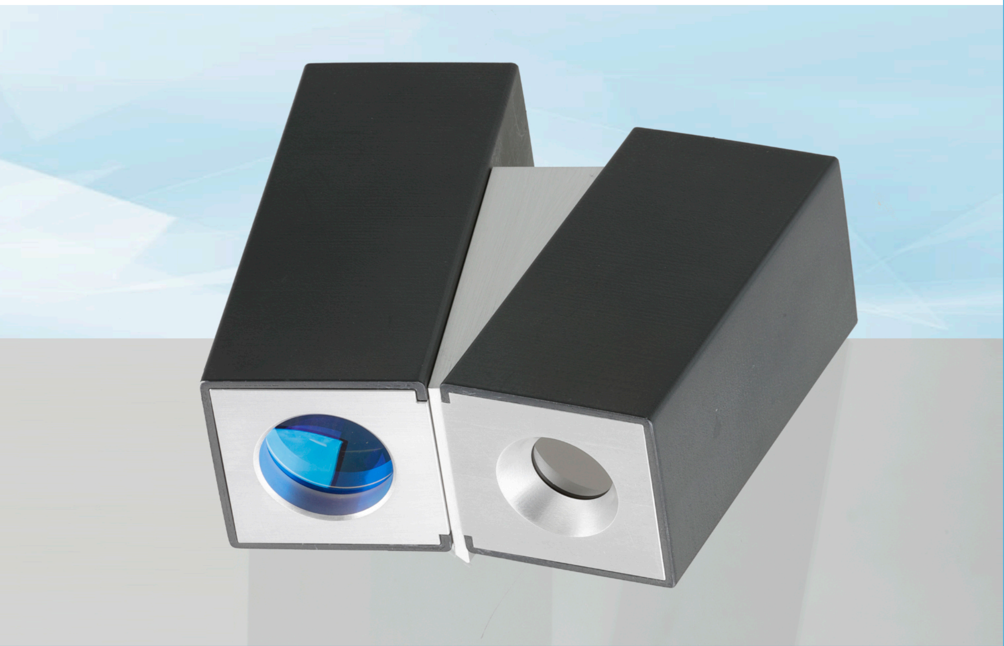
PaintChecker Move – Measuring in motion

Pioneering new coating thickness measurement method for extended surfaces and moving components

The newly developed photothermal testing method from measuring system manufacturer OptiSense allows endlessly long surfaces and moving objects to be tested without having to move along with the components.

The new technology actively utilises the movement between the workpiece and the sensor instead of compensating for it, as is the case with conventional devices. This makes it possible for the first time to inspect objects of any length, movement and even large surfaces.



The new, scanning OptiSense system is called PaintChecker Move and has a completely modular design so that the measuring device can always be optimally adapted to the respective application: The excitation and detection modules are self-contained and can be configured independently of each other.

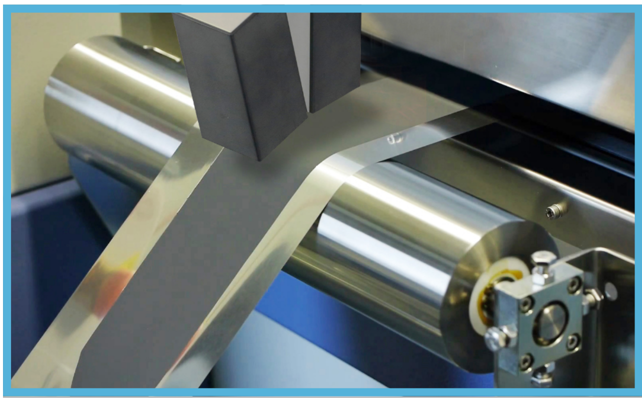
The innovative measuring system can inspect endlessly long surfaces and moving objects without having to move along with the components.

Status quo of coating thickness measurement on moving objects and extended surfaces
Economic efficiency, precision and surface quality are the dominant requirements in the coating industry to date. At the same time, however, it is still hardly possible in many companies to permanently monitor a very decisive parameter in this context at an early stage: the amount of paint applied.

It makes sense to check the coating thickness as a relevant parameter even before curing, i.e. while it is still liquid or soft, as incorrect coatings can still be easily corrected at this stage

A typical example is the coating of flat substrates such as foils for battery production. Strip coating is carried out with liquid slurry on a copper or aluminium foil.

