



Die BMW Group

With its BMW, MINI and Rolls-Royce brands, the BMW Group is the world's leading premium manufacturer of automobiles and motorcycles.

After the BMW Group established an e-drive center of excellence in Dingolfing and a battery center in China, the car manufacturer launched another battery production facility in Leipzig, Germany.

Next, the BMW Group will join forces with partners to set up additional large-scale factories for electric car batteries and manufacture its own battery cells.

Coating thickness becomes safety-critical:

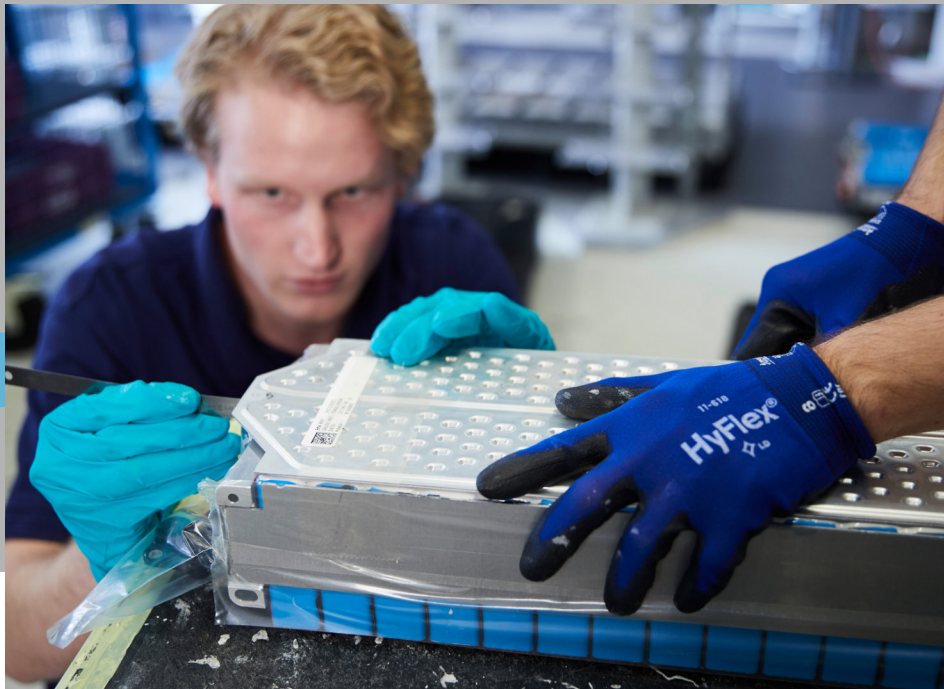
OptiSense develops a new coating thickness inspection system for the battery cells of BMW Group

Battery cells are the new heart of the automobile, because the transition to electromobility will eliminate the combustion engine as the central element of the automotive industry in the future. For a battery to be competitive, it must be inexpensive to manufacture, have a high energy density and last as long as possible, and above all it must be safe. Production faults can lead to self-destruction and in extreme cases set the battery on fire.

Together with Sturm Maschinen- & Anlagenbau GmbH in Salching and another integrator, OptiSense developed a system for testing the insulating coating of the battery cells, thus making an important contribution to the safety of the new batteries.

Electric car battery systems

Battery systems of electric cars consist of lithium-ion cells, similar to those installed in cell phones or notebooks. Several of these cells are assembled into battery modules, whose size and number in turn determine the vehicle's performance and operating range. Up to 800 Volts are generated – many times more than what the mains socket at home supplies. The cells must therefore be properly insulated from each other to reliably prevent short circuits and



The aluminum enclosure of the battery cell is equipped with a coating that both protects the surface and performs the required electrical isolation

potential burnout of the entire battery. This is achieved by applying a special coating to the aluminum enclosure that both protects the surface and provides the necessary insulation. Coating thickness is a safety-critical parameter here, which must be carefully monitored during production.

