Electronic Supplementary Information for

A one-pot method to prepare a ZnO/Ag/Polypyrrole composite for zinc alkaline secondary batteries

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1. Preparation of ZnO/Ag/Polypyrrole composite

In this paper, silver-ammonia solution, pyrrole monomer and ZnO were adopted as the initial materials. ZnO/Ag/polypyrrole composite (ZAP) was synthesized through a redox reaction between silver-ammonia solution and pyrrole. In a typical preparation process, 0.6 g ZnO was dispersed in 20 mL distilled water under ultrasound, a fresh silver-ammonia solution prepared with 0.15 g $AgNO_3$ was added into above ZnO suspension liquid, then excess pyrrole monomer of 0.24 ml was introduced to above system. After 5 min ultrasonic treatment, the above mixture solution was kept under stir for 10 h. As the redox reaction continues, the color of the system changed from white to brownish black slowly. The resulting product was filtered and washed thoroughly with distilled water and methyl alcohol, and the filtered sample was dried in a vacuum oven at 333 K for further test.

For fabrication of zinc electrode, 85wt. % of ZnO powder was mixed with 10wt. % acetylene black served as conductive agent and 5wt. % PTFE served as binder, respectively. And the mixture was grinded with agate mortar until it became muddy mixture with proper viscosity. Then above muddy mixture was incorporated to a copper mesh that served as current collector. For the fabrication of ZAP electrode, 95 wt. %

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ZAP was mixed with 5wt. % PTFE, in which acetylene black is abandoned because the exist of silver in ZAP composite could play the conductive agent instead of acetylene black. The obtained electrodes were dried at 333K in a vacuum oven for further testing.

2. Characterization of ZnO/Ag/Polypyrrole composite

Fourier transform infrared (FT-IR) spectroscopy of ZAP samples was conducted on a Nicolet Nexus-670 FT-IR spectrometer, using KBr pellets, with wave number 400-4000 cm^{-1}. Scanning electron microscope (SEM) (JSM-6360LV) and transmission electron microscope (TEM) (JEOL-2010) was used to observe the morphology and structure of samples. X-ray powder diffraction (XRD) measurement using X-ray diffractometer (Philips X' Pert Pro) with Cu Kα radiation source was utilized to characterize the crystal structures of all the samples were characterized.

3. Electrochemical measurements

A two-electrode system which includes working electrode and counter electrode was adopted to conduct galvanostatic charge/discharge cycle test. The capacity of chosen counter electrode (sintered $Ni(OH)_2$ electrode) was three times higher than working electrode in the aim of making sure that the capacities of cells was controlled by working electrode. In addition, 6.0 M KOH solution with saturated ZnO was used as the electrolyte, multilayer polypropylene micro-porous membranes as the separator. The two-electrode system were charged at 1C for 60 min and discharged at 1C down to 1.2V cut-off. Cycle test was performed with a battery test apparatus NEWWARE BTS-610 (Newware Technology Co., Ltd., China). As to electrochemical impedance spectroscope (EIS), a three-electrode cell with an Hg/HgO electrode as the reference electrode was adopted. EIS was conducted over the frequency range from 100 kHz to 0.01 Hz, the amplitude of the ac potential perturbation was 5 mV. And EIS data was fitted using the software of Zview. EIS analysis was conducted with Parstat 2273 (Princeton Applied Research) electrochemical workstation. The cyclic

voltammetry test (CV) was carried out using RST 5000 (Zhengzhou Shiruisi Technologh Co., Ltd.) electrochemical workstation over the rage from –0.85V to –1.65V with scanning rate of 20 mV s-1.