German Research Pinpoints Safety Risk for Lithium-ion Batteries

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Sydney, Australia - Ground breaking research recently completed by a leading German battery technology institute has identified a previously unrecognised contamination and safety risk for lithium-ion batteries - the use of lower purity (grade) alumina in battery cell manufacture.

The Fraunhofer Institute for Ceramic Technologies and Systems IKTS in Dresden Germany, recently completed test work that has the potential to rock the lithium-ion battery industry.

Globally, lithium-ion battery production is rapidly expanding to meet the burgeoning demand from electric vehicles (EV's) and portable electronic devices. The Fraunhofer ITKS research was triggered because a significant part of the industry, including those that supply EV batteries, are turning to cheaper substitutes such as low grade alumina and boehmite as the coating material on battery separator sheets and composite separators. However, this hot-off-the-press German research brings into question the safety of using lower quality separator coating materials.

A lithium-ion battery stores then releases power by lithium ions moving between the battery cathode and anode, representing the charge and visa-versa discharge cycles. Separating the cathode and anode within the battery is a liquid electrolyte and a thin polymer sheet through which lithium ions pass - a separator sheet. The composition of these polymer separator sheets has evolved over time in parallel with increases in battery energy density and faster charging requirements. Now separator sheets are mostly coated with thin layers of alumina powder to maintain separator integrity under the ever-increasing operating temperatures of modern high-energy lithium-ion batteries.

Wisely it would seem, the lithium-ion battery industry initially adopted high grade 4N alumina (99.99%) as the standard coating material for separator sheets, especially where battery safety was paramount - such as in EV's. The scientific tests recently completed by the Fraunhofer IKTS plainly vindicate the initial choice of 4N alumina by the battery industry. In its tests, the Institute exposed various commercially available lower grades of alumina / boehmite powders to lithium battery electrolyte solution under controlled battery type conditions. What was observed was extremely concerning - the severe leaching of sodium from the lower grade alumina's into the organic electrolyte solution, which resulted in significant electrolyte contamination.

Specifically, the research reported that in its test of 3N alumina (99.9% alumina) the sodium content within the electrolyte solution rose from an acceptable 0.5 ppm up to a potentially catastrophic level of 40 ppm (an 80-fold increase). Similar leaching was observed for boehmite (99.7% alumina), where the level of sodium in the electrolyte jumped 20-fold. As a base line, sodium leaching from 4N alumina (99.99%) into the electrolyte is negligible, as there is virtually no sodium present in the 4N product.

Sodium contamination is one of the major no no's for anywhere within a lithium-ion battery. Sodium can dramatically reduce battery discharge capacity and adversely affect the reactivity of lithium ions. When too much sodium is present in a battery's organic electrolyte solution, the movement of lithium ions is hindered and the discharge capacity is rapidly reduced; the performance of the battery is compromised. Lithium-ion battery end-users such as EV assemblers or high-end portable electric device manufactures would never accept a battery with an electrolyte solution containing 40ppm sodium - yet it would seem that this is where they are set to end up if 3N alumina / boehmite is adopted by industry as a coating on battery separator sheets.

It would appear that the lithium-ion battery industry currently incorrectly assumes that sodium impurities contained within lower grades of alumina and boehmite do not leach out of the alumina. This is now proven to be incorrect! In its rush to expand capacity, perhaps the industry has not taken time to adequately consider the consequences of adopting this lower quality material?

Dendrite growth within the battery cell is another a significant safety concern. Dendrites are microscopic metals that are as thin as hairs and as sharp as needles, they grow from the anode during overcharging of a lithium-ion battery. Unchecked dendrites will in all likelihood eventually pierce the separator sheet and cause a thermal runaway leading to a battery fire or even battery explosion.

The ramifications from the Fraunhofer Institute's research findings for the large portion of the lithium-ion

battery industry that seems set to transition away from 4N alumina (99.99%) as the standard separator sheet coating material, have the potential to be quite profound.

When asked for comment, a representative from the high purity alumina industry stated that it is hard to comprehend why lithium-ion battery manufacturers would put battery safety and performance in jeopardy by transitioning to a lower quality alumina material as a separator coating. He stated that "runaway sodium ions in a lithium-ion battery are a disaster waiting to happen" and "perhaps industry simply does not fully understand the likely long-term consequences of this move".

"The extra cost of a high purity alumina coating versus the lower grade material is minimal, likely less than US$ 1 per kWh battery capacity or US$ 100 for a typical EV. A small cost impact to the end product to ensure the highest level of battery safety", he added.

He went on to say that "every component of a lithium-ion battery, especially when that battery is used in an EV, needs to be of the highest quality - whether it be the anode, cathode, electrolyte, separator or casing. Manufacturers need to be absolutely certain that they understand component materials, materials interaction and can guaranteed safety, performance and durability over the life of the battery. This is normally achieved through rigorous quality control with stringent specifications and standards to prevent contamination, to this the most sensitive of battery technology.

In the case of the alumina coating on battery separator sheets, it is potentially catastrophic that many in the industry appear to be attempting to move to lower quality material.

A minimum quality standard for all alumina used as coating on battery separator sheets should be adopted by industry "

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