Testing here must be contact-free and seamless, as the production and subsequent use of battery modules and packs are associated with numerous safety risks that require special protective measures.



"Slurry" on aluminium foil is measured in a moist state.

How moving objects are tested today

To date, coating thickness testing of moving objects has been difficult, as the object leaves detector's field of view after a short time. Of course, it is possible to move the entire measurement setup along with the object, but this approach is often technically complex and not an option where space is limited. In addition, no checks can be carried out while the coating thickness inspection system is travelling back to the starting point in order to detect other moving objects. This "return gap" therefore does not allow seamless measurement.

To avoid this dilemma, the heating area is enlarged for measurements in motion. This gives the moving component sufficient time to absorb the necessary amount of heat. During the test phase, the heated workpiece passes through the detector's field of view and the temperature curve is detected. The result is a coating thickness value - however, as the part is moving during measurement, the spatial resolution no longer corresponds to the size of the detector's field of view, but to the distance travelled during the measurement time. Even at relatively low speeds, this is already several centimetres. The layer coating determined then corresponds to the average value of this area, so that small imperfections can no longer be recognised.

Measurement of large areas

The situation is no better when it comes to checking the coating thickness of extensive surfaces: A current idea for checking large surfaces with spatial resolution sounds simple at first: the heating region is enlarged for this measurement task and an IR thermal imaging camera is used as a detector. However, this approach quickly becomes very complex. The larger the area, the greater the required excitation power, which often requires several energy-intensive light sources. In addition, the larger the area, the greater the demands on the camera and therefore the higher the costs. A further legal issue is that high-resolution IR cameras are often regarded as dual-use goods, which leads to trade restrictions.

This means that reliable and continuous monitoring of the coating thickness of large surfaces or moving objects before curing can only be realised with enormous effort by conventional approaches.

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New scanning 3D inspection method fulfils all requirements

Dr Fabian Gaußmann from the development department of the measuring system manufacturer OptiSense was therefore looking for a solution that could check both large and moving objects for correct coating without contact, precisely, continuously and even before curing.

The new, scanning 3D PaintChecker Move is flexible and user-friendly. It is easy to integrate into new and existing coating lines - even in the most difficult production environments.

The result is a scanning measurement process that utilises the movement between the component and the sensor instead of compensating for it in a complex manner. The object is not captured once as a whole, but is scanned continuously as it passes the measuring device. "The movement of the workpiece is therefore no longer an obstacle, but an elementary part of the process.

The inspection system can be guided along the stationary workpiece, the workpiece can move along the fixed sensor, or both sensor and component can move relative to each other," says Dr Gaußmann, explaining the basics of the new measuring principle: "The process is patent pending and represents a milestone in the measurement of moving and large-area workpieces."

Operation of the measuring method

The photothermal measuring method

As is well known, photothermal coating thickness testing is a non-contact process for paints, powder coatings and glazes on metallic and non-metallic substrates. The different thermal properties of the coating and substrate are utilised to determine the coating thickness. The surface of the coating is heated up 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 over time is recorded by a highly sensitive infrared sensor and converted into the coating thickness. The process works contactlessly and non-destructively with both freshly applied and cured powder and paint coatings.

The scanning, 3D inspection process

The new scanning 3D inspection process complements previous fields of application with the non-contact, fast and precise measurement of large workpieces and moving objects.

