

Free-Standing S-CNT-rGO Nanocomposite Paper Cathodes for Li-S Batteries

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Extended Abstract

For electric vehicles (EVs), hybrid electric vehicles (HEVs), and smart electric grids, it is important to develop advanced energy storage systems due to the ever-increasing demands for high energy density and long-life energy sources. With a high theoretical gravimetric energy density of 2500 Wh kg⁻¹, Lithium-sulfur (Li-S) batteries are considered to be one of the most promising candidates in this respect [1]. However, the practical electrochemical performance of Li-S battery have been restricted by the low conductivity of sulfur and the insoluble and insulating lithium sulfides, Li₂S₂/Li₂S on the cathode surface [2]. To resolve these problems, especially carbon materials are used to increase the conductivity. Due to their high electrical conductivity, porous carbon, carbon nanotubes (CNTs) and reduced graphene oxide (rGO) are generally used to enhance the conductivity of sulfur and Li₂S / Li₂S₂ during charge-discharge process [3].

In this work, we produced S-CNT-rGO nanocomposites as binderless free-standing paper. Firstly, functionalized MWCNTs were prepared with H₂SO₄/HNO₃ mixture (3:1, v/v) and graphite oxide was produced by modified Hummers method. Then, Na₂S₂O₃.5H₂O precursor was added into the mixture of graphite oxide and CNTs. After ultrasonication of 2h, HCl solution was added dropwise to resulting homogeneous suspension. During this process, the sulfur anions reduced and deposited on the surface of the graphene oxide and CNTs as sulfur nanoparticles. The resulting suspension was filtered through a 0.22 µm porous PVDF membrane filter (Millipore, Durapore Membrane) with a vacuum filtration system and washed three times with deionized water and ethanol. After the paper dried, it was peeled off the membrane and flexible S-CNT-rGO paper was obtained. To obtain S-CNT-rGO from this structure, the S-CNT-rGO paper was treated with a dilute solution of hydrazine as reducing agent. Obtained papers were characterized by field emission scanning electron microscopy (FESEM), energy dispersive X-ray spectrometer (EDS), X-ray diffraction (XRD) and Fourier transform infrared spectroscopy (FT-IR) analyses. Electrochemical analysis was performed using battery tester device. Charge-discharge capabilities, specific capacity and capacity retention parameters were investigated of the cathode electrodes assembled in the type of CR2032 cells. When the results have been evaluated, it has seen that the aimed structure of S-CNT-rGO has been obtained for advanced Li battery applications.

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References

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