Coating thickness is critical to safety

Dr. Peter Scheibner, Head of Project Management at Sturm Maschinen- & Anlagenbau GmbH explains: "Since the coating thickness is a function-critical parameter, all types of coating defects such as uneven application or running, but also flaking, scratches, cracks or trapped foreign particles such as dust or lint must be reliably detected".

Immediately after curing, each cell moves on a conveyor belt into a measuring station where the coating thickness is checked at several points without touching the insulating layer.

Most demanding challenges require innovative products

The ideal solution for this safety-relevant measuring task was found with the PaintChecker Industrial devices from OptiSense. These coating thickness measurement systems employ the photo-

thermal measurement method to determine the thickness of coatings in a non-contact and non-destructive manner. This method employs the different thermal properties of the coating and substrate to determine the coating thickness.

The surface of the coating is heated by a few degrees 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 curve is recorded over time with a highly sensitive infrared sensor from the distance and finally converted into the coating

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Dr. Peter Scheibner

Head of Project Management
Surface Technology Division
Sturm Maschinen- & Anlagenbau GmbH

thickness. Due to the tiny, point-shaped measuring spot, even the smallest components can be precisely measured. The photothermal measurement method thus provides a fast and convenient way to determine coating thickness with accurate, reproducible results.

However, this project presented some very particular challenges due to the short cycle times and very confined space. In order to assess the overall coating quality, measurements must be taken at several locations. Moreover, the measurement time cannot be shortened arbitrarily for physical reasons. Moving to several measuring locations one after the other takes too long and the sensors of other suppliers are simply too large for this demanding application.

The PaintChecker Industrial becomes redeveloped for BMW Group

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. However, there was no such product available on the market.

Dr. Scheibner reviews: "In just four months of intensive collaboration between BMW Group and OptiSense, the PaintChecker

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Industrial was developed, a photothermal measuring device for non-contact, non-destructive coating thickness measurement that can operate multiple sensors at the same time. It is suitable for wet and dry organic coatings such as paints, varnishes and powders on metal, rubber and ceramics.”

The system consists of a central controller with up to eight sensors connected by cable. The PaintChecker Industrial features various interfaces to the upstream PLC for easy software integration into the production line.

The space problem was also solved in a smart way. By folding the optical beam

path by 90°, the size of the sensor could be sufficiently reduced to fit into the available installation space. Weighing only 150 g, the angular sensor can measure coating thicknesses of up to 300 µm fast, accurate and reproducible with an installation depth of just 40 mm. The coating line was equipped with the new system and immediately delivered excellent results.

And this, even though the coating thickness, as a function-critical quality parameter, is subject to strict requirements regarding the accuracy and reproducibility of the measurement. A measurement system analysis (MSA) once again proved the advantages of

*Bottom left image:
Construction of a battery cell*

*Bottom right image:
The enclosure is coated with a light blue UV paint. As coating thickness is a safety-critical parameter, it is precisely measured and reliably documented by OptiSense.*

