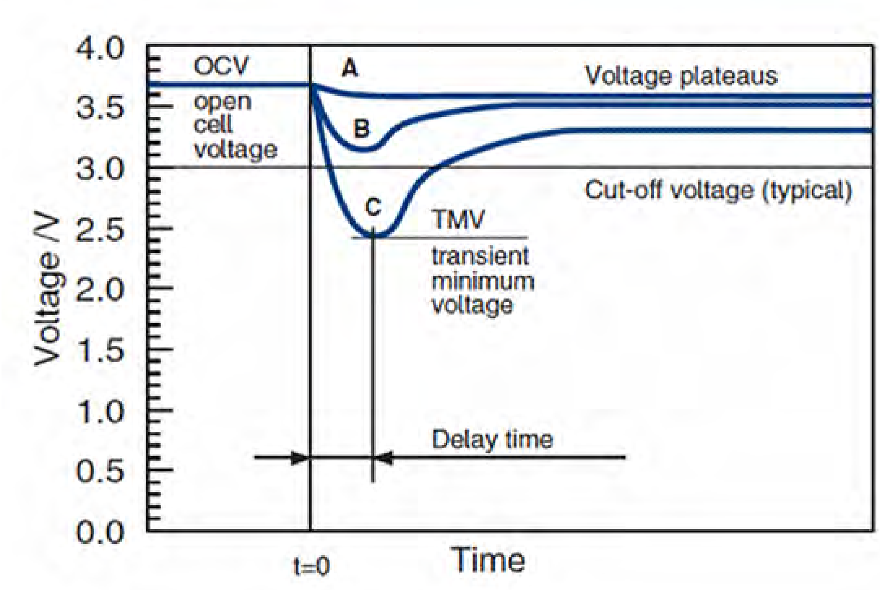
Passivation of Lithium Thionyl Chloride (LTC) Batteries

Passivation is a natural phenomenon of all Lithium Thionyl Chloride (LTC) batteries/cells as the result of surface reaction of the lithium metal (anode) with the electrolyte. A solid passivation layer forms on the surface of the lithium metal at the instant the battery is manufactured. This layer is important because it protects the anode from further reaction or discharging on its own while the cell is not in use and results in a long shelf-life.

However, the passivation layer is electronically insulating which may have some detrimental consequences for battery operation. Passivation increases the internal resistance of the batteries, which means they cannot deliver high currents or power. Passivation also causes voltage delay, which is a temporary drop in voltage when the battery is first activated after a long period of rest. Voltage delay can affect the performance of devices that require a stable voltage or a quick voltage response. Therefore, its structure, morphology and buildup over time must be properly managed.

Several factors are known to have an impact on the passivation, affecting the length and depth of voltage delay. Long storage periods of months will cause the passivation layer to grow thicker. The higher the temperature during storage and operation, the faster the passivation layer will grow. At low temperature, the passivation layer will grow slowly, but the layer will be more compact. The effect of passivation could be more visible, especially under high current draw.



[1] Figure 2: Voltage behavior when applying a load to a passivated battery [1] Battery A has mild passivation, B takes longer to restore, and C is affected the most.

[1] Courtesy EE Times

The passivation layer causes a voltage delay when applying a load to the battery. Figure 1 illustrates the voltage drop and recovery with batteries affected by different passivation levels. Battery A demonstrates a minimal voltage drop while Battery C needs time to recover. As the passivation layer thickens, the voltage delay becomes more severe.

The passivated battery may not deliver a normal working voltage in a certain period of time, especially under high current draw, and may fail to perform in the field applications.

The passivation builds up over time in the battery operation. For IoT devices, if the power consumption (voltage, current draw, time duration) is too low to reverse the passivation, it may lead to malfunction and premature end of battery life. Therefore, properly depassivation of the battery before and during use is very critical for IoT devices.

A passivated battery requires depassivation (activation). Depassivation is very important for efficient operation of the batteries for IoT devices.

On continued discharge for a period of time, the voltage of a passivated battery will rise to a level equivalent to the load voltage of an unpassivaed battery. Depassivation works better in warm environment as the increased thermal conductivity and mobility of the ions helps in the process.

Depassivation methods or procedures may vary with battery sizes and types (high capacity, high power rate and high temperature). Please consult with BIPOWER for more information.