Cell formation studies to improve the SEI layer in Li-ion batteries

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To cope up with the high energy demand, Li-ion batteries (LIBs) and the related technology is growing rapidly and new materials and chemistries are being developed for automotive applications[1]. Besides material cost, and the electrolyte wetting, the SEI formation is the most expensive process which is done at a very low charge/discharge rates[2]. This process may take up to 1.5 to 3 weeks, depending on the cell manufacturer and cell chemistry, requiring battery cyclers, floor space and environmental chambers. Therefore, the formation process is a major production bottleneck and it is important to reduce formation time to lower the production cost. Furthermore, the nature and behavior of SEI layer affects the performance of the cell and safety[3].

In this study, we present the utilisation of electrochemical methods and modeling techniques to understand the effect of formation cycling process on the SEI layer and cycling performance of the LIBs. For this purpose, coin cells were fabricated using NMC111 vs graphite chemistry. Electrochemical formation cycling protocols were carried out at different voltages for 24 hours to develop a stable SEI layer and these were compared to a standard low current complete charge-discharge formation protocol. After formation cycling, the characteristics of the SEI layer were analysed by employing EIS (Figure 1) and XPS. The different formation processes were undertaken at 2.7, 3.2, 3.6 and 4.0 V during the charging of the cells and corresponding cell resistance was measured. Furthermore, the charge-discharge cycling of the cells was also carried out to observe the effect of formation techniques on the capacity degradation/retention. In addition a physics-based electrochemical model was employed to further elaborate the cycling behavior of these cells with respect to formation strategies.

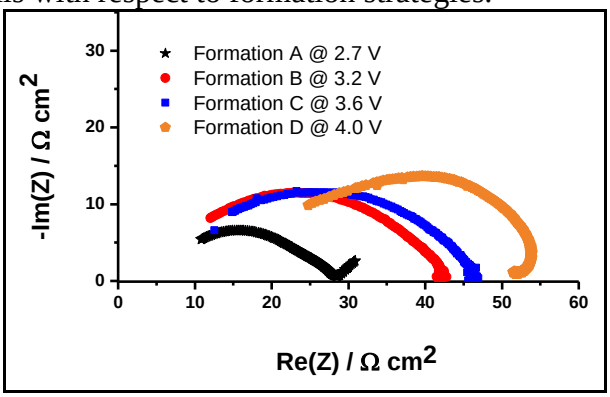

Figure 1: Electrochemical impedance spectra (EIS) obtained for four cells with different formation processes at 2.7 V, 3.2 V, 3.6 V and 4.0 V

References:

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