Technology Brief

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Technologies in Quality Control Enable Significant Improvements in Cell Manufacturing

The rapid development in the field of electro-mobility has elevated batteries to a key component. The quality of these batteries is crucial for reliability and range of electric vehicles, as well as for consumer trust. Recent incidents, such as the fire on the "Fremantle Highway" car freighter, highlight how quality issues can easily shake public confidence in electric vehicles.

www.drschenk.com

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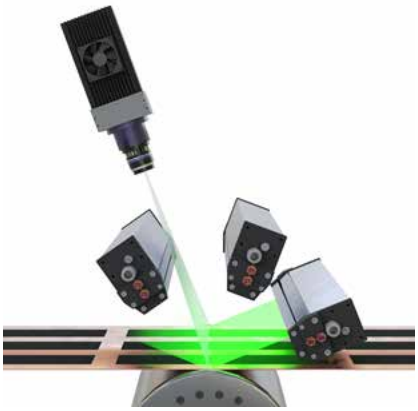
It has been modified for this technology brief.

Quality Control

In this context, quality control proves to be a significant opportunity for battery manufacturers in the USA and the EU to differentiate themselves from Asian producers while significantly increasing produc-tion output. This is economically crucial for all suppliers. Experienced manufacturers in Asia demonstrate that yields exceeding 90% are possible when quality issues are detected and addressed early. In this case, machine vision is one of the most powerful technologies in cell manufacturing as it can detect numerous production issues with one inspection system. Something that is unachievable with any other inspection method.



This becomes clear with the latest systems from Dr. Schenk, a German supplier. With just one inspection system, three of the most common quality inspections in cell production can be simultaneously checked. These are:

1. Coating defects, such as particles, scratches, cracks, holes, roller imprints, etc.
2. Highly accurate measurement of coating layers
3. Material properties, such as homogeneity, roughness, porosity, coating thickness, etc.

The last type of quality inspection is regularly used for quality improvement since it enables the detection of production variations very early in the production process. Experienced operators can quickly deduce the causes. *Figure 1* illustrates the possibilities using an intermittently coated electrode (Cu anode). Different effects from production, such as streaks, repetitive marks, or uneven coating, are clearly visible.

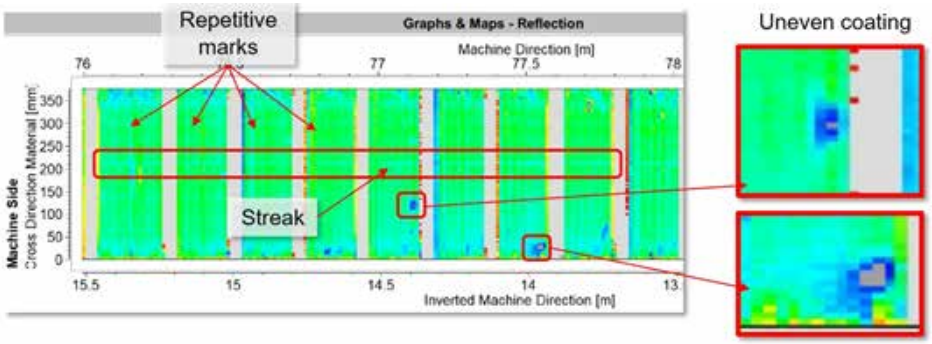


Figure 1: Material properties, e.g. repetitive marks, streaks or coating defects can be reliable detected and classified

The systems from Dr. Schenk, with self-developed camera and lighting technology, push the boundaries of what is technically feasible. An example of a battery separator foil demonstrates the possibilities (*Figure 2, next page*). Here, thickness variations of the coating in the sub-micrometer range are reliably detected. Unlike other technologies, for example confocal sensors or X-ray, inspection up to 10 m web width at a full production speed of up to 800 m/min. is possible.