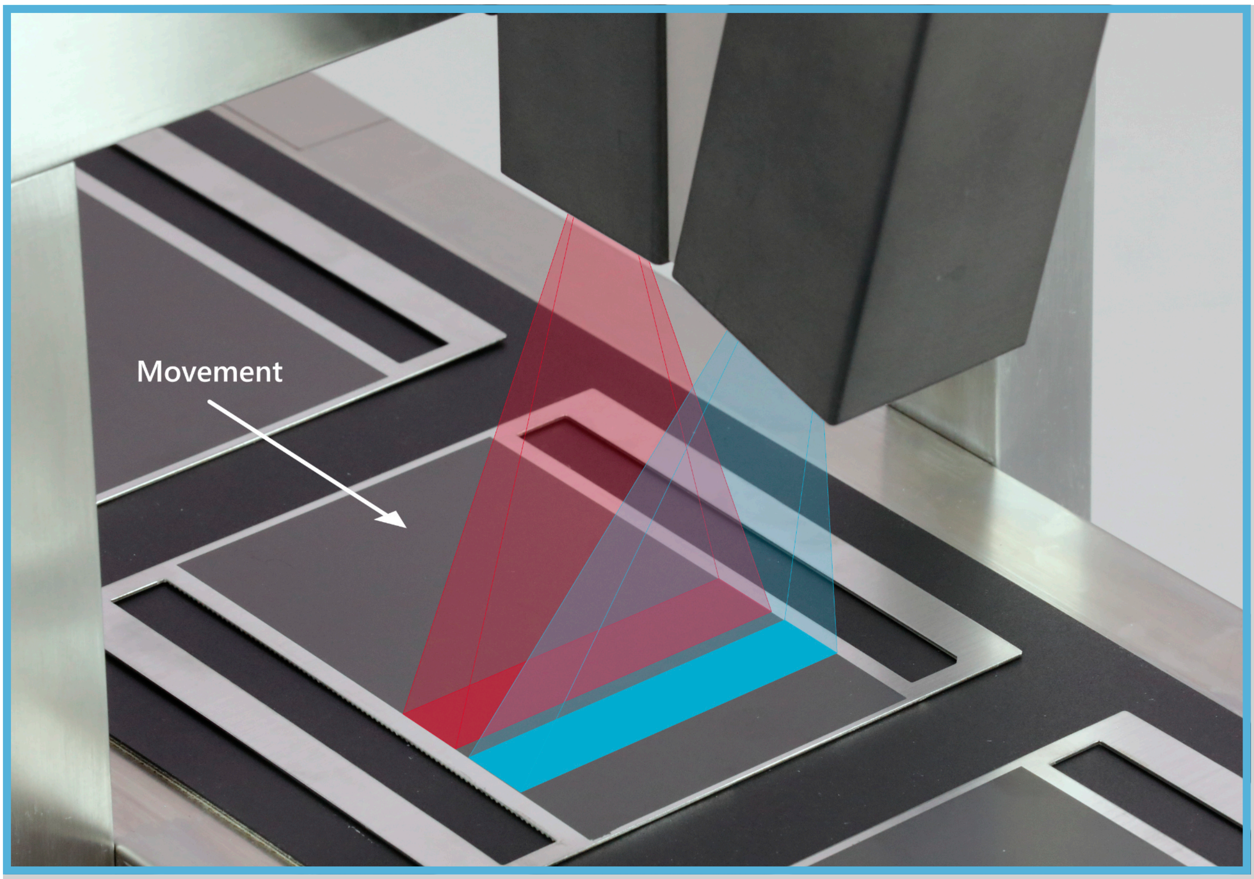
For the new process, the OptiSense development team extended the heating range of the test system to enable a greater heat input. However - and this is revolutionary - with the innovation presented here, the heated area does not have to cover the entire surface to be tested, but only a small section, usually just a few centimetres. As an interesting side effect, it is also no longer necessary to stimulate with pulsed light. On the contrary - constantly illuminated excitation sources are actually an advantage.

The detector used is an integrated matrix of IR sensors with a relatively small field of view and a low number of pixels, which covers a measuring field approximately the size of the heating area. The temperature curve is recorded on a pixel basis to determine the coating thickness with localised resolution. In simple terms, the image of the previously excited (heated) workpiece moves from pixel to pixel in the sensor due to the relative movement. The temperature profile of each individual surface element of the workpiece can thus be determined by continuously analysing the pixels over time. This temperature curve is then converted into the corresponding coating thickness, as in conventional photothermal technology.

The heated area passes under the detector

The coating thickness can be determined locally in this way, whereby the spatial resolution is determined by the effective pixel size of the sensor. Typically, the resolution is in the range of approx. 1 mm/px. The final result is an image with the desired coating thickness information.

The width of the image perpendicular to the direction of movement corresponds to the width of the excitation area and the width of the sensor field of view. The length of the image in the direction of movement is in general unlimited..



As the component moves along the sensor, it first passes through an excitation zone (red), in which the coating is heated by a few degrees by light radiation. It then enters the measuring zone (blue), in which the local temperature is recorded at several hundred points simultaneously. As the component passes through the measuring zone, the cooling of the coating is measured periodically and the coating thickness is calculated from the temperature curve. The temporally overlapping evaluation results in continuous, uninterrupted recording.

