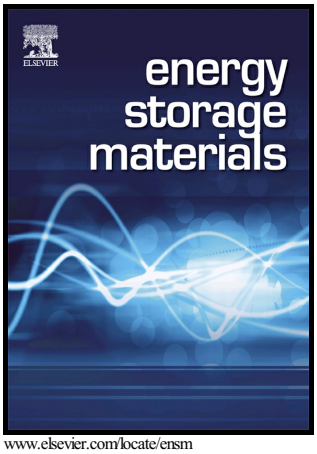

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Volumetric expansion of Lithium-Sulfur cell during operation – fundamental insight into applicable characteristics

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Abstract

During the operation of a Lithium-Sulfur (Li-S) cell, structural changes take place within both positive and negative electrodes. During discharge, the sulfur cathode expands as solid products (mainly Li_2S or Li_2S/Li_2S_2) are precipitated on its surface, whereas metallic Li anode contracts due to Li oxidation/stripping. The opposite processes occur during charge, where Li anode tends to expand due to lithium plating and solid precipitates from the cathode side are removed, causing its thickness to decrease. Most research literature describe these processes as they occur within single electrode cell constructions. Since a large format Li-S pouch cell is composed of multiple layers of electrodes stacked together, and antagonistic effects (*i.e.* expansion and shrinkage) occur simultaneously during both charge and discharge, it is important to investigate the volumetric changes of a complete cell. Herein, we report for the first time the thickness variation of a Li-S pouch cell prototype. In these studies we used a laser gauge for monitoring the cell thickness variation under operation. The effects of different voltage windows as well as discharge regimes are explored. It was found that the thickness evolution of a complete pouch cell is mostly governed by Li anodes volume changes, which mask the response of the sulfur cathodes. Interesting findings on cell swelling when cycled at slow currents and full voltage windows are presented. A correlation between capacity retention and cell thickness variation is demonstrated, which could be potentially incorporated into Battery Management System (BMS) design for Li-S batteries.

Keywords:

Lithium-Sulfur battery
Pouch cell
Volume expansion
Thickness change
Laser gauge

1. Introduction

The low weight, low cost and high specific energy of Lithium-Sulfur (Li-S) batteries make this technology one of the most promising energy storage system for the future. Predicted to exceed the energy density of secondary Li-ion batteries by five times [1, 2], they have been extensively researched in academia and industry over past years [3-5]. The lithiation of sulfur during discharge,