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1 Background

Lithium-ion batteries are commonly used in many appliances due to the high energy density and long service life. To facilitate the analysis and control of the Li-ion batteries, models of batteries are required. The Doyle-Fuller-Newman (DFN) model is a well-known model in both the electrochemical and control community, and it is schematically shown in Figure 1, see [1]. The model includes electrochemical charge transfer reactions on both electrodes, diffusion and migration of lithium ions in the liquid electrolyte, diffusion of lithium in spherical particles of composite electrodes and porosity of both electrodes and separator. The DFN model contains a large number of parameters that have to be estimated in order to have an accurate model.

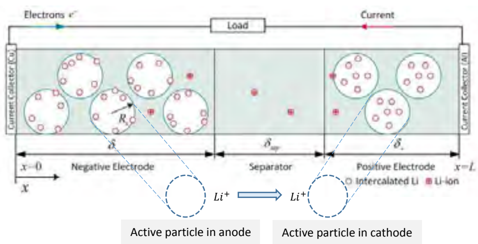

Figure 1: Layout of the model for Li-ion battery

2 Approach

In this work, a computationally feasible two-step estimation approach has been proposed in which the original set of parameters is split in two. The first set contains thermodynamically determined parameters, which should be estimated using low-current discharges. The second set contains kinetic parameters, which are estimated using a highly-dynamic pulse (dis-)charge current (shown in Figure 3a). A sensitivity analysis had been done to find the most identifiable parameters. The DFN model implemented according to [1] was used for simulations and experimental data were collected for Nickel Cobalt Aluminum 12 Ah pouch battery.

3 Results

Figure 2 illustrates the agreement between experimentally measured and simulated static discharge curves for several currents. Figure 3 shows performance of the model on dynamic pulse (dis-)charge input. Figures 3b and 3c present measured voltages (blue) in comparison with model (red) for 20 and 80% State-of-Charge (SoC) accordingly, obtained by solving a nonlinear least squares optimization problem. Finally, Figure 3d displays the validation experiment, performed at 50% SoC. In these figures, the measurements are plotted in blue and the simulations in red. It can be seen that the model output is in good agreement with the measured data in both the static and dynamic experiments.

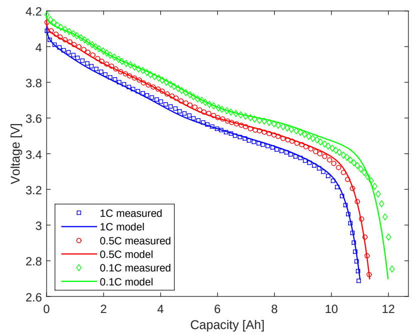

Figure 2: Experimentally measured (symbols) and simulated (lines) static discharge curves

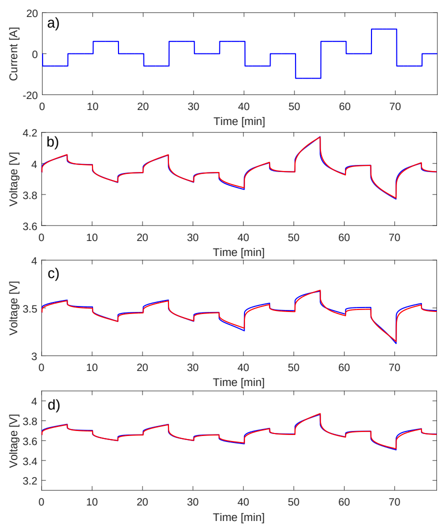

Figure 3: Performance of model on pulse (dis-)charge experimental data.

References

[1] K. A. Smith, C. D. Rahn, C.-Y. Wang, Control oriented 1D electrochemical model of lithium ion battery, *Energ. Convers. Manage.*, 48(9), 2565–2578, 2007.