance cathode material for aqueous zinc-ion batteries

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Among the various candidates of the new type of metal-ions batteries as an alternative power sources, rechargeable aqueous zinc-ion batteries (AZIB) has received much attention last decade due to their safety and cost-effectiveness.

V_2O_5 has been regarded as a promising cathode material for AZIBs, attributed to its unique layered structure providing possibility to reversibly intercalate Zn^{2+} ions and relatively high theoretical capacity. However, there are several drawbacks of V_2O_5 like its dissolution, structural instability, low electronic conductivity. Different strategies can be applied to overcome these problems: 1) nanostructuring the materials with specific architecture; 2) introducing other metal ions; 3) selection the electrolyte; 4) surface modification by graphene, carbon nanotubes, conducting polymers.

Vanadium oxide coated by poly(3,4-ethylenedioxythiophene) (V_2O_5@PEDOT) was successfully synthesized by chemical oxidation of EDOT. V_2O_5@PEDOT was characterized by energy dispersive X-ray and thermogravimetric analyses to evaluate the amount of PEDOT on the oxide surface and by scanning electron microscopy. Electrode materials were prepared by mixing of V_2O_5 and V_2O_5/PEDOT (70 wt.%) with carbon black (20 wt.%) and polyvinylidene fluoride (10 wt.%) dissolved in N-methylpyrrolidone. The resulting viscous slurry was cast on the titan foil, dried under vacuum and pressed. Coin cells CR 2032 were assembled vs. Zn foil as anode with 3 M $ZnSO_4$ as electrolyte. Comparative study of electrochemical properties of V_2O_5 and V_2O_5@PEDOT electrodes was performed by cyclic voltammetry and galvanostatic charge/discharge in a potential range 0.3 – 1.4 V vs. Zn/Zn^{2+}.

The gradual transformation of V_2O_5 material structure and the corresponding development of cyclic voltammograms shapes were observed for first several cycles (1-5 cycles). Finally, two pairs of anodic/cathodic peaks in the CV curves. For V_2O_5@PEDOT electrode the two pairs of peaks were observed right after first cycle, their potentials were at 1.05/0.95 and 0.75/0.65 V, respectively. These peaks are attributed to the formation of new Zn-containing phases of $Zn_xV_2O_5$, corresponding to the different degree of intercalation of Zn^{2+} ions.

Enhanced specific capacities of V_2O_5@PEDOT-electrodes were observed immediately from the first cycles compare to V_2O_5 at different current (see Table 1, Q for 1st / 10 cycles).

Table 1. Specific capacities of V_2O_5 and V_2O_5@PEDOT-electrodes.

	Q, mAh·g^{-1}			
	0.1 A·g^{-1}	0.3 A·g^{-1}	1 A·g^{-1}	5 A·g^{-1}
V_2O_5	100 / 260	125 / 187	62 / 110	32 / 64
V_2O_5@PEDOT	320 / 280	300 / 360	333	265

Acknowledgements: The financial support from RFBR (grant № 21-53-53012) is gratefully acknowledged. The authors would like to thank the Research Park of Saint Petersburg State University: 1) the Center for X-ray Diffraction Methods, 2) the Interdisciplinary Center for Nanotechnology, the Center for Thermogravimetric and Calorimetric Research.

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