**PERFORMANCE CHARACTERISTICS OF SANDIA BUILT 18650 LI-ION CELLS**

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**Abstract**

As part of the Freedom Car program funded by the US Department of Energy, at Sandia National Laboratories we have initiated 18650 cell building activity. The principal aim of this activity is to evaluate new materials in an 18650 configuration. Electrolyte salt appears to have a significant effect on discharge capacity. For example, cells with $LiPF_6$ as the salt show the highest capacity and that with LiBOB shows the lowest capacity. The discharge capacity of cells with $LiPF_6$ is around 920 mAh and that with LiBOB is only around 860 mAh while the discharge capacity for cells with LiBETI is around 900 mAh. Between the salts the room temperature resistances for the cells differ greatly. For example the total cell impedance for $LiPF_6$ cells is around 58 mohms while that for the LiBOB is around 112 mohms. In addition we have measured the thermal properties of the cells and the results will be presented at the meeting.

**Introduction**

At Sandia National Laboratories we have initiated a new activity aimed at building 18650 Li-ion cells as part of the Freedom Car program funded by the US DOE[1]. In this paper we will compare the electrical, electrochemical and thermal properties of 18650 cells built at Sandia and commercial ones. The primary effort is to develop in-house capability to build and test Li-ion cells in 18650 configurations for quick screening of new materials that will improve thermal abuse tolerance and electrical performance. In this paper we will discuss the electrical and the electrochemical performance characteristics of full cells built at SNL and that of the commercial cells. Our cells are nominal 900 mAh cells using ethylene carbonate: ethyl methyl carbonate (EC:EMC) (3:7 wt.%) mixed solution containing 1.2 M $LiPF_6$ or other electrolyte salts, $LiNi_{0.85}CO_{0.1}Al_{.05}O_2$ as cathode, 6% carbon coated GDR natural graphite as anode and Celgard 2325 as separator.

**Experimental**

The cells were formatted using a procedure described elesewhere[2]. The cells were cycled in a Maccor tester between 4.1 and 3 V at a 0.2 A charge/discharge current. Finally, these cells were tested for impedance at three voltages and capacity at various temperatures.

The thermal response of the cells was measured in a thermal block ramped at a constant heating rate until cell thermal runaway. The cells were allowed to vent into the atmosphere in the presence of an external spark ignition source to determine the flammability of the evolved gases and solvents. Thermal data will be presented at the meeting.

**Results and Discussion**

**Formation Cycle:** In Figure 1 are plotted time vs. cell voltage during formation for two identical Sandia built cells. The plots are very nearly identical implying that our cells are highly reproducible.

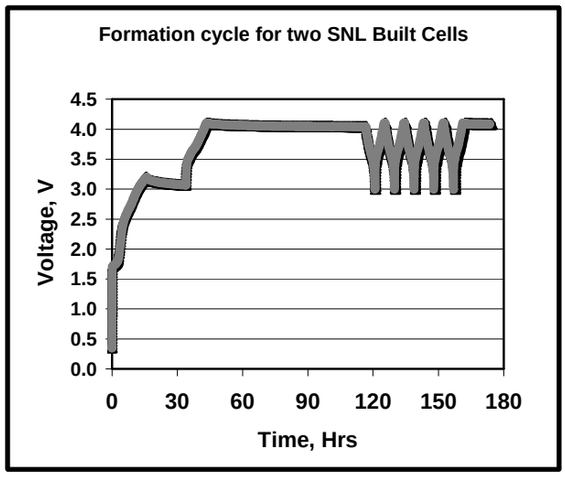


Figure 1. Voltage vs. Cell voltage plots for two SNL built cells

***Impedance:*** Following the formation cycle the cell impedance was measured at ~4.1, ~3.7, and ~3.1V at 25°C. After the voltage adjustment the cell was left at open circuit for a minimum of 12 hrs before making impedance measurements. In **Figure 2** are shown NyQuist plots of impedance at 4.1V, 25°C for three SNL built 18650 cells. $LiPF_6$ show the lowest impedance compared to the other two salts. The differences in the measured capacity are attributed to the differences in cell impedance.

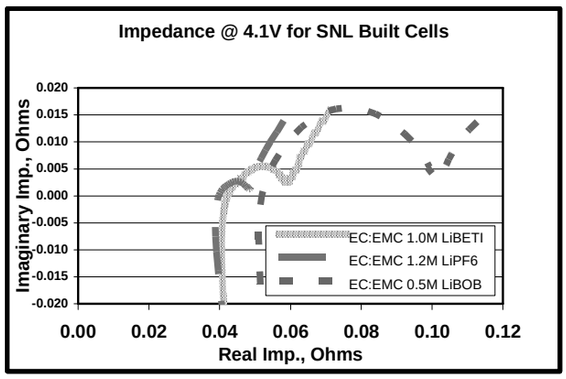


**Figure 2.** NyQuist plots of impedance for SNL and commercial 18650 Li-Ion cells

**References**

1) Manager: Tien Duong, DOE, Office of FreedomCAR & Vehicle Technologies, Office of Energy Efficiency and Renewable Energy, http://www.eere.energy.gov/vehiclesandfuels/pdfs/program/2002_energy_storage.pdf.

2) G. Nagasubramanian, E. P. Roth, C. C. Crafts, B. M. Sanchez, H. Case and D. H. Doughty in 41st Power Sources Meeting paper # 14.1, June 14-17, 2004 Philadelphia, Pennsylvania.

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