Bottlenecks to Fast Charging of Lithium-Ion-Insertion Cells for Electric Vehicles

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Customers of plug-in hybrid and all-electric vehicles may place a premium on the ability to quickly recharge the battery. However, several fundamental bottlenecks limit the charge acceptance of the battery pack at high rates. In this work, an isothermal, physics-based model is used for simulating the performance of a dual lithium-ion-insertion cell[1] at various galvanostatic charge rates (Figure 1) at room temperature. Simulation results[2] show that the cell can be charged to ~ 55% SOC and 10% SOC at 3C and 10C rates respectively during the constant- current step before the cut-off potential is reached for the system under consideration. Modeling results are compared with available experimental data for validation. The various limitations are quantified in terms of their contributions to the cell overpotential as shown in Figure 2 for 3C galvanostatic charge rate. Simple expressions are provided to quickly evaluate limitations wherever feasible. Engineering solutions for averting these limitations and the corresponding improvement in performance are also developed from the simulations. Other bottlenecks to fast charging are also briefly discussed. Further details will be presented at the meeting.

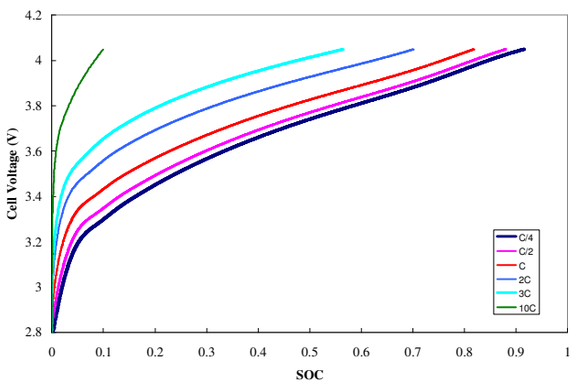

Figure 1. Cell Voltage *vs.* State of Charge (SOC) of the cell at various constant-current (CC) density charging rates.

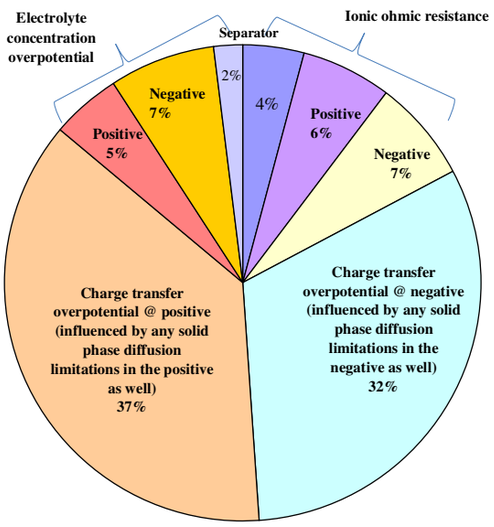

Figure 2. Contributions to the cell overpotential at the end of galvanostatic charging at 3C rate.

References:

1. Thomas F. Fuller, Marc Doyle, John Newman, *J. Electrochem. Soc.,* 141(1), 1-10 (1994).

2. R. Chandrasekaran, *J. Electrochem.Soc.*, 2013 (manuscript to be submitted soon).