A New Measurement System for Battery Production

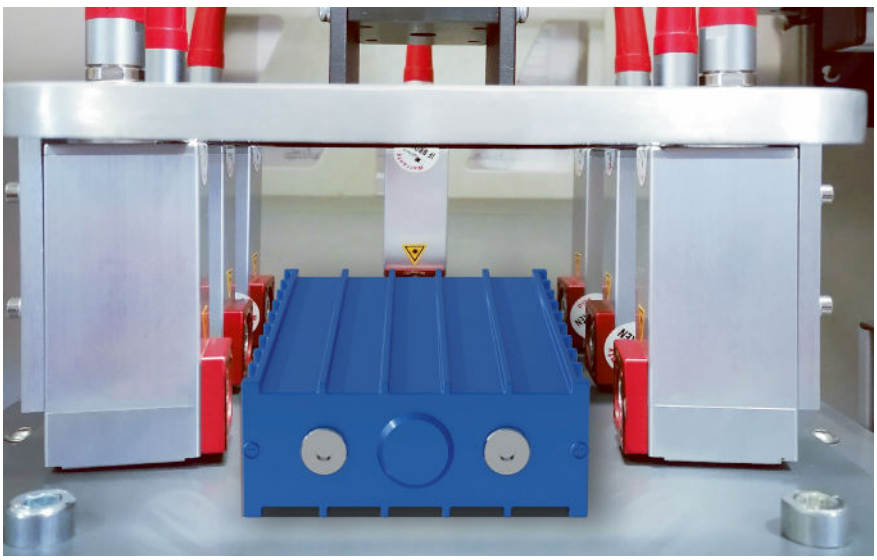
The Li-ion battery plays an important role in the transportation transition. In addition to cost-effectiveness safety is a decisive factor in its manufacture. This is because faulty production can lead to a fire in the battery in extreme cases. Together with two integrators a measurement technology specialist developed a system for testing the insulating cell coating.

Battery systems in electric cars consist of lithium-ion cells, such as those installed in cell phones or notebooks. Several of these cells are combined to form battery modules, the size and number of which in turn determine the performance and range of the vehicle. Up to 800 V are applied – significantly more than at the 230 V socket at home. The cells must therefore be reliably insulated from one another to reliably prevent a short circuit and possible burning of the entire battery. For this purpose, the aluminum housing is provided with a coating that must both protect the surface and perform the necessary insulating function. The coating thickness is a safety-relevant parameter that must be carefully monitored during production.

Together with Sturm Maschinen- & Anlagenbau GmbH in Salching (Germany) and another integrator, Optisense developed a system for testing the insulating cell coating for the BMW Group.

Coating thickness as a safety-relevant factor

Since the coating thickness is a function-critical parameter, all types of coating defects such as uneven coating application or coating flow, as well as damage, scratches, cracks or trapped foreign particles such as dust or lint must be reliably detected," explains Dr. Peter Scheibner, head of project management at Sturm Maschinen & Anlagenbau. This enables us to reliably detect all coating defects, such as uneven coating application or coating run, but also damage, scratches, cracks or trapped foreign particles such as dust or fluff," explains Dr. Peter Scheibner, head of project management at Sturm Maschinen- & Anlagenbau GmbH. For this purpose, each cell travels on a conveyor belt to a measuring station directly after curing, where the thickness of the coating is checked at several points without contact.



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A system was needed that could measure multiple points simultaneously and whose sensors were small enough to fit side by side in the confined installation space.

Photothermal measurement method

Based on OptiSense's PaintChecker technology, a suitable solution was found for this safety-relevant measurement task. The PaintChecker coating thickness testers use the photothermal photothermal measurement method to determine the thickness of coatings in a non-contact and non-destructive manner. The different thermal properties of the coating and the substrate are used to determine the absolute coating thickness.

The surface of the coating is heated by a few degrees Celsius with a short, intense light pulse and then cools down

again by dissipating the heat into deeper areas. The thinner the coating, the faster the temperature drops. The temperature profile over time is recorded from a distance by a fast, highly sensitive infrared sensor and converted into a corresponding coating thickness. The point-shaped measuring corner allows even the smallest components to be measured precisely. The photothermal measurement method thus provided a fast, quantitative method of determining coating thickness that delivers precise, reproducible results.

Special challenges

However, the short cycle times and very confined space meant that this project presented some very special challenges: In order to assess the overall quality of the coating as a whole, measurements have to be taken at several points. In addition, the measurement time cannot be shortened arbitrarily for physical reasons. Moving to several measuring points one after the other takes too long, and the sensors of comparable suppliers, the sensors are simply too large for this demanding measurement task.

New development for this application

A system was needed that could measure several points simultaneously and whose sensors were small enough to accommodate them side by side in the tightly limited installation space. However, nothing like this was available on the market. “After intensive dialog between the BMW Group and OptiSense development, the PaintChecker Industrial was created in just four months as a photothermal measuring device for non-contact, non-destructive coating thickness measurement that can control multiple sensor heads simultaneously,” reports Scheibner, “It is suitable for moist and dry organic coatings such as paints, varnishes and powders on metal, rubber and ceramics.”
The system consists of a central controller to which up to eight sensors can be connected via cable. For software integration into the production line, the PaintChecker Industrial has various interfaces to the higher-level PLC. (In Deutsch SPS)
The space problem has also been elegantly solved: By folding the beam path of the optics by 90°, it was possible to shorten the sensor head enough to fit into the available installation space. According to Opti-Sense, the angle sensor, which weighs only 150 g, can measure coating thicknesses of up to 300 µm quickly, accurately and reproducibly with an installation depth of just 40 mm. The coating line was equipped with the new components and immediately delivered excellent results, according to those involved in the project. Here, the coating thickness as a function-critical quality parameter is subject to strict requirements regarding the accuracy and reproducibility of the measurement. Within the scope of a measuring equipment capability analysis, the photothermal measuring method was once again able to demonstrate its advantages. After 6.5 h of endurance testing with over 2900 measuring cycles, the standard deviation of the measurement was below 0.5 µm and was thus far more accurate than what can be achieved with conventional eddy current or magnetic inductive measuring methods.

Long-term partnership

One might think that the project was now over, but the successful first use of photothermal measurement technology in battery production was the beginning of an intensive cooperation between the BMW Group and OptiSense. For there was further development. First, the PaintChecker industrial angle sensors were equipped with diffusers to increase the distance range between sensor and component in which accurate measurement is possible. On subsequent production lines, the developers envisaged more space in order to be able to use more powerful, more flexible sensors. The distance between the sensor head and the component to be measured was thus more than doubled, and the tolerance range of the measuring distance was increased once again. This means that battery cells can be measured – even if they do not enter the measuring station quite accurately – without risking damage to the sensor or cell.
The measurable coating thickness range has also been extended several times, since on the one hand larger cells and higher voltages require a thicker coating, but on the other hand one would also like to quantitatively precisely detect faulty coatings that are too thin. //

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