Analysis of Aging Mechanisms in a Commercial LiFePO4/Graphite 26650 Cylindrical Cell by FIB/SEM Tomography

R. Scipioni

Li-ion batteries (LIBs) find widespread use in many electricity storage applications, from portable devices to electric vehicles, and LiFePO4 (LFP) and Graphite are considered a promising electrode material choice for powering electric vehicles. LFP is a cost-competitive and non-toxic cathode material, with a relative high capacity and good structural stability, because of strong P – O bonds, which reduce the risk of oxygen release and self-ignition.

Graphite is one of the most common anode materials for commercial LIBs, and its predisposition to form SEI layer at the electrode/electrolyte interface prevents the anode surface from corrosion while being permeable to lithium ions. Although relatively stable, however, upon cycling, the SEI layer grows causing increasing internal resistance and capacity fade.

In this work we study the aging mechanisms that occur in a Commercial LiFePO4/Graphite 26650 Cylindrical Cell by Focused Ion Beam (FIB)/Scanning Electron Microscopy (SEM) tomography, one of the most used techniques for the study of the three-dimensional microstructure of porous electrodes.

The morphology analysis shows that both LFP and Graphite suffer from mechanical stress during lithiation/delithiation process with consequent cracking of particles. Furthermore, a big layer of what is believed to be electrode/electrolyte decomposition products is observed on the electrode/electrolyte interface of the aged samples.

The layers at the anode and cathode electrode/electrolyte interfaces are possibly composed of LiF and Li-organic species, and are observed to be the main degradation mechanism causing loss of lithium inventory (LLI) in the cylindrical cell.

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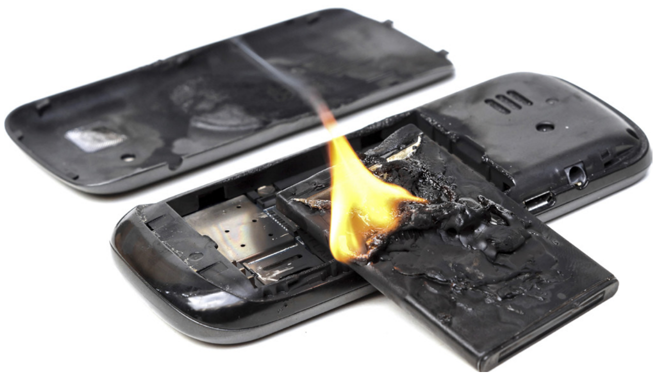
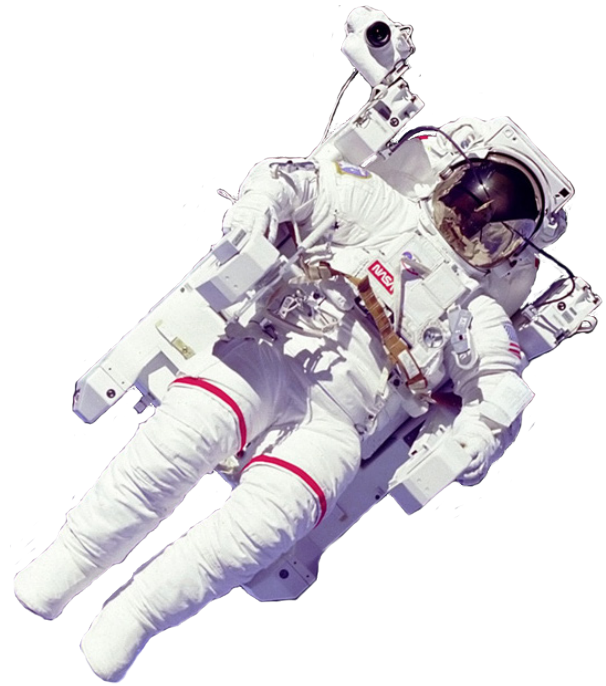
Registration is required
No-show fee 200 DKK



Li-ion Battery Technology and Safety in Applications

7/2/2017, 9:30 - 15:45, SDU,M301, Sønderborg



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Introduction to Battery safety

Paul T. Coman

Theoretical background on thermal runaway and the state-of-the art research performed on the field of safety will be presented. Different experimental methods and modeling approaches used for investigating the behavior of thermal runaway in a single battery cells and in battery packs will be briefly introduced.

With the current methods and models it is possible to measure or calculate the temperatures and the amount of energy released during the event. The amount of energy and implicitly the temperatures are the key factors in designing a safe storage system.

