Performance and Cycle Life Testing of Silicon Anode Cells

[1]Hartmut Popp, [2]Jiahao Li; [2]Michael Danzer; [3]Istaq Ahmed

hartmut.popp@ait.ac.at

[1] AIT Austrian Institute of Technology, Mobility Department, Vienna, Austria
[2] ZSW Labor für Batterietechnologie, Electrochemical Accumulators, Ulm, Germany
[3] Volvo Group Trucks Technology, Advanced Technology & Research, Goteborg, Sweden

Introduction

One of the goals of the **EuroLiion project** (no. 265368) funded by the FP7 initiative from the European Commission is to develop a Lithium-Ion cell with a major increase in energy density compared to the state of the art (>200Wh/kg). This is realized by utilizing Silicon as a high-capacity anode material and LNMO as a high - voltage cathode material. So far, the first generation of cells in 18650 format with a conventional LFP cathode and the newly developed anode with a 66% Silicon content have been manufactured and tested. The tests include first a comprehensive characterization of the cells with capacity determination for different current rates, high pulse power current tests, and impedance spectroscopy, all at different temperatures. After characterization, the cell went to cycling tests at different temperatures and different state of charge windows, and to storage tests at three different temperatures. Regular checkups are made to monitor the evolution of the main performance parameters of the cells. An overview of the results is given in this poster.

Cell Data Outline

- Generation I cell
- 18650 shape
- Pilot line assembly
- Cathode material LFP
- Anode material Silicon 66% and 10,1% graphene, rest binder and additives
- Anode material capacity 1800 mAh/g for 200 cycles
- Electrolyte LiPF6

EuroLiion LFP/Si 18650 cell
Gen. I in test frame

Operational Values

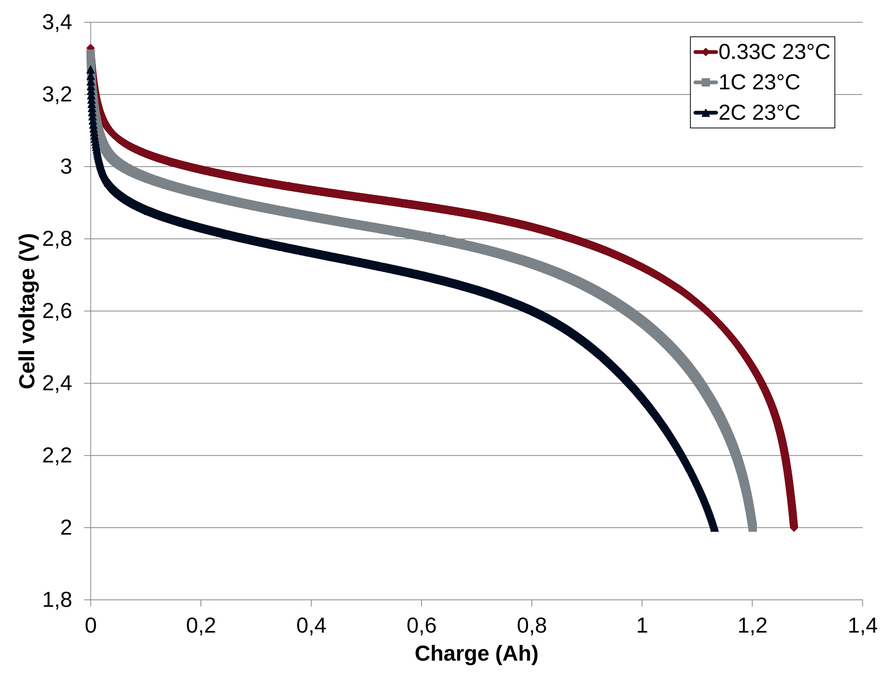
- Mass = 38.5 g
- Energy = 4 Wh
- Energy density = 105 Wh/kg
- Nom. voltage = 2. 9 V
- Max. voltage = 3.6 V
- Mini. voltage = 2.0 V
- Max. discharge current = 2. 8A

Test Sequence

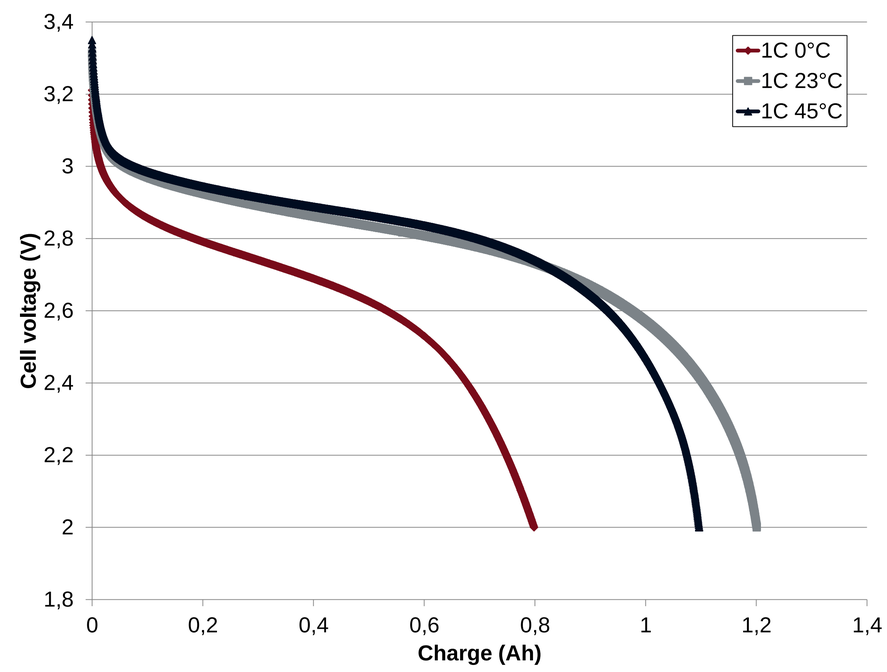
- Forming (6 to 8 cycles)
- Full performance test at different temperatures (sequence 23, 0 and 45° C; including OCV, HPPC, multiple C and impedance spectroscopy
- Life cycle and calendar life tests

