Passivation of Lithium Primary Battery

A little-known chemical reaction is essential to extended battery life

Passivation is a surface reaction that occurs spontaneously on the lithium metal surface in all primary Lithium batteries with liquid cathode material such as Li-SO_2, Li-$SOCl_2$ and Li-SO_2Cl_2. A film of lithium chloride (LiCl) quickly forms on the lithium metal anode surface: this solid protecting film is called the passivation layer. It prevents a direct contact between the anode (Li) and the cathode ($SOCl_2$) thus enables liquid cathode-based cells to have a long shelf life.

The level of passivation is influenced by factors such as the current capacity of the cell, length of storage, storage temperature, discharge temperature, and prior discharge conditions, as removing the load from a partially discharged cell can impact passivation more relatively to when the cell was new.

The passivation layer is electronically insulating, which may have some consequences for battery operation. The internal resistance of the cell is enhanced by the passivation layer. Under normal conditions, the thin passivation layer does not degrade cell performance. However, thick passivation layer will cause initial voltage delay problem for high current start-up applications.

Adjusting storage conditions to reduce the level of passivation is the best way to reduce voltage delay problems. However, there are several effective methods for dealing with excessive passivation when storage conditions cannot be controlled. The layer can be kept from growing too thick by maintaining a light load on the cell during storage. Alternatively, a high load, placed on the cell at regular intervals during storage, or just prior to the anticipated start-up of the cell, can be used to disrupt the passivation layer and restore normal performance quickly. The transport of lithium ions by diffusion through the pores of the passivation layer becomes predominant over initial resistance. Keep in mind that the passivation restarts after each current drain interruption.

Both of above two methods will have an impact on the capacity of the cell. In particular, a low rate discharge tends to increase the normal self-discharge reaction of the cell and reduce the available capacity.

Please contact AkkuTronics for detailed de-passivation (activation) procedures.

NOTICE: Do not attempt any of the de-passivation (activation) procedures unless you have reviewed the Safety and Handling Guidelines for Primary Lithium Batteries as well as the Material Safety Data Sheet for the specific cell type.