Online Proceedings

POSTER SESSION 2

Balcony, Easel 102

1:00 PM to 2:30 PM

Effect of MnO_2 Crystal Structure on the Electrochemical Performance of Zn/MnO_2 Batteries

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Mentor: Jihui Yang, Materials Science and Engineering
Mentor: Yun Li, materials science and engineering

Due to society's increasing energy demand and the push for technological innovation within key industries (e.g. consumer electronics and electric vehicles), major advancements in energy storage technology, specifically battery technology, are needed. While Li-ion batteries are currently regarded as one of the premier options for reusable energy storage, they are not as safe, environmentally-friendly, or cost-effective as currently researched alternatives. One promising alternative is the rechargeable Zn/MnO_2 battery which offers many benefits such as high energy density, low cost, and the ability to use non-corrosive electrolytes. In addition, the cathode material, MnO_2, can exist in a variety of crystal structures which will offer distinct pathways or mechanisms for Zn-ion transport. This project explores how the crystal structure of MnO_2 influences the electrochemical reaction mechanisms and subsequent performance of the Zn/MnO_2 battery. Three different phases of MnO_2 (α, β, and δ) were synthesized hydrothermally for use as cathode materials. Coin cells consisting of a Zn metal anode, MnO_2 cathode, and an aqueous $ZnSO_4$ electrolyte were then assembled and cycled to determine the charge/discharge behaviors of the batteries. Finally, the results of this project will help identify optimal cathode materials for improving the electrochemical performance of Zn/MnO_2 batteries.

POSTER SESSION 2

Balcony, Easel 103

1:00 PM to 2:30 PM

Engineering a Restacked MoS_2-polymer Composite as Li-ion Battery Anode Material for Improved Capacity and Cycle-Life

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Mentor: Jessica Tjalsma, Materials Science and Engineering
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Current commercial Li-ion batteries use carbon-based anode materials, most commonly graphite. The low theoretical capacity (372 mAh/g) [1, 2] and slow Li-ion diffusion ($10^{-}8cm^2s^{-}1$) [2] through graphite limits the batteries energy density and power capability. Molybdenum disulfide (MoS_2) is a promising graphite replacement. The layered structure of the 2H trigonal prismatic phase is very similar to graphite where van der Waals (vdW) interaction between layers of S-Mo-S slabs accommodates Li-ion intercalation [3, 1]. MoS_2 has high initial capacity (669 mAh/g), low discharge voltage (0.6V), and low diffusion barrier, but has poor cycling stability resulting in short cycle-life [2]. Herein it is proposed that the degradation in capacity over cycling could be mitigated by engineering a restacked MoS_2-polymer composite material using a one-pot wet chemical synthesis method. The MoS_2 slabs are first exfoliated and then restacked in the presence of a polymer, inserting organic layers in the vdW gap. This work probes the effectiveness of this synthesis technique by comparing materials prepared with PEO and PEDOT. Characterizations will be conducted with X-ray Diffraction (XRD), Fourier Transform Infrared Spectroscopy (FTIR), Thermogravimetric Analysis (TGA), and Differential Scanning Calorimetry (DSC) to confirm the synthesis of restacked MoS_2-polymer composites. XRD will be used to determine the d-spacing that correlates to an expansion in the c-direction, specifically looking for peak shifts of (002) or (004), and with no shifting of the (hk0) directions. FTIR will be used to verify the presence of PEO and PEDOT in the composite. TGA and DSC will be used to check the stoichiometry of the polymer in the prepared composites. Pristine MoS_2 and synthesized composite materials will be compared in Lithium half cells to determine effect of restacking on cycling stability. Restacked MoS_2 would be an ideal anode material for Li-ion batteries if it brings enhanced energy density and greater cycle-life.