Results and Discussion

- The cells show an initial capacity of 1850mAh which is a specific capacity of 48Ah/kg and after forming 1350mAh which leads to 35Ah/kg.
- After formation the loss of capacity gets reduced to ~0.012% per cycle.
- Cells in this case show better performance at 23° C than at 45° C for both capacity and impedance. This is belived to be a result of test procedure sequence and loss of performance due to cycling.
- Temperature and SOC window have significant impact on cycle life also for this chemistry. Cycle life for 23° C (best test case) and 60% SOC is 50% longer than 45° C and 100% SOC.



Capacity at different C-Rates



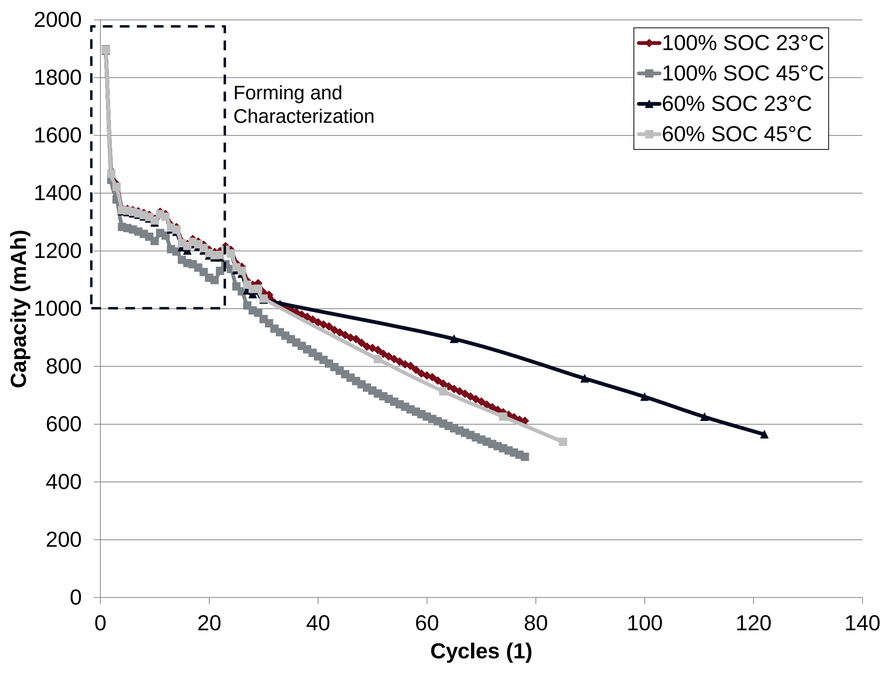
Capacity at different temperatures

Summary

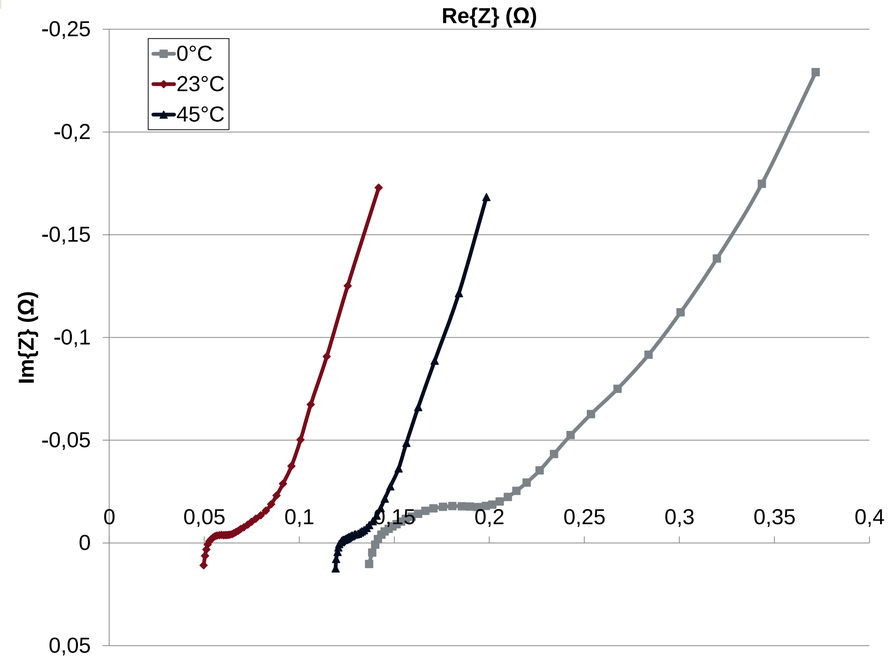
- Non reversible capacity after first cycle is ~25%
- Shallow cycles lead to longer life
- After forming capacity loss ~0,012% per cycle

Outlook Gen 2 Cell

- Higher energy density through LNMO cathode
- Better stability with enhanced components



Cycling performance



Impedance at different temperatures

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