4th International Symposium on
Energy Challenges & Mechanics
- working on small scales

11-13 August 2015
Aberdeen, Scotland, UK

Dendrite-Separator Interaction and the Propensity for an Internal Short

Corey T. Love

Chemistry Division, U.S. Naval Research Laboratory, Washington, DC USA

Accepted for publication on 8th January 2015

Lithium-ion batteries are efficient and effective as dense, rechargeable energy/power sources, but several sensational civilian and military battery fires, particularly during charging, have raised concerns about their safety. Lithium dendrite formation at the anode during charging can initiate internal short circuits, a known failure mechanism. Dendrite-induced short-circuits at low temperature have been identified as a causal factor in recent lithium-ion battery failures aboard commercial aircraft. Low temperature charging affects the kinetic processes occurring within the cell, causing lithium ions to reduce and plate metallic lithium (Li^0) on the carbon anode rather than favoring ion intercalation into the carbon electrode. At best, this lithium metal deposition is manifested as uniform plating leading to a loss of useful capacity of the battery. In the worst case the lithium electrodeposits grow uncontrollably to form an internal short to the cathode capable of initiating the thermal runaway reaction.

Recent work by the authors has shown a strong temperature depedence of lithium dendrite initiation time, growth rate and morphology. The morphology of dendrites changes with temperature, where low temperature favors mushroom-shaped deposition, while lithium needles form wound-balls and particulates at 5°C and 20°C, respectively. Needle-like morphologies have a greater propensity to short a cell due to faster initiation time, quick growth rates and rigid mechanical properties to induce “hard” short-circuits.

This talk focuses on dendrite-separator interactions at various temperatures and the propensity of the dendrite to induce an interal short-circuit. We use in-situ optical microscopy to directly observe the physical interaction between growing dendrites and a commercial polymer separator in the presence of a traditional electrolyte. The effect of electrolyte-induced softening of polymer separators will also be discussed.

Keywords: lithium-ion battery; safety; dendrite; separator