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Hollow structure in MnO2 wrapped sulfur microsphere to suppress the volume changes in lithium-sulfur battery

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Abstract

Statement of the Problem: Lithium-sulfur batteries are considered as a promising candidate for next-generation energy-storage devices due to their high theoretical energy density of 2600 W h kg-1 (sulfur cathode coupled with lithium metal anode). The sulfur cathode has a high theoretical specific capacity of 1673 mA h g-1. It is low cost and environmentally friendly. However, there are several challenges in sulfur cathodes before using in practical application such as low conductivity of sulfur and their intermediates, large volumetric expansion during lithiation and "shuttle effect" of soluble polysulfides.

Methodology & Theoretical Orientation: In this study, we have prepared sulfur microspheres with hollow structures by adding MWCNT. These hollow structures are able to provide space for the expansion of sulfur during the lithiation. Then, the sulfur microspheres were wrapped by MnO2 nanoflakes, which can strongly absorb the polysulfides to prevent from the "shuttle effect". Moreover, carbonized polyaniline (PANI) separated reduced graphene oxide (RGO) was used as the conducting additives coupled with carbon black, which helps to build a light and conductive matrix. The characterization of electrode materials was performed by XRD, SEM, TEM and Raman spectroscopy. The electrochemical performance of assembled lithium sulfur batteries was measured by cyclic voltammetry (CV) and galvanostatic charge-discharge (GCD) techniques. The effect of hollow structure in the sulfur microspheres on the electrochemical performance especially on cycling life was evaluated.

Findings: The hollow structure in the sulfur microspheres were obtained by adding MWCNT during the formation of sulfur. MnO2 shells were easily created by one-step oxidation. The hollow structure provides space for the expansion of sulfur during the charge/discharge, resulting in a better cycling stability.

Biography:

Dr. Haojie Fei's research interests focus on the electrochemical energy storage devices, especially on sueprcapacitores and their flexibilization. Recently, a new research direction on lithium sulfur batteries are carried out in UTB energy storage team, which is a promising candidate for advanced batteries in the future. The team has prepared several cathode materials for lithium sulfur batteries based on reduced graphene oxide, Mxene, MOF and other materials.

Speaker Publications:

1. Fei, H.; Saha, N.; Kazantseva, N.; Moucka, R.; Cheng, Q.; Saha, P. (2017) A highly flexible supercapacitor based on MnO2/RGO nanosheets and bacterial cellulose-filled gel electrolyte. Materials, 10 (11), 1251.
2. Fei, H.; Saha N.; Kazantseva N.; Babkova T.; Machovsky M.; Wang G.; Bao H.; Saha P. (2017) Polyaniline/reduced graphene oxide hydrogel film with attached graphite current collector for flexible supercapacitors. Journal of Materials Science: Materials in Electronics

22nd International Conference on Advanced Energy Materials and Research; Webinar- July 15-16, 2020.

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