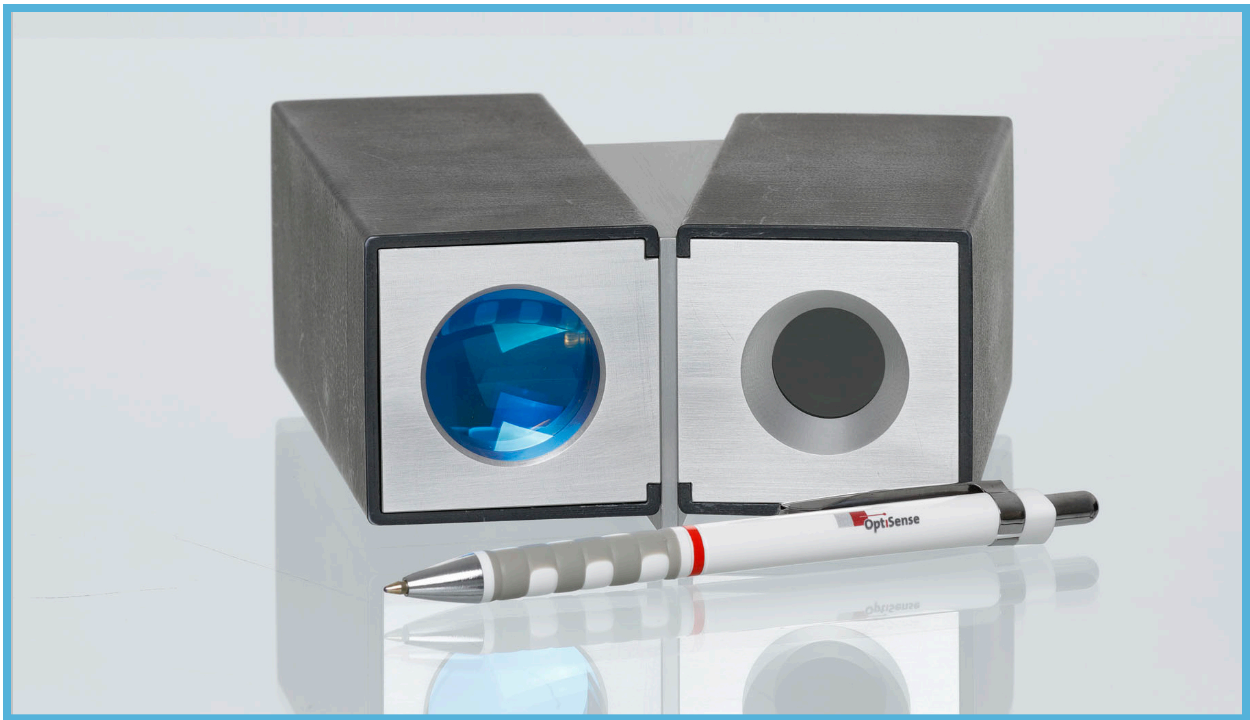
The modular structure of the PaintChecker Move

The new, scanning OptiSense system is called PaintChecker Move and has a completely modular design so that the measuring device can always be optimally adapted to the respective application:

The excitation and detection modules are separate and can be configured independently of each other. They are connected via mounting wedge that also contains the data cable connection and provides the mechanical connection to the customer's system. The angle of the wedge is selected accordingto the respective test situation.

The excitation module contains the optical components for beam shaping. Depending on the measuring situation, different shapes of the excitation area on the workpiece surface are possible. In a standard configuration, a homogeneously illuminated rectangle with an edge length of up to 100 x 10 mm² is generated. The edge lengths can be configured independently of each other.

Lasers of different power classes and wavelengths are used as excitation sources. What all variants have in common is that the laser itself is installed in the external controller housing and is connected to the excitation module via an optical fibre. This means that the excitation module does not require cooling, as it only contains passive optical components. The glass fibre is protected from mechanical stress by a 5 metre long metal braid with plastic sheathing and is suitable for drag chains.



At its core, the sensor consists of an excitation and detection module. The modules are configured independently and optimised for the respective measuring task. OptiSense has remained true to its credo of miniaturisation: The sensor is not even as long as a biro.

