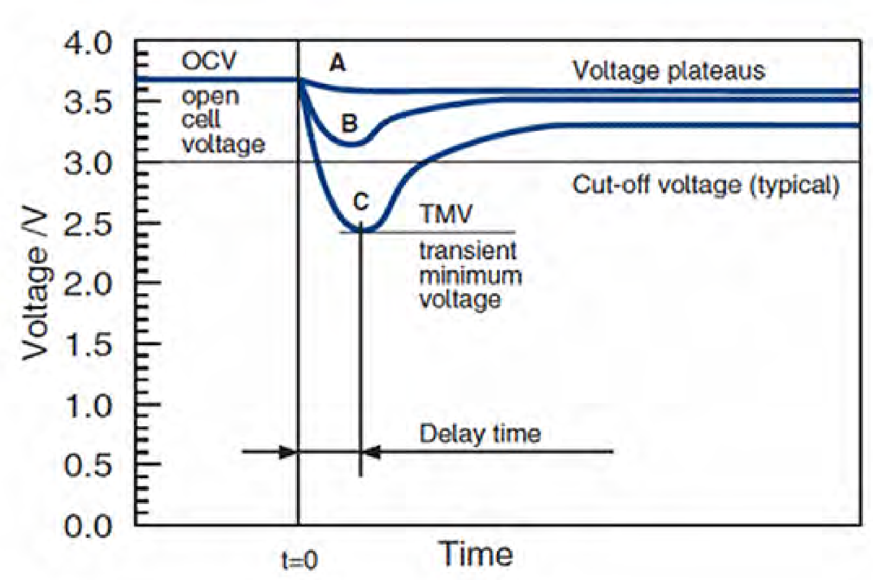
Passivation of Lithium Thionyl Chloride (LTC) Batteries

Passivation is a natural phenomenon in all Lithium Thionyl Chloride (LTC) batteries and cells, resulting from the surface reaction between lithium metal (anode) and the electrolyte. Upon introduction of the electrolyte, a solid passivation layer forms on the lithium metal's surface. This layer is essential as it protects the anode from further reactions or self-discharge when the cell is not in use, ensuring a long shelf life.

However, because the passivation layer is electronically insulating, it can negatively impact battery performance. Proper management of its structure, morphology, and buildup over time is necessary.

Several factors influence the passivation effect, affecting both the duration and severity of voltage delay. Extended storage over months results in a thicker passivation layer. Higher storage and operating temperatures accelerate its growth, while lower temperatures slow the process but lead to a more compact layer. Passivation effects are more noticeable 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 voltage delay when a load is applied to the battery. Figure 1 illustrates how voltage drop and recovery differ based on passivation levels. Battery A exhibits minimal voltage drop, while Battery C requires time to recover. As the passivation layer thickens, voltage delay becomes more pronounced.

When a load is placed on the cell, the high resistance of the passivation layer leads to a voltage drop. The cell may not immediately deliver a normal operating voltage, potentially causing performance issues in field applications.

A passivated battery requires **Depassivation (activation)** for efficient operation, particularly in IoT devices. Passivation occurs during each data transmission. With continued discharge, the voltage of a passivated battery eventually rises to match the load voltage of an unpassivated battery. Depassivation is more effective in warmer conditions due to improved thermal conductivity and ion mobility.

LTC batteries used in low-current applications, such as IoT transmitters, may develop a passivation layer that causes malfunctions. High temperatures further promote passivation growth.

Not all primary lithium batteries recover upon installation in a device or when a load is applied. In some cases, power consumption may be too low to reverse passivation. Additionally, equipment may reject a passivated battery if its voltage drops below the cutoff threshold. Therefore, proper depassivation before and during use is crucial for IoT devices.

Depassivation methods vary based on battery size and type, including high-capacity, high-power, and high-temperature models. For more information, please consult BIPOWER.