Electrochemical impedance spectroscopy for monitoring state-of-health of battery cell

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To monitor the performance and reliability of a lithium ion battery according to State of Health(SoH), an Electrochemical Impedance Spectroscopy(EIS) analysis was performed. The study utilized a pouch-type commercial lithium-ion battery with a capacity of 22mAh and a voltage of 3.7V. A charge/discharge cyclic test was executed within a voltage range of 3.0-4.2V at a rate of 0.5C, continuing until the SoH reached 80%. During the charge/discharge cyclic test, an EIS test was performed on batteries in a charged state using a potentiostat. This EIS test was carried out at various SoH levels during the charge/discharge cyclic test and encompassed a frequency range of 1MHz-10mHz. The Nyquist plot for EIS was analyzed using an Equivalent Electrical Circuit (EEC), comprising Rs (electrolyte impedance), Rsei (SEI layer impedance), Rct (electrode degradation impedance), and Warburg impedance. The Rtotal value (total impedance of the EEC in the battery) increased as the SoH decreased. Rs and Rsei values saturated at SoH 95%, while Rct value increased with decreasing SoH. The Rtotal value depended on the Rct value, indicating that the decrease in SoH (battery degradation) was associated with electrode degradation. Conversely, the slope of the Warburg impedance was not dependent on SoH within the range of 80-100%. This result suggests that the degradation type of the battery is similar in the SoH range of 80-100%.