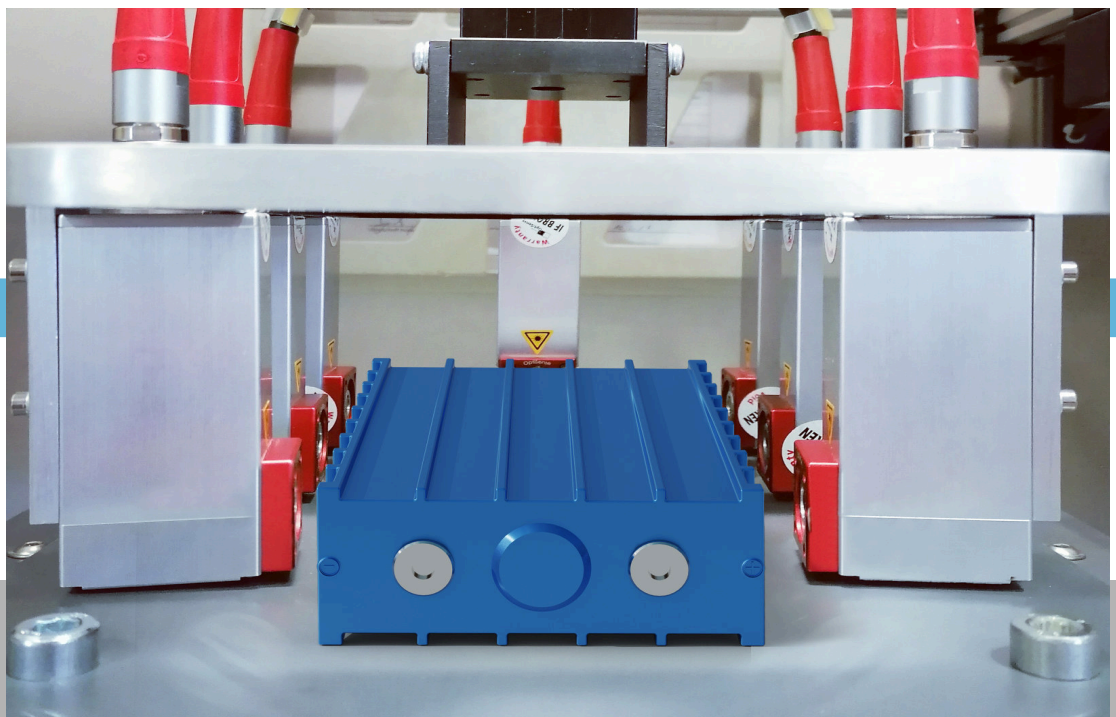
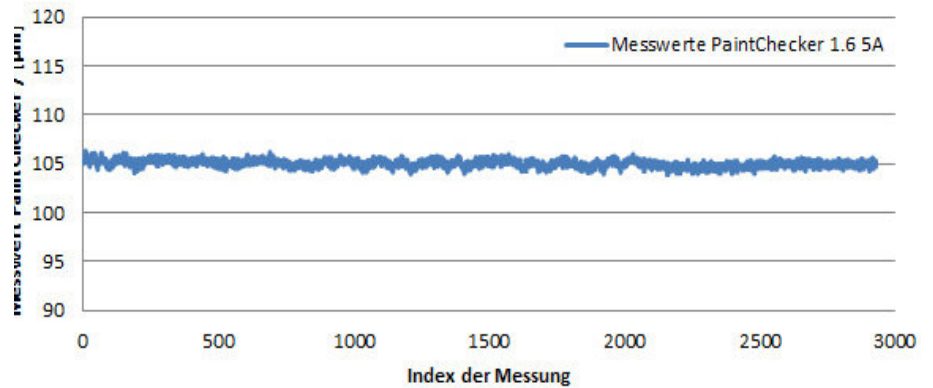


OptiSense's photothermal measurement method. After 6 ½ hours of continuous operation with over 2,900 measurements, the standard deviation of the results was less than half a micrometer. It turned out to be far more accurate than the conventional eddy current or magnetic induction measurement methods.

Long-term partnership protects know-how and creates synergies

This could have been the successful completion of the project. However, this first-time application of photothermal measurement technology in battery production was only the beginning of an intensive cooperation between BMW Group and OptiSense.

Messwerte PaintChecker 1.6 5A



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Summary and outlook

The next step was to add diffusors to the PaintChecker Industrial Angle sensors in order to increase the distance range between sensor and part in which accurate measurement is possible. On the subsequent production lines, the engineers planned for more space to make room for even more flexible sensors with even higher-performance.

Thus, the distance between sensor and part to be measured could be more than doubled and the tolerance range of the measuring distance was increa-

sed even further. This allows the battery cells to be tested even if they do not enter the measuring station completely accurate, without risking damage to the sensor or cell.

The coating thickness measurement range has been extended several times because larger cells and higher voltages require thicker coatings, while the thickness of faulty, undercoated cells should also be measured accurately.

The PaintChecker Industrial in a long-term test: After 6 ½ hours of continuous operation with over 2,900 measurements, the standard deviation was less than half a micrometer.





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