Integrating Electrochemical Impedance Spectroscopy and Current Interruption Tests for State of Health Detection and Performance Prediction of Lithium-Ion Batteries

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Lithium ion batteries have been a special interest of recent because of its wide use, especially in electric vehicles. Though it has many advantages for its popularity, state of health (SOH) is a big concern for its lifetime and overall perfomance. To elaborate, in the case of electric vehicles, a declining SOH can lead up to declined driving range and power capacity. Further, safety concerns hamper the wide utilization of electric vehicles. Hence, SOH estimation is a crucial part of the maintenance of a battery.

Electrochemical Impedance Spectroscopy (EIS) is a frequently used technique to study several parameters related to batteries. It has been a preferable method as it is non-invasive and applicable in-situ and in real-time. It can also give information about the solution resistance, ion transport and solid electrolyte interface of the battery through gathered spectrum's equivalent circuit fit independently from each other. However, this fit can be made with different elements that give the same mathematical result, which arises from complex reactions that occur in the battery. Thus, different impedance analysis techniques should be utilized for the best interpretations of the results.

To reduce the ambiguity aforementioned, distribution of relaxation times (DRT) can be employed. DRT helps the construction of equivalent circuit fit by turning impedance data gathered in frequency domain into time constant domain. This way, the overlapping peaks are able to be broken down into its constituent peaks, resulting in distinguished elements in the circuit and clearer understanding of the processes occur in the batteries [1].

Moreover, Intermittent Current Interruption can also be used during the cycling of batteries at different states of charge (SOC). This is done by chronopotentiometry followed by lack of applied current. The decay of cell potential that is observed at i=0 and t=0 can be related to the internal resistance and diffusion resistance coefficient of the battery without disturbance [2].

For the standardization and commercialization of the implemetation of the techniques explained, firstly the

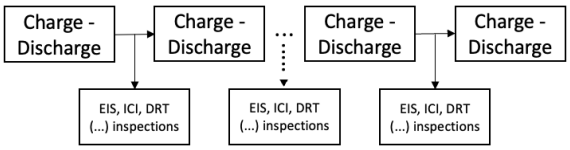

Figure SEQ Figure * ARABIC 1. Flowchart of Electrochemical Measurements.

parameters that will be derived from the techniques should be determined. Following, the conditions that reveal the parameters should be used only to reduce the time for the examinations. Moreover, inspections should not be done for every charge-discharge cycle to make the process more practical, but the number of cycles it will take to observe significant changes should be determined to decrease the number of inspections that must be done. [3]

References

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