Learnings from>5 MWh LFP in the field

P.E.Seekjær

LiFePO4 cells are commonly considered robust and safe. Having more than 25.000 cells in the field for everyday use proves this to be correct. However quite deep application knowledge has shown to be required to make a design that can truly support and exploit the positive nature of the cell.

Having that amount of cells running, of course also reveals some of the natural variations in performance and quality. This presentation will take a real life application approach and will cover some of the main design considerations and solutions to make a robust and safe product for the customer to use on everyday basis.

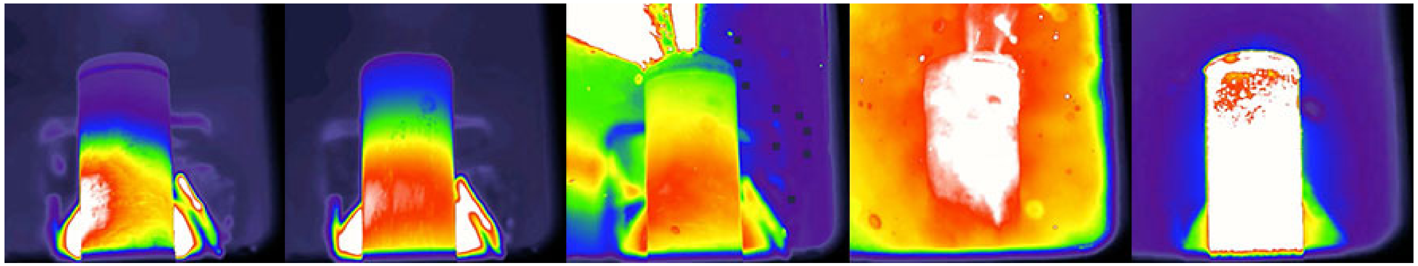
Test of battery degradation at DTI

K. Nørregård

It is well known, that high temperature can shorten the lifetime of Lithium-ion batteries and thermal management with cooling are often part of large battery packs. A single Arrhenius equation describes the relation between temperature and capacity loss well for temperatures above room temperature. The impact of low temperature conditions are less obvious and cold degradation seems often overlooked. Many academic papers seem to ignore the temperature range below room temperature.

Danish Technological Institute has through the last 5 years made a series of lifetime tests on different lithium-ion cells. In the subsequent modeling work, some difficulties with cycle life data at low temperatures have been encountered, but using models with two different Arrhenius equations gives a better match below room temperature.

Unfortunately, sharing measured results is typically limited by strict NDAs on batteries tested, still a few results from low temperature degradation can be shared. Low temperature capacity fade is mainly the result of lithium plating at the anode during charging. The plating is believed to increase the risk of growing dendrites and reduce acceptance for higher charge currents, which can lead to thermal runaway if warning signals are ignored. Some examples of batteries contributing to fire are presented – and some of these are likely caused by thermal runaway. The presentation will also shortly discuss safety measures for a few different applications.



In-operando high-speed tomography of lithium-ion batteries during thermal runaway, Donal P. Finegan, Mario Scheel, James B. Robinson, Bernhard Tjaden, Ian Hunt et al. (Nature Communications)

Designing and Experimenting safe battery packs for space applications

E. Darcy

Boeing Dreamliner and Galaxy Note 7 incidents are very high profile and costly failures that resulted from poor design, manufacturing, and verification.

This talk will address what NASA is doing in manned space applications to prevent this risk and mitigate the hazards even if a single cell were to experience a thermal runaway in a battery during field use.

Several innovations were required to improve cell screening (prevention) and to reduce the severity of the hazard (mitigation) in case a cell failure still happens. No cell screening is 100% full proof at rejecting cell latent defects. These innovations include OCV bounce back after deep discharge for screening cells with poor charge retention, implantable on-demand internal short circuit device for triggering cells into thermal runaway, cell bottom vents to reduce side wall rupture risk, and battery design measures to protect adjacent cells.

Mathematical Modeling of Lithium Ion Cells

R.E.White

Development of the porous electrode equations used to produce a physics-based model of a lithium ion cell will be presented. Solution of these equations using COMSOL will be then be demonstrated.

This physics-based model of a lithium ion cell will then be used to make predictions of the voltage of the cell as a function of time for charge and discharge given the design parameters and operating conditions of the cell. The model will then be used to demonstrate the effect of changing design parameters on cell performance for several cases.