The detection module essentially contains the IR sensor matrix including imaging optics. Data transfer is performed by cable. Power supply and communication take place via a 5 metre cable.

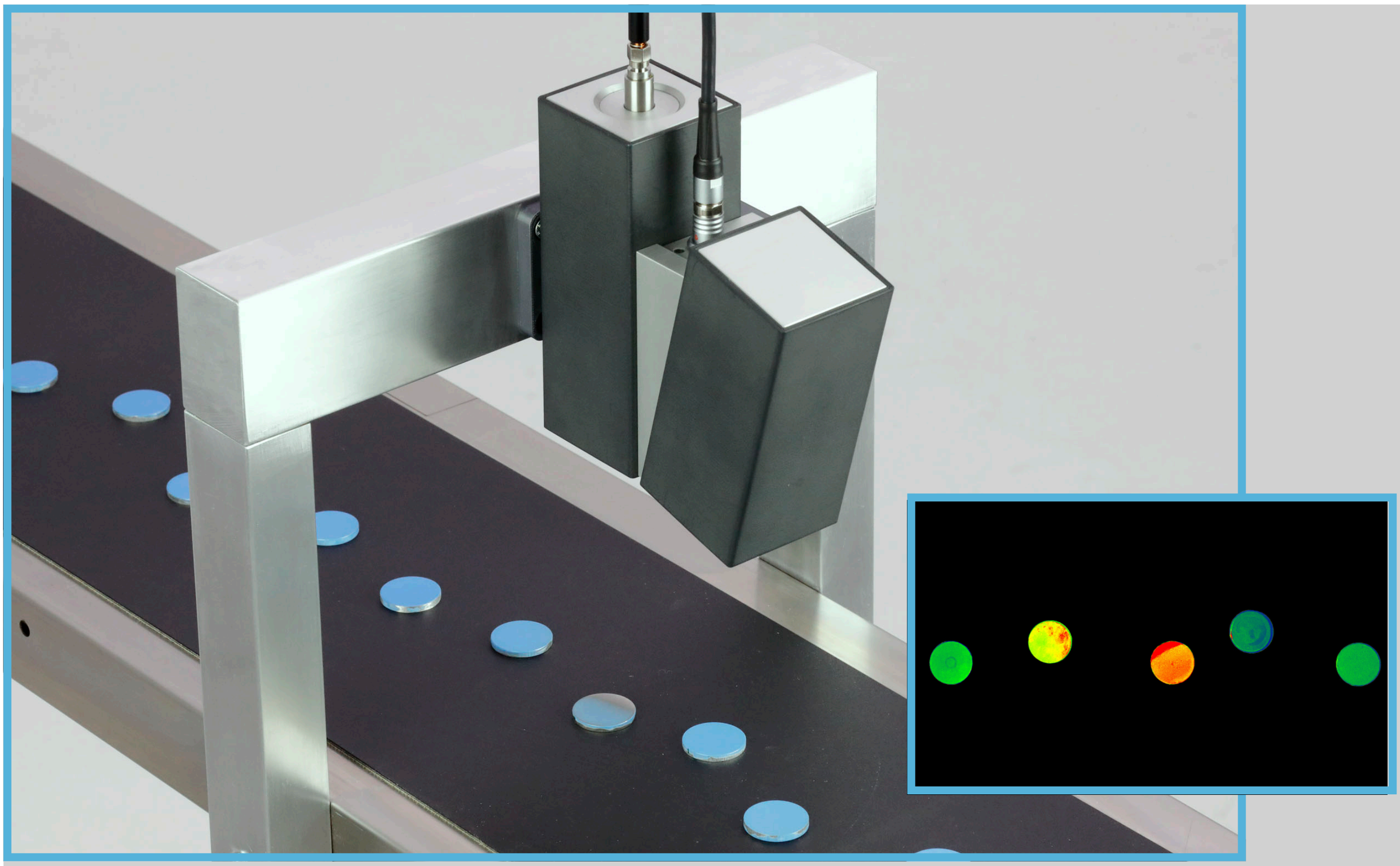
The excitation and detection modules have a footprint of 55 x 55 mm^2. The height is approx. 150 mm (excitation module) and 115 mm (detection module). The sensor weighs around 1.5 kg. The external controller housing has the same dimensions and type as the models currently used by OptiSense for industrial applications. The system is controlled via a PC connected to the controller via a network cable.

