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Rujian Fu, Song-Yul Choe, Victor Agubra, Jeffrey Fergus

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Development of a physics-based degradation model for lithium ion polymer batteries considering side reactions

Rujian Fu[a], Song-Yul Choe[a, *], Victor Agubra[b], Jeffrey Fergus[b]

[a]1418 Wiggins Hall, Mechanical Engineering, Auburn University, Auburn, AL, USA

[b]273 Wilmore Laboratories, Materials Research and Education Center, Auburn University, Auburn, AL, USA

*Corresponding author. Tel.: 334 844 3328; fax: 334 844 3307. E-mail address: choe@auburn.edu

Abstract:

Experimental investigations conducted on a large format lithium ion polymer battery (LiPB) have revealed that side reactions taking place at anode are the major factor for degradation of the battery performance and lead to capacity and power fade. Side reactions consume ions and solvents from the electrolyte and produce deposits that increase the thickness of the solid electrolyte interphase (SEI) layer and form a new layer between composite anode and separator. These phenomena are described using physical principles based on the Tafel and Nernst equations that are integrated into the developed electrochemical-thermal model. The key parameters for the side reactions used in the model are experimentally determined from self-discharging behavior of the battery. The integrated model is then validated against experimental data obtained from different operating conditions. Analysis has revealed that the capacity fade is predominantly caused by loss of ions and active materials. The results also show that the rate of side reactions and degradations are more severe at charging process under high SOC and high C-rate due to low overpotential of the side reactions.