ALTECH - GERMAN RESEARCH CONFIRMS 4N HPA CRITICAL IN LITHIUM-ION BATTERIES

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Highlights

- Test work shows sodium contamination from low grade alumina
- Up to 80-fold increase of sodium levels
- Almost no sodium leaching for 4N alumina (99.99%)
- Potentially serious battery safety risks, performance and durability problems
- Altech calls for minimum quality industry standards for alumina coated separators

Altech Advanced Materials AG (26.05.2020/12:30; "AAM") is pleased to to provide an update from Altech Chemicals Limited, Australia, ("Altech Chemicals"), on its high purity alumina research activities with various research bodies such as the internationally renowned Fraunhofer Society for the advancement of applied research.

As already announced in our Corporate News of March 25, 2020, Altech Chemicals commissioned the Fraunhofer Institute for Ceramic Technologies and Systems (IKTS) of Dresden, Germany, to undertake various HPA battery product application test work. The institute specialises in lithium-ion battery research but more specifically, separator technology. The commissioned work focused on assessing how readily impurities (predominantly sodium) leach from lower quality alumina (sub-4N) and boehmite into battery electrolyte solution, a cause of lithium-ion battery thermal runaway, efficiency and life cycle reduction.

As the lithium-ion battery industry rapidly expands in response to increased demand for electric vehicle (EV) and portable electronic device batteries, some in the industry have turned to cheaper low-grade alumina and boehmite as a coating material for battery separators. This substitution is away from high quality 4N alumina (99.99%) as a standard separator sheet coating. Results from the Fraunhofer test work point to a previously unrecognised contamination risk and heightened safety hazard – sodium leaching – where lower grade alumina or boehmite is used as a separator coating material.

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 (see Figure 1). The composition of these polymer separator sheets has evolved over time in parallel with increases in battery energy density and faster charging and discharging 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 (see Figure 2).

Figure 1. Cross section of lithium-ion battery

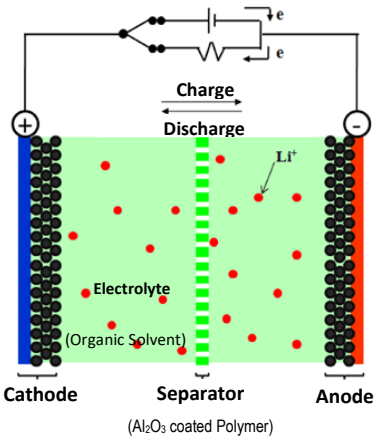
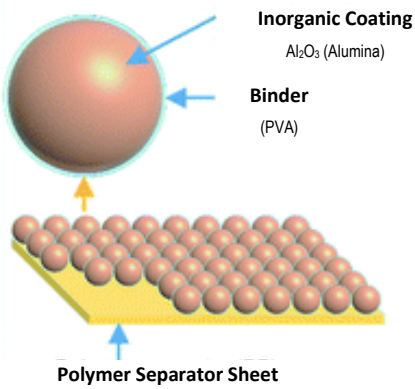


Figure 2. Schematic of alumina (Al_2O_3) coated polymer separator



The Fraunhofer test work exposed various commercial grade alumina / boehmite powders known as being adopted for battery separator coatings, to lithium battery electrolyte solution under controlled battery type conditions. What was observed was severe sodium leaching and contamination of the organic electrolyte solution from the lower grade alumina powders. The institute reported that the sodium content in the electrolyte rose from an initially acceptable 0.5 ppm, up to potentially catastrophic level of 40 ppm (an 80-fold increase) for the test using low quality 3N alumina (99.9%). Similar leaching and electrolyte contamination was observed for the boehmite test (99.7% alumina), where the sodium level in the electrolyte jumped 20-fold. For the 4N alumina (99.99%), almost zero leaching of sodium was observed.

Figure 3 illustrates the discolouration of the organic electrolyte solution that resulted from the leaching of contaminates from the Fraunhofer test work.

