ELECTROCHEM®
AN ULTRALIFE COMPANY

Passivation of Primary Lithium Cells

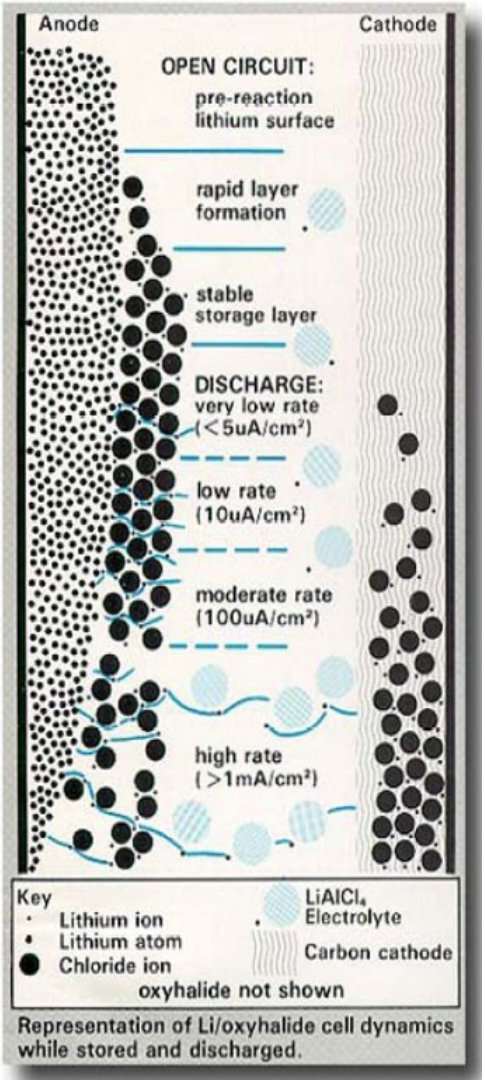
NOTICE: *Do not attempt any of the depassivation procedures described in this document unless you have reviewed the Safety and Handling Guidelines for Primary Lithium Batteries as well as the Material Safety Data Sheet for the specific cell type. These documents are available at www.electrochemsolutions.com/resources/battery-academy.*

Passivation is a phenomenon of all lithium primary cells related to the interaction of the metallic lithium anode and the electrolyte. A thin passivation layer forms on the surface of the anode at the instant the electrolyte is introduced into the cell. This layer is important because it protects the anode from reaction while the cell is dormant – resulting in a long shelf-life.

During low rate discharge (5-10 microamps/cm^2), the lithium ions that allow the cell to operate can migrate through the passivation layer. As the rate of discharge increases (0.1-1.0 milli-amp/cm^2), so does the porosity of the passivation layer, allowing greater ion flow and higher power output. This change in the structure of the passivation layer is illustrated in the diagram.

Under normal conditions, the thin passivation layer does not degrade cell performance. When the layer grows too thick, however, discharge performance may be affected. The growth of the passivation layer is influenced greatly by storage conditions. Long storage periods of months or years and/or storage of the cells above room temperature (23°C) will cause the passivation layer to grow thicker. A passivated cell may exhibit voltage delay, which is the time lag that occurs between the application of a load on the cell and the voltage response. As the passivation layer thickens, the voltage delay becomes more severe. On continued discharge though, the voltage of a passivated cell will rise to a level equivalent to the load voltage of an unpassivated cell.

Adjusting storage conditions to reduce the likelihood 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.



Representation of Li/oxyhalide cell dynamics while stored and discharged.

Both of these 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.

Electrochem utilizes additives in many of its cell chemistries to minimize passivation formation and enhance restart performance. Under most operating conditions, depassivation of an Electrochem cell is unnecessary. However, under some more severe conditions (such as high temperature storage) it may be beneficial to depassivate a cell. For the most effective depassivation, Electrochem generally recommends discharging a cell at the specified maximum continuous discharge rate at room temperature (23°C).

See next page for information regarding the maximum discharge current and recommended depassivation load for some of Electrochem's most popular cells.

Please contact Electrochem regarding recommendations & guidelines for any cells not contained in the table below.

	Cell Type	Part Number	Depassivation Load (single cell)*
High Rate	BCX AA	3B0064	30 ohm
	BCX C	3B0070	6 ohm
	BCX D	3B0075	3 ohm
	BCX DD	3B0076	1 ohm
	CSC AA	3B0024	20 ohm
	CSC C	3B0030	3 ohm
	CSC D	3B0035	2 ohm
	CSC DD	3B0036	1 ohm
	PMX AA	3B1065	20 ohm
	PMX C	3B3700	6 ohm
	PMX CC	3B3000	6 ohm
	PMX DD	3B2800	2 ohm
	VHT C	3B4800	10 ohm
	MWD DD	3B3900	6 ohm
Moderate Rate	21-100-150MR	4248	100 ohm
	25-48-150MR	4264	100 ohm
	26-76-150MR	4322	100 ohm
	26-97-165MR	4330	100 ohm
	26-102-150MR	4342	100 ohm
	33-60-150MR	4362	100 ohm
	33-127-150MR	4422	100 ohm
	14-24-150 Bobbin	4161	600 ohm
	25-102-150 Bobbin	4282	100 ohm
Low Rate	26-48-150 Bobbin	4301	150 ohm
	26-76-150 Bobbin	4321	100 ohm
	26-102-150 Bobbin	4341	100 ohm

NOTICE: *All recommended depassivation loads are to be conducted at room temperature (23°C). Note also that the load should be adjusted accordingly for multi-cell battery packs. A depassivation load should be applied until the cell voltage recovers to a normal level (> 3.0 volts). The duration will depend on the severity of the passivation. The information on this sheet is for single cells only. Please consult with Electrochem if you are interested in additional information on these cells or on other cells that are not listed here. The information in this document is subject to change without notice and does not constitute a warranty of performance.*