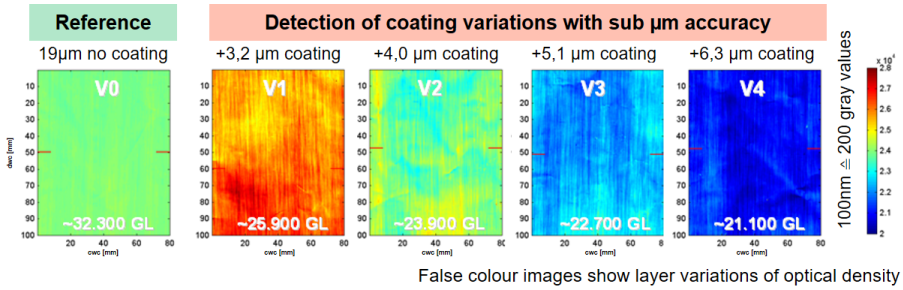
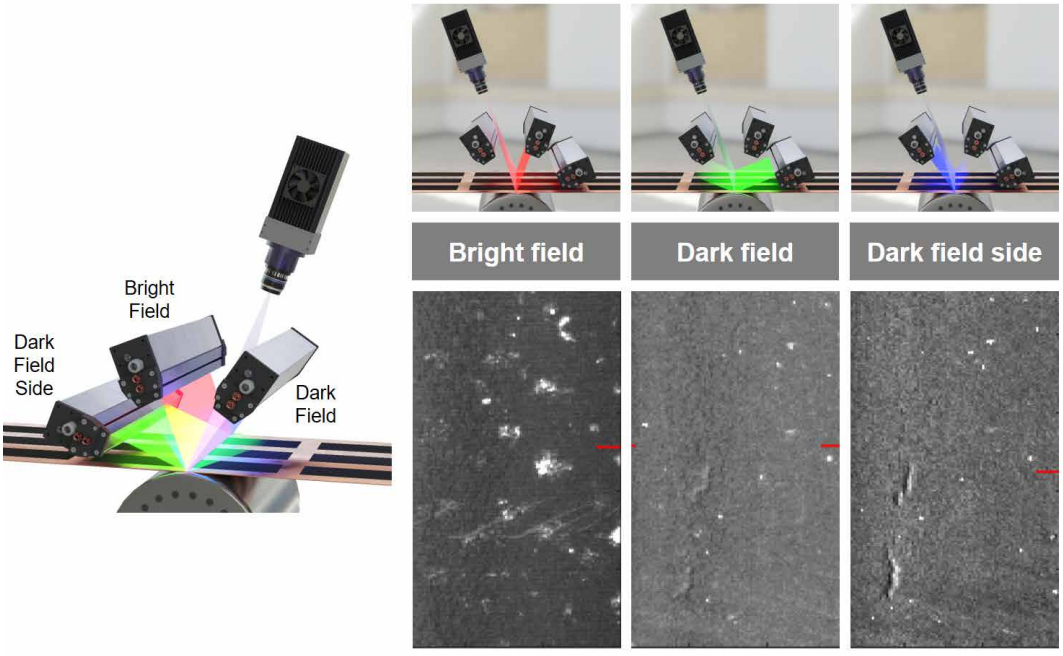


Figure 2: With 12bit cameras and water-cooled illumination we can detect even coating variations of some sub micrometer of coated battery separator foils – over the entire width with full production speed

Exemplary for the technological progress in optical quality inspection is the camera used. It enables the speed required for surface control of up to 300 m/min in new coating or slitting lines. This is approximately 3-8 times faster than current systems. The challenge lies in the deep black anode and cath-ode coating. Only about 100 µm thick, it absorbs almost all incident light. At these high speeds, conventional systems simply no longer have enough light.

Dr. Schenk's new cameras not only have sufficient light sensitivity and a 12-bit dynamic range, but with up to 280,000 line scan frequency per second, they are also fast enough to achieve resolutions in the µm range and capture multi-ple views from different perspectives. *Figure 3* illustrates the principle. Every four µs, one of the illuminations is switched on, and the camera captures an image. Different features become visible due to light incidence from various angles and directions. This is comparable to the human approach to detect defects, where we often rotate and turn the part before our eyes to see reflections from different angles.

