Post-Mortem Analysis of commercial Li-ion Pouch Cells For Use in Second Life Applications.

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European production of lithium-ion batteries (LIB) is set to reach 223 Gigawatts[1] in 2025,with a global production around 1.5 Terawatts reported in 2022 largely due to to the increased sales of electric vehicles. As batteries age, 80% of remaining nominal capacity is considered the end of first life. Understanding the aging mechanisms is crucial to developing better evaluation techniques to ensure reliability and safety for battery use beyond their first life. These large format high capacity LIBs may be found in passenger and commercial EVs and marine craft, and are being explored for additional applications in larger vehicles, even aircraft.

This discussion is based on results from a battery life study performed on a large renowned Li-ion pouch cell with an initial capacity of 64 Ah. We will examine electrodes harvested from cells cycled under different conditions: each cell was cycled from 0-100% state of charge (SOC) at 0.75C cycle rate at 5°C, 25°C, and 45°C and mechanically confined. These results are compared to electrodes harvested from one charagteiized, unconfined cell. The original cells are part of a larger battery life study consisting of over 100 commercial cells following a selected test matrix involving cell testing under varying temperature, current and state-of-charge windows, both, with and without mechanical constraints on the cell.

Here we present electrochemical testing data for both the full cells and for half cells from the recovered post-mortem electrodes. We will also discuss detailed electron microscopy, x-ray diffraction (XRD) and synchrotron results. Some observed phenomena we will discuss including capacity loss, decreased rate capabilities, and physical degradation pheonomena. Additionally, this study also looks at the calendar aging of recovered electrodes.

While the effects of aging are not well understood, typical results found in aged cells are deterioration of NMC cathodes[2, 3] and increased resistance of the anode to lithiation[4] which may be due to loss of lithium inventory, and "ion trapping".

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