# Calendar Life Studies on Lithium-Ion Pouch Cells

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Lithium Batteries exhibit self-discharge phenomena even at moderate oxidation levels due to electrolyte decomposition and spontaneous $Li^+$ reinsertion due to instability of de-lithiated cathodes.[1] Self discharge is predominantly due to the loses occurring at the negative electrode and is governed by the electronic conductivity of the SEI layer.[2] Moreover, aging of Li-ion cells depends upon the storage temperature as well.[2, 3]

The objective of the work is to study the storage characteristics of Lithium ion batteries. The calendar life experimental studies done on the MSA Lithium ion pouch cells for space applications will be presented. The effects of Temperature, End of Charge Voltage (EOCV) with trickle charge and EOCV without trickle charge are to be evaluated on stored Li ion cells in a stretch of two years. The nominal capacity of the pouch cell is 1.67Ah. The storage characteristics were done at two different temperatures $5^0$C and $35^0$C with and without trickle charge at two different voltages 4.2V and 4.0V. A capacity measurement experiment was done at every 1-month interval at $25^0$C. During the Capacity measurement tests, the cells were discharged at C/2 rate from their existing state of charge to 3.0V to measure their residual capacity. The cells are then charged back to 4.2 V at C/5 rate with a taper to 50 mA. A second discharge to 3.0V at the same rate will give the measure of the actual capacity of the cell.

Impedance experiments were done at 100% State of charge for all the cells during the Capacity measurement tests. After the completion of the Capacity measurement tests, all the cells were restored to their original test conditions. The cells stored at $5^0$C exhibit a higher storage loss than the cells stored at $35^0$ C. It was also found that the cells, which are float charged, degrade faster than the cells that are kept under open circuit conditions. Among those cells, which are float charged, the cells charged at 4.2V show poor performance than the cells that are charged at 4.0V. These observations are discussed by means of impedance experiments. It has been reported that the interfacial impedance increases as the state of charge of the cell decreases.[4] It has also been reported that the impedance increase with ageing is mostly due to the cathode. The figure shows the OCP decay with time during storage for different experimental conditions.

The presentation will include the calendar life studies of Li-ion pouch cells stored at different operating conditions. Discussions on capacity loss during storage, aging and self-discharge mechanisms will also be presented.

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**References**

1. G. Pistoia, A. Antonini, R. Rosati and D. Zane., Electrochimica Acta, 41, 17, 2683.
2. M. Broussely, S. Herreyre, P. Biensan, P. Kasztejna, K. Nechev, R. J. Staniewicz., J. Power Sources, 97-98 (2001), 13.
3. R. B. Wright et al., J. Power Sources 4822 (2002) 1.
4. J. Baker, K. Shaw, G. Nagasubramanian, D. Doughty., Proceedings of the Electrochemical Society, Vol 99-25, New Jersey, 2000, 664.

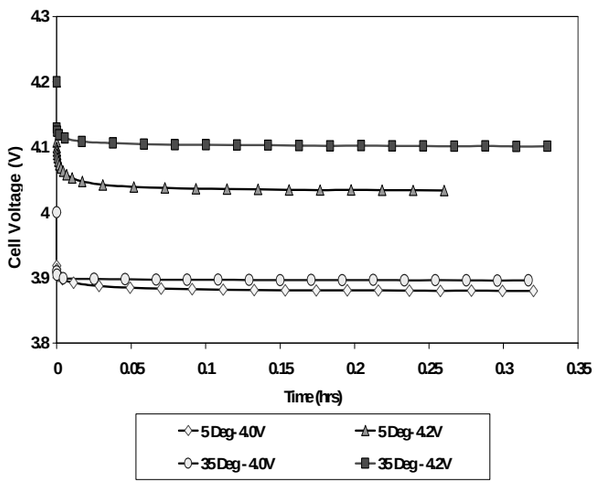


Fig. 1 Variation of OCP of Li-Ion Pouch cells under storage at different operating conditions