

Thermal Modeling of Lithium-ion Pouch-type Cell for Better Cycle Life and Safety Application

J. B. Sangiri¹, S. Ghosh¹, C. Chakraborty²

¹Indian Institute of Technology Kharagpur, Kharagpur, West Bengal, India

²Indian Institute of Technology Kharagpur, Kharagpur, West Bengal, India.

Abstract

Lithium-ion batteries are most preferable energy storage devices for its higher energy density, flexible form factor and lightweight design than comparable battery technologies. Considerations of thermal effects in Lithium-ion cells (related to cycle and calendar life) are important for the safety issues because higher temperature may leads to the thermal runaway. Substantial diagnostic and practical modeling efforts are required to fully understand the thermal characteristics of the Lithium-ion cells across various operating conditions. Thermal modeling enables us to understand the thermal behavior of cells, quantification of heat generation inside the cell and changes in cell chemistry at the time of battery operation. The various thermal models of Lithium-ion cells have been investigated using methods like control volume, finite elementary, differential method etc. In Lithium-ion pouch cell electrolyte soaked separator is sandwiched in between cathode and anode.

In the present study COMSOL Multiphysics® software has been used to model the electro-thermal behavior of Lithium-ion cell with LiCoO₂ cathode, non-graphitizable carbon anode and hexafluorophosphate containing ethylene carbonate/dimethyl carbonate (1:1 EC: DMC/ LiPF₆) electrolyte. Lithium-ion battery and heat transfer interface of COMSOL Multiphysics® software have been used to make the model. A one-dimensional cell model is used to model the battery cell chemistry and a two-dimensional model is used to model the temperature in the cell. The cell has been charged/discharged at different Charging rate (C-rate) like 0.5C, 1C, 2C and 3C. After a critical review of the present literature several research issues has been identified in the thermal modeling of Lithium-ion cell. One of the important research issues is the non-consideration of contact thermal resistance within the cell. The present simulation work is focused on incorporating contact thermal resistance within a two-dimensional thermal model of Lithium-ion pouch cells. Variation of thermal contact resistance values in between active battery material sections has been done and the variation of cell temperature has been noticed. It is found that the heat generation inside the cell at the time of battery operation is increased due to the contact thermal resistance present in between different sections of Lithium-ion cells like active battery material layers, current collectors, separators.

Reference

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Figures used in the abstract

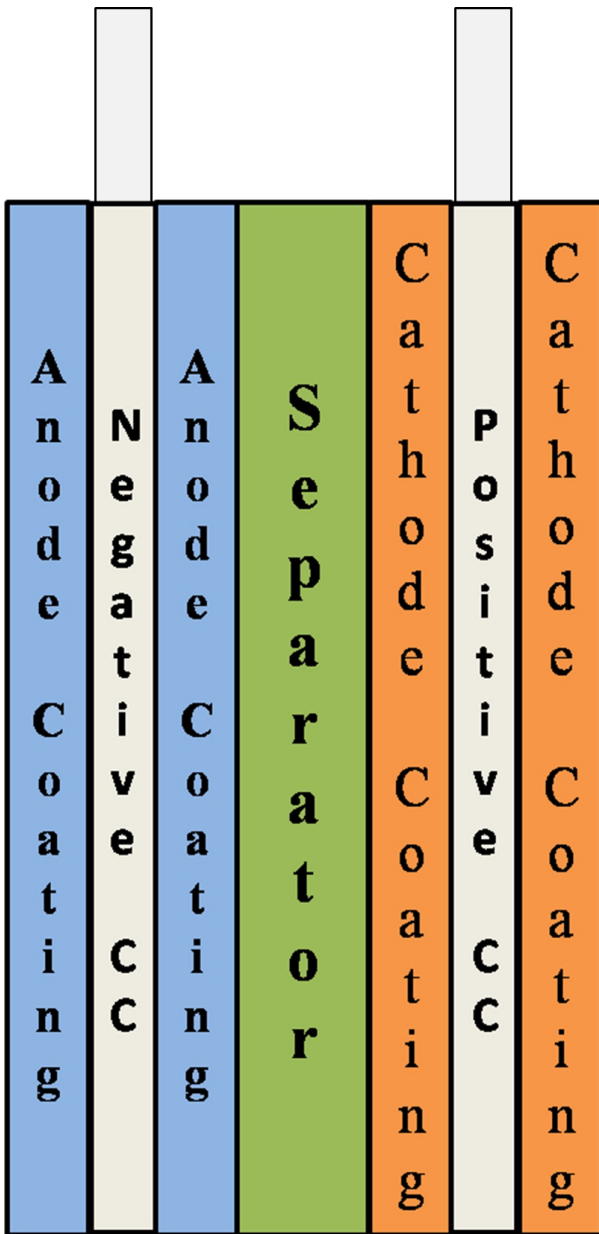


Figure 1: Schematic diagram of the model.

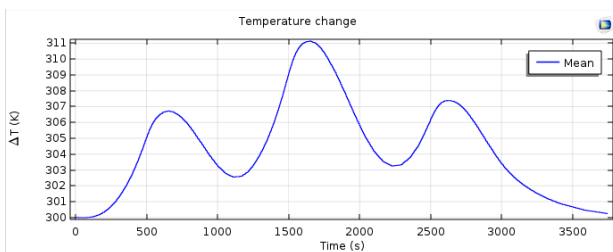


Figure 2: Change of temperature with time.

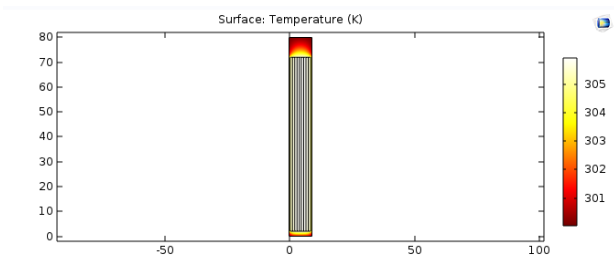


Figure 3: Surface temperature of the cell.

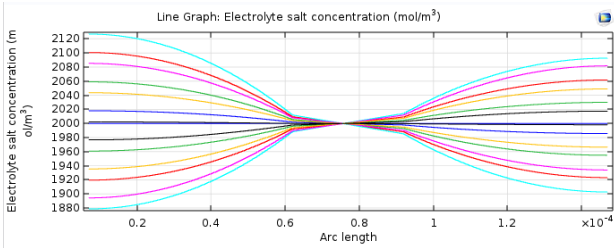


Figure 4: Electrolyte salt concentration across the cell.