Figure 3 (below) : MIDA illumination: three inspection channels are combined to supply more information and detect different kinds of defects



Future Innovations

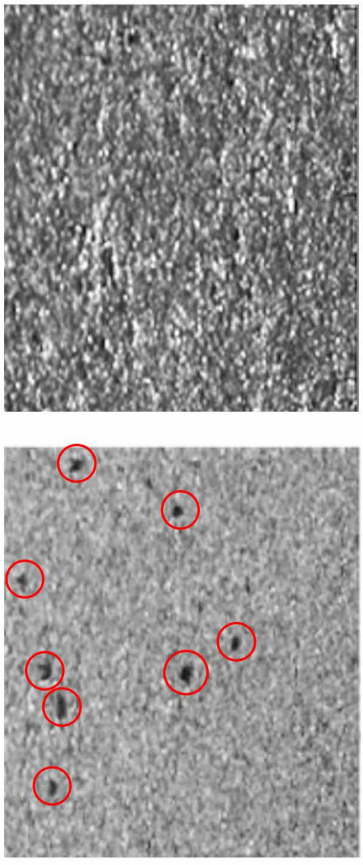


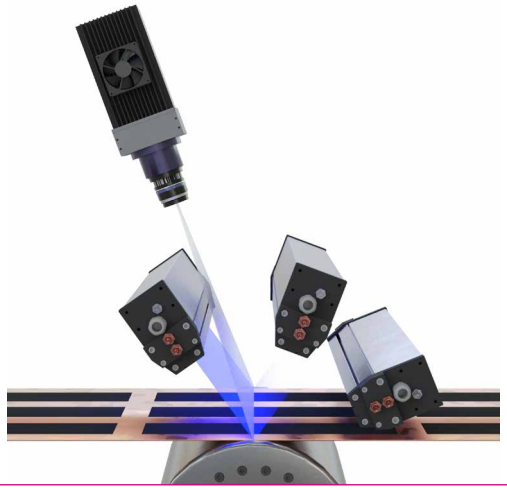
Figure 4: Particle Inspection

Even at this speed, the images can be pre-processed in the camera. This is particularly helpful for the noisy surfaces of the coatings caused by the micro-crystalline particles. *(Figure 4 left)*. Due to this noise, the detection of foreign particles is practically impossible. With a filter based on artificial intelligence, such disturbances in the image are "corrected".

Thanks to the support of FPGAs, each camera has computing power comparable to a 32 core high-end server. The result of particle detection, as shown in *Figure 4*, is quite impressive.

Integration of more powerful AI evaluations and optimized neural networks for recognizing common surface defects offers several advantages: Improved detection, better classification, reduced training time, and operation by less qualified operators are just a few of these advantages.

For customers, there are clear benefits of this enhanced technology. Battery quality is increased, effort is reduced, and ramp-up times are shortened. Machine vision provides extensive information for assessing cell quality, and integration into Manufacturing Execution Systems (MES) is now standard. This offers valuable data for process optimization and forms the basis for the upcoming "Battery Pass". Customers can thus rely on higher quality, a more efficient process, and improved feedback for optimizing their products. Overall, advances in quality control represent a milestone in electro-mobility by not only enhancing product quality but also paving the way for future innovations.



About Dr. Schenk GmbH

Dr. Schenk GmbH offers inspection and measurement solutions for automated quality assurance and production process control - e.g. plastics, nonwovens, metal, structured surfaces, paper or glass, for a multitude of markets like display glass, automotive, packaging, medical, renewable energy, and many more.
Throughout the world Dr. Schenk's 300+ employees continue to set new standards for the inspection of surfaces. Over 18,000 m² of modern, cleanroom-capable production and testing facilities are available for research, development and production to apply cutting-edge optics and electronics to customer applications.
From modular standard units to highly customized systems – Dr. Schenk's solutions have your material in focus!

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