Measurement procedure and measurement variants

A measurement is either actively triggered by the user or automatically started by an external trigger signal. The spatially resolved calculation of the coating thickness and visualisation takes place seamlessly on the fly. This allows the coating thickness to be determined in real time, even for continuous measurements such as coil coating, so that process parameters can be adjusted immediately if necessary. There are three different variants of the modular concept:

High-resolution surface scan

This configuration enables the continuous measurement of coating thickness maps; the test result is a 2D image with the spatially resolved coating thickness. The width across the scan direction is up to 100 mm. The length in the scanning direction is virtually unlimited.

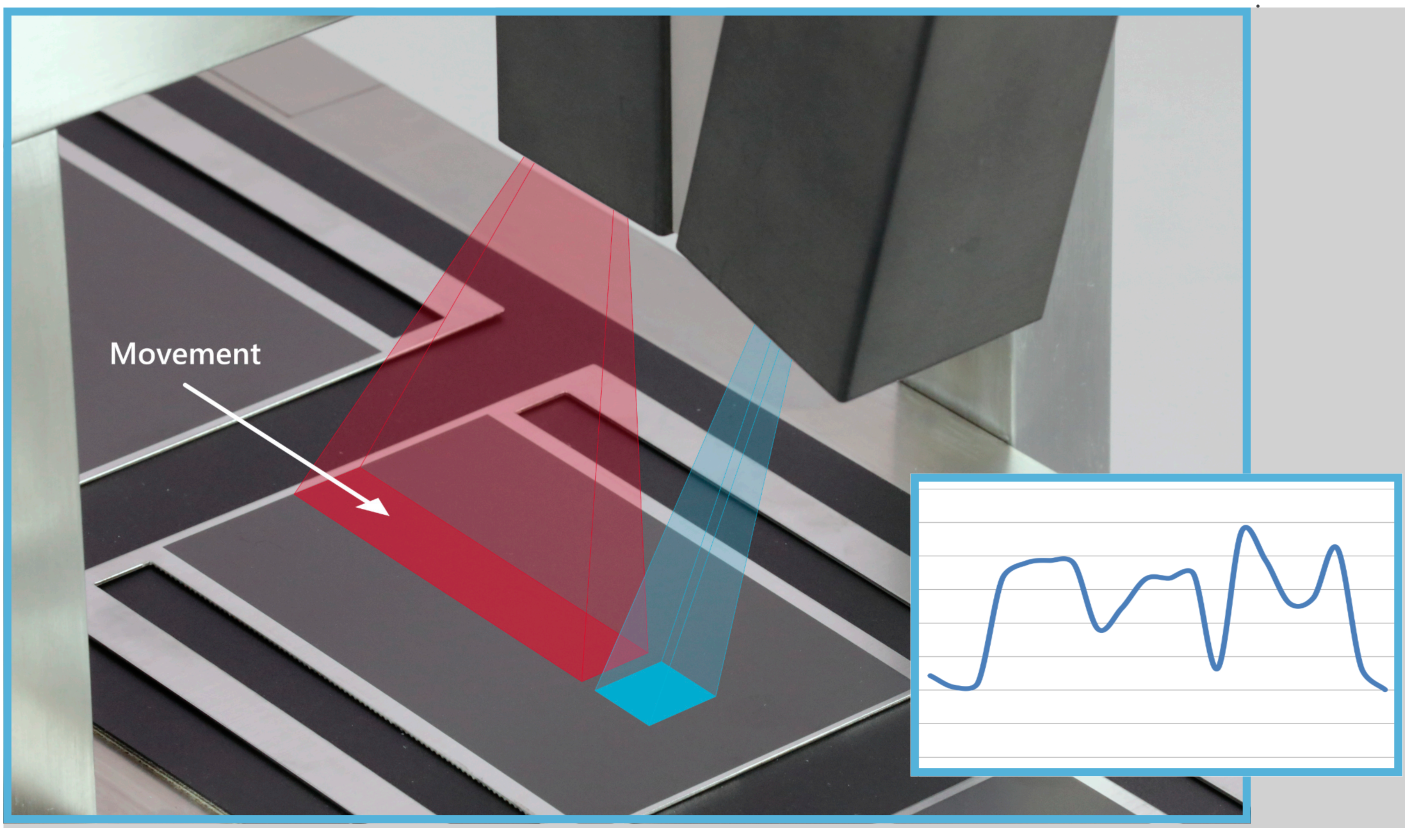


The surface scan provides a full-surface map of the component coating, in which the coating thickness is displayed in colour. This makes it immediately recognisable where the component has been undercoated (red) or overcoated (blue). Defective coatings can be distinguished from faultless components (green) at a glance and can be reworked before curing. The innovative continuous scanning process enables seamless testing in flow production and of workpieces of any length, where the results are already available during the ongoing measurement.

