COMSOL Multiphysics® Modelling for Li-ion Battery Ageing

P. Singh[1], N. Khare[2], P. K. Chaturvedi[3]

[1]Banasthali University, Banasthali, Rajasthan, India
[2]EOS Energy Storage,Edison, NJ, USA
[3]SRM University, Ghaziabad, Uttar Pardesh, India

Abstract

Introduction: Recently, Li-ion battery is being widely used as power source for various applications from electronic gadgets to automotive industry. The performance and cycle life of Li-ion battery are becoming gradually important issues as the applications are shifting from small scale consumer electronics to dynamic power applications (Electric Vehicles, Hybrid Electric Vehicles). To create a better control over the performance and cycle life of a Li-ion battery, accurate modelling for battery ageing is essential. During a battery lifetime, its health tends to deteriorate slowly due to irreversible physical and chemical changes like: internal impedance rise, excess out-gassing, internal temperature rise, electrolyte decomposition and electrodes' cracking. This paper describes the use of magnetic field probing to induce above parameters for indicating the battery ageing. Once their effect on ageing is determined, an ageing model can be created to determine battery's age and predict its future ageing.
Use of COMSOL Multiphysics®: In this work, a 2D model using Newman's pseudo two dimensional (P2D) model coupled with the magnetic field equation for lithium ion battery, model has been developed in COMSOL Multiphysics® environment in order to investigate the impact of magnetic field on the Li-ion battery ageing parameters. The boundary conditions are kept similar to library model at this stage.
Results: The simulation results will provide behavior of battery during charging/discharging and rest conditions. In the process of magnetic field response analysis, we get magnetic field response with each domain 1, 2 and 3 and determine the behaviour pattern of each domain separately. The fairly early simulation work is shown in figure 1 and 2. We may expect to get following results after completion of simulation work.
• The effect of MFR (Magnetic Field Response) with respect to the capacity of the Li-ion battery
• MFR with respect to change in internal impedance of the Li-ion battery
• MFR with respect to charging/discharging behavior of the Li-ion battery
Conclusion: This 2D model of a Li-ion battery combining with magnetic field probing is a simulation tool that can be useful in predicting battery age and help to design a prototype for real-time ageing prediction. COMSOL Multiphysics® tool has been used to determine Li-ion model and its initial response to magnetic field probing. This paper mostly define a simulation work of prototype system.

Figures used in the abstract

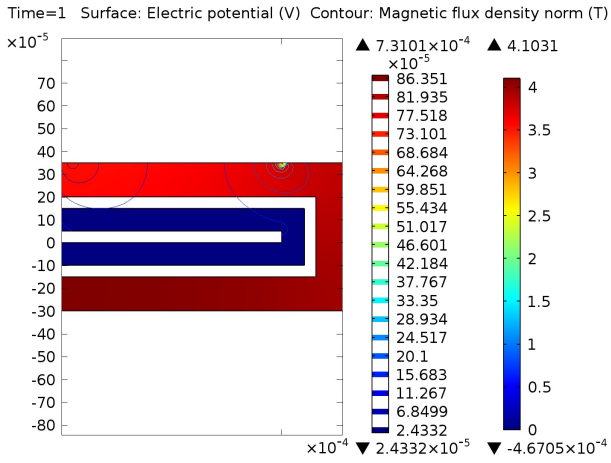

Figure 1: Surface: Electric potential (V) Contour: Magnetic flux density norm (T).

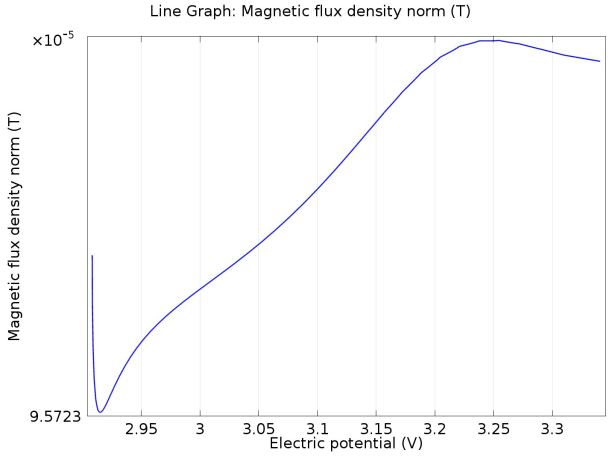

Figure 2: Line Graph between Magnetic flux density norm (T) and Electric Potential (V) of Li-ion battery.