Figure 3. Electrolyte samples showing discolouration – Left to Right, 4N Alumina (99.99%), 3N Alumina (99.9%), Boehmite (99.7%)

The presence of high levels of sodium in the extremely sensitive lithium-ion battery electrolyte solution presents potentially serious battery safety risks, battery performance issues and battery durability problems. Sodium contamination is to be avoided at all costs anywhere within a lithium-ion battery. Sodium can dramatically reduce battery discharge capacity and adversely affect the reactivity of lithium ions within the battery. When there is too much sodium present in the battery's organic electrolyte solution, the movement of lithium ions is hindered and the battery discharge capacity is rapidly reduced. Overall, sodium has a negative impact on battery performance and safety.

Dendrite growth within the battery cell is also a significant safety concern. Dendrites are microscopic metals that are as thin as hairs and as sharp as needles, and which grow from the anode during overcharging of a lithium-ion

battery and unchecked will in all likelihood eventually pierce the separator and cause a thermal runaway leading to battery fire or even explosion. Sodium presence in electrolyte promotes dendrite growth.

It would appear that the lithium-ion battery industry currently incorrectly assumes that the sodium impurities contained within lower grade alumina and boehmite are “crystal bound”, and simply do not leach out of the alumina – this just completed test work proves this assumption to be incorrect!

Altech managing director and AAM CEO, Iggy Tan said that *“the ramifications from these research findings for the portion of the lithium-ion battery industry that is transitioning to cheaper alumina substitutes for separator coatings, are set to be profound.*

It is hard to comprehend why lithium-ion battery manufacturers are transitioning to a lower quality alumina – when this material is introducing sodium into the battery electrolyte and as a result jeopardising battery safety and performance. 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 on the end product to ensure the highest level of battery safety.

It is potentially catastrophic that many in the industry appear to be attempting to move to lower quality material as a battery separator coating. A minimum quality standard for all alumina used as coating material on battery separator sheets should be adopted by industry”.

As an independent German based institute, the results of the HPA test work will be highly regarded by German and other European Industry within the value chain of the lithium ion battery and electric mobility. The Fraunhofer-Gesellschaft is the largest organisation for applied research in Europe and conducts research under contract for industry. A total of 72 institutes and research facilities work together under the umbrella of the Fraunhofer-Gesellschaft, which has an annual operating budget of EUR 2.6 billion.

The Management Board

About Altech Advanced Materials AG

Altech Advanced Materials AG (“AAM”) currently plans to subscribe up to 49% in Altech Chemicals Australia PTY LTD ("Altech Australia") for up to USD 100 million from Altech Chemicals Ltd, Australia. AAM is currently implementing its capital raising strategy to be able to fund the investment.

Altech Australia is currently building a high-purity alumina (99.99%, 4N HPA) production facility for 4,500 tons p.a. in Malaysia and also has its own deposit for the mining of the main raw material kaolin. 4N HPA is needed for the production of LED lights as well as a separator for lithium-ion batteries, e.g. needed for electric vehicles and smartphones. Market demand for 4N HPA is expected to grow with a CAGR of 30% p.a. until 2028. The process patented by Altech Australia allows the production of HPA as cost leader, as the HPA can be obtained directly from kaolin. This allows production without the use of energy-intensive aluminium. The production volume for the first 10 years is secured by an off-take agreement with Mitsubishi Australia and the production capacity and quality is guaranteed by the German plant manufacturer, SMS group GmbH, Dusseldorf, which has also agreed to contribute in equity to the Altech HPA project.

The project has an investment volume of approximately USD 390 million, of which KfW-IPEX Bank has already committed USD 190 million under certain conditions and of which USD 10 million is assumed as equity investment from SMS group GmbH. Altech Chemicals is in talks with Macquarie Bank on the provision of USD 90 million in mezzanine capital. The remaining USD 100 million is to be made available by AAM.

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