High-resolution profile scan

In applications with a high relative speed between the sensor and the component, the available excitation power is rearranged so that less light power is applied to the measurement object in the width (transverse to the scanning direction) and more in the length (along the scanning direction).

This setup allows higher speeds or longer measuring times (equivalent to greater layer thicknesses) to be addressed. The detector field of view is also adapted. The result is a 2D scan with a reduced width transverse to the scan direction or, in the extreme case, a profile scan. In both cases, the local resolution along the scan direction remains high.



The light source is rotated by 90° on fast-moving lines or coatings that are difficult to heat, so that the component is in the excitation zone for longer. The measurement then records a linear strip of the coating as a continuous, gapless coating thickness profile.

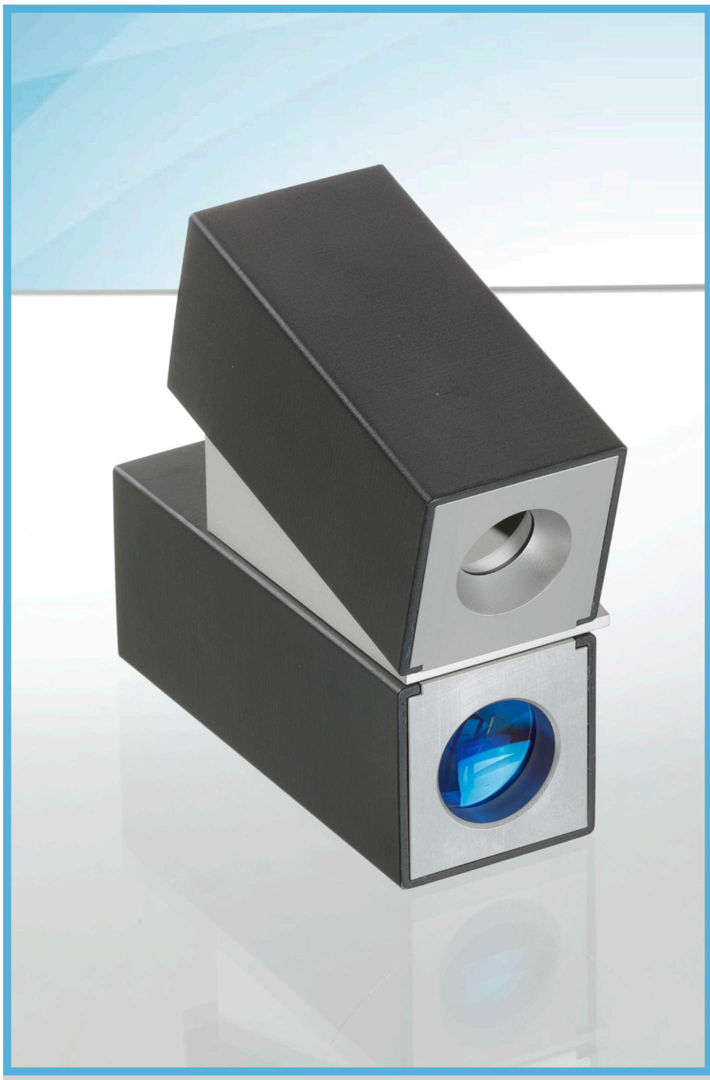
Non-scanning profile check

A non-scanning mode is also possible. In this case, the matrix of IR sensors is replaced by a single, highly sensitive IR sensor. In this way, the accuracy of the coating thickness measurement can be further increased at the expense of the spatial resolution. This configuration is suitable, for example, for very high speeds or for applications in which a resolution in the mm range is not essentially needed.

