Heat Generation Simulation Of A LiFePO4 Coin Cell Battery Based On Self-Measured Material Data

J. Buch[1], M. Damm[1], P. Ganninger[1], T. Markus[1], D. Henriques[1]

[1]Mannheim University of Applied Sciences, Mannheim, Germany

Abstract

The continuously increasing energy and power density of lithium-ion batteries are crucial for enhancing the range and performance of electric vehicles but also introduce higher safety risks. The temperature of a lithium-ion battery plays a significant role in the performance of electric vehicles. Charging and discharging processes generate internal heat within the Li-ion batteries. There are primarily two types of heat produced: irreversible heat (Joule heat) and reversible heat (reaction heat), both of which are influenced by various factors such as temperature, state of health (SOH), state of charge (SOC), and the operating current (C-Rate). Traditionally, the analysis of battery performance under specific conditions involved conducting numerous mechanical, electrical, or thermal tests. However, due to the time-consuming and cost-intensive nature of these tests, mathematical models are increasingly used to simulate batteries and gain a better and deeper understanding of their behavior.
In this study, the COMSOL Multiphysics® software environment was used to develop a two-dimensional electrochemical-thermal model for a lithium iron phosphate (LiFePO4) coin cell battery. Experimental data obtained by our research group, "Kems4Bats," in Mannheim, were implemented into the simulation model to enhance the accuracy of the battery model. This self-measured material data includes parameters such as layer thicknesses, particle size distribution, lithium diffusion coefficients, as well as the entropic heat coefficient, heat capacity, and thermal conductivity. These parameters are particularly significant in calculating the heat flux within a battery.