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Determination of Cell Rupture and Separator Shutdown of a Pouch Cell Using an Oven Test

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Introduction:

Lithium-ion batteries have become common place in everyday household items. Therefore, it is critical that their safety is analyzed to prevent potential hazards. Lithium-ion batteries are often favored over other types of energy storage systems because they offer high energy density. High energy density also means there are potential risks, including cell rupture and thermal runaway reactions. While some parameters such as onset temperature and heat of reaction can be measured using Accelerating Rate Calorimeters (ARC®), an oven test is often needed to determine when the cell ruptures, and when the separator has shutdown.

Exothermic onset temperature is the temperature where the cell begins to self-heat. This can lead to a thermal runaway reaction where the cell will continuously heat itself until the cell catches fire and/or explodes. As this process occurs, the pouch cell will expand and push against the outer coating of the cell, eventually leading to a cell rupture. It is important to know at what temperature the cell ruptures, so potential hazards associated with the release of the chemicals from the cell can be addressed.

Lithium-ion pouch cells also contain a thin, porous, polymer separator which prevents the anode and cathode from coming in direct contact, while still allowing charged ions to flow through. When the temperature within the cell gets high enough the separator will melt, which closes the pores and prevents the exchange of ions between the anode and cathode. The separator shutdown will render the cell incapable of preforming work. However, a traditional voltage reading measures cell potential, meaning a cell with a shutdown separator will appear to have full voltage, even though it is incapable of preforming work. This makes determining separator shutdown temperature difficult when using a data logger. Separator shutdown and cell rupture temperatures can be determined using the oven test method developed by Belmont Scientific, Inc. Belmont Scientific has also recently developed a method for determining separator shutdown (But not cell leak) in an ARC test. For more information on ARC testing capabilities, see the white paper, *Thermal Stability Evaluation of Lithium-ion Cell Using Accelerating Rate Calorimetry.*

Experimental Method:

A Lithium-ion pouch cell is placed into an oven with a controlled heating rate. Thermocouples are attached to the top and bottom of the cell. The temperature and voltage data is collected using data logger. The experiment is also recorded on video. The rupture temperature is determined by reviewing the video. Belmont Scientific has developed a proprietary method to measure onset temperature of cell heating, cell leak, and separator shut down temperature. More detailed information is available at www.belmontscientific.com

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Results:

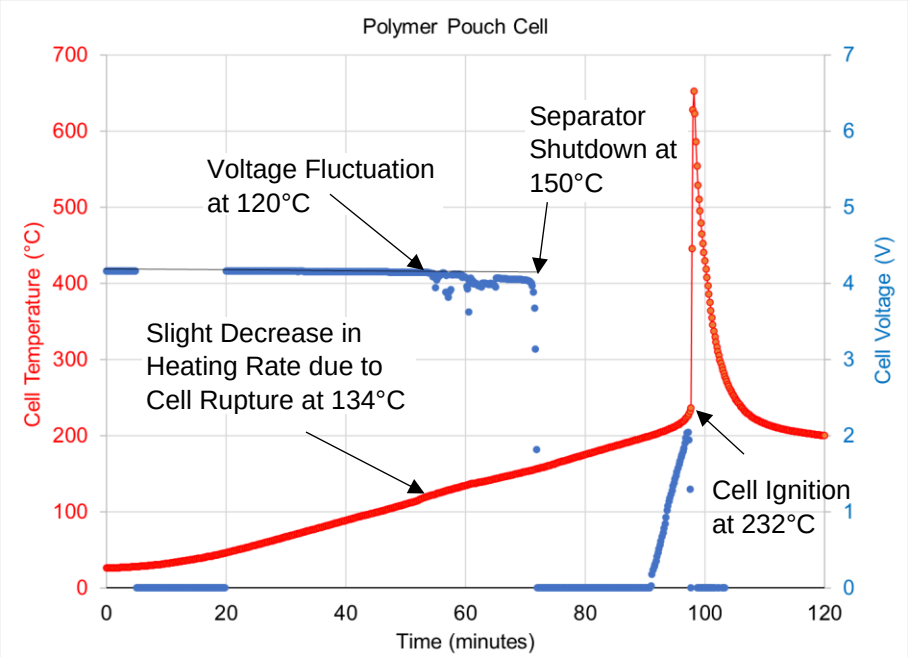

Figure 1. Plot of Temperature and Voltage vs. Time.

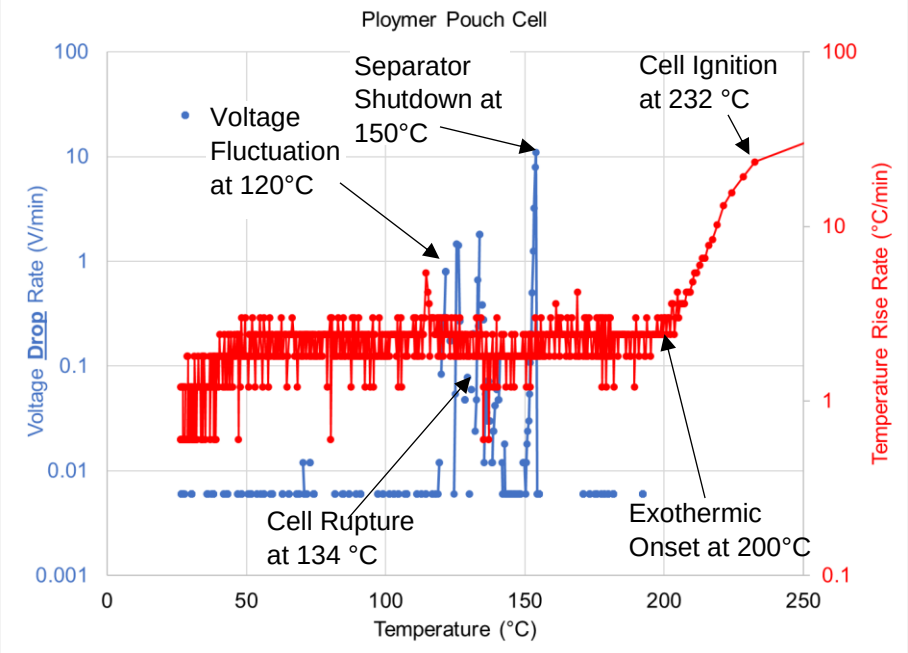

Figure 2. Plot of Voltage Drop Rate and Temperature Rise Rate vs. Temperature

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