Economic benefits and amortisation

The PaintChecker Move is flexible and can also be easily integrated into existing production lines at a later date. In particular, the condition of the coating (wet, moist, soft, dry, baked) and the dimensions of the workpiece hardly play a role. It is even possible to accurately inspect objects of any width in a non-contact and repeatable manner with several measuring systems mounted next to each other.

The economic benefits of the OptiSense measuring system are considerable. The PaintChecker Move reduces material waste, optimises production processes and increases product quality. Coating companies can also achieve significant cost savings. For example, reducing the reject rate by just 0.5 per cent saves a medium-sized contract coater annual costs in the five-figure range. These savings result not only from the reduced material consumption, but also from less reworking or reduced rejects and the associated savings in labour costs.



The inspection system thus offers coating companies a powerful solution for optimising their production processes and ensuring and increasing their product quality.

At the same time, the system helps to increase production efficiency. Continuous monitoring guarantees more stable and efficient production, which minimises downtimes and increases the overall productivity of the systems. PaintChecker Move also significantly reduces the risk of complaints.

Furthermore, the PaintChecker Move's continuous data acquisition and analysis enables comprehensive process and quality monitoring. The data obtained can be used to identify weak points in the production process and take selective improvement measures.Interest in the market is already very high. The evaluation phase with several pilot customers has already got off to a very good start and the measuring system will be available soon.

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Conclusion

The PaintChecker Move marks a significant advance for the coating industry as a scanning 3D coating thickness inspection method. The precise and continuous measurement of coating thickness significantly increases both production quality and efficiency. The resulting material and cost savings as well as the increase in quality make this technology a worthwhile investment.

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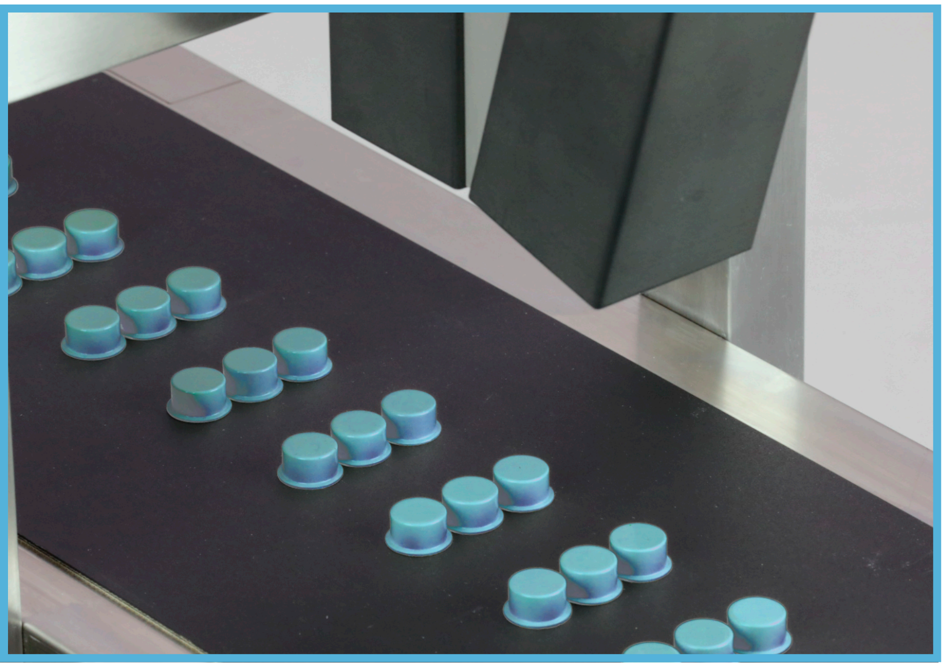

By permanently and reproducibly monitoring the application, a uniform and consistent coating can be ensured. This is particularly important in order to improve the durability and optical properties of the products and to fulfil the increasingly demanding quality standards and all necessary safety regulations. The latter are particularly crucial for products that are relevant to liability, such as battery modules or highly stressed parts from the transport sector, such as in the aircraft and automotive industries, railways and bicycle production.

The new, scanning 3D PaintChecker Move is flexible and user-friendly. It is easy to integrate into existing coating lines – and in the most difficult production environments. The inspection system thus offers coating companies a powerful solution for optimising their production processes and ensuring and increasing their product quality.

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