Investigating Cathode Dissolution by Homogenous Sol-Gel Coating on Manganese Dioxide Nanofibers to Extend Battery Performance

The cathode dissolution is a known phenomenon for manganese dioxide (MnO_2) based cathode materials in both aqueous and non-aqueous batteries. Upon battery discharge, reduced Mn^{3+} species disproportionate ($2Mn^{3+} \rightarrow Mn^{4+} + Mn^{2+}$) and Mn^{2+} dissolves into the electrolyte causing the loss of active material. While MnO_2 is a promising cathode for rechargeable aqueous zinc ion batteries (ZIB) due to its availability and low toxicity, the electrochemical performance is limited during battery cycling due to the dissolution of the cathode. In this work, a homogeneous sol-gel SiO_2 coatings with various thicknesses on hydrothermally synthesized α-MnO_2 nanorods are reported. In-depth characterization of SiO_2 coated α-MnO_2 are done by X-ray diffraction spectroscopy, Brunauer-Emmett-Teller surface area analysis, X-ray photon spectroscopy, thermogravimetric analysis and scanning and transmission electron microscopy to analyze the surface of the silica coated α-MnO_2 cathodes. The electrochemical performance of the SiO_2 coated α-MnO_2 cathodes are studied in two electrode zinc batteries at room temperatures using a Zn metal anode and in 2 M $ZnSO_4$ and 1 M TFSI electrolytes. The cathode dissolution is investigated by determining the total dissolved Mn content by inductively coupled plasma spectroscopy and characterization of the cycled electrodes by X-ray diffraction spectroscopy. Electrochemical performances of SiO_2 coated α-MnO_2 are evaluated using cyclic voltammetry, electrochemical impedance spectroscopy, and Galvanostatic cycling tests. This study will further benefit all different battery types that have the same cathode dissolution problem.