WORKFLOWS FOR DETECTION OF LITHIUM DEPOSITIONS IN AGED Li-ION CELLS

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Increased sustainability and reduced dependency on foreign critical resources (e.g. Co, Li, and graphite) go hand in hand with increased cycle life of Li-ion batteries in applications. However, cycle life is limited by aging mechanisms. Under certain conditions, lithium metal can deposit as a parallel reaction to intercalation and alloying into Si/graphite anodes. Lithium deposition/plating is a critical aging mechanism that leads to rapid capacity degradation (reaction of Li with electrolyte and formation of ‘dead Li’) and can even reduce the safety level. Lithium plating on negative electrodes often occurs during fast charging or at low temperatures.

However, the exact operating conditions to avoid lithium plating need to be measured for each cell type. To avoid lithium depositions, it is essential to detect it. After considering general aspects of characterization workflows in batteries, we present three specific workflows for the detection of Li depositions and to answer the following questions [1]:

(i) Did lithium depositions occur in an aged cells?
(ii) Where in an aged cell do lithium depositions occur?
(iii) Which operating conditions avoid lithium depositions for a specific cell type?

These workflows are based on a variety of complementary advanced methods which were validated against each other in the project CharLiSiKo, such as GD-OES depth profiling, neutron depth profiling, SEM, optical microscopy, in situ optical microscopy of cross-sectioned full cells, operando XRD, full cells with lithium reference electrode, 3D microstructure resolved simulation, voltage relaxation, and Arrhenius plots. Workflows are exemplarily applied to different types of commercial and pilot-line Li-ion cells to reveal effects on lithium deposition such as Si content in Si/graphite negative electrodes, temperature, and charging C-rate.

[1] T. Waldmann et al., J. Electrochem. Soc. 171 (2024) 070526, 10.1149/1945-7111/ad5ef8

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