Public Abstract
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The research in this dissertation focuses on convection cells that have the potential to provide some of the needed breakthroughs in batteries. The convection cell utilizes electrolyte flow to decrease concentration overpotentials in batteries through the reduction of concentration gradients in the electrolyte. This allows for the use of thicker electrodes, which results in less current collector and separator material in the cell. The initial validating studies on the convection cells are reviewed, and show that flow reduces the overpotential in Zn/MnO2 and Li/MnO2 cells regardless of flow direction. Also, it is indicated the convection cell performance can be further enhanced by using separator materials to increase the ionic-conductivity of the electrolyte. New work on LiFePO4 convection cells reveals that the flow of electrolyte enhances performance for both charge and discharge. In addition, a model of the LiFePO4 convection cell is developed and shows that the flow of electrolyte virtually eliminates concentration gradients in the cell, and confirms the initial findings with the Zn/MnO2 that when a high enough flow rate is used the direction of flow has no detectable impact. A new multiple-reference electrode cell is used to directly measure the electrolyte potential during cycling. It is compared to the model calculations and found that the model is limited in predicting internal resistances in the cell. Overall, this research shows that the convection cell has the potential to provide the needed breakthrough in batteries to offset fossil fuel usage.