Predefined Coating Thicknesses for Vehicle Bodies and Wheel Rims

The thickness of the coating plays a central role in the coating process, because it has a direct impact on the functional and decorative properties of the coating. For this reason, manufacturers specify tolerance ranges for coating thickness which have to be monitored using appropriate measuring devices.

Professor Nils A. Reinke, Mario Oesterle

The automotive industry sets high standards for process reliability and quality which mean that coating thickness measurements must be repeatable and traceable. Conventional methods, such as measurement system analysis, can be used for the qualification of the measuring device. These methods have highlighted the fact that traditional contact measuring systems are no longer suitable for process monitoring, as a result of the higher industry standards. They are increasingly being replaced by measurement devices based on ATO (advanced thermal optics) technology.

The first part of the article illustrates the use of ATO technology for the manual measurement of electrocoatings on vehicle body components. The second part describes how a coating thickness measurement device complements an innovative, automated process for coating wheel rims.

Contact measuring devices are typically based on a process involving the distance-related damping of an oscillating electrical circuit. In the case of flat substrates and smooth coatings, this can be used to calculate the coating thickness. However, varying material compositions and curved surfaces can result in significant deviations. A rough or rippled coating has a negative impact on the repeatability of the measurements. Because contact measuring devices are usually hand-held, the operator too can influence the measuring result. The measurement probe can penetrate soft coatings and distort the measurement. In addition, contact coating thickness measurement devices can only be used with fully cured coatings and are therefore unsuitable for making measurements at an early stage in the application of the coating. As a result, they do not help to improve the reliability of the process.

Non-contact coating thickness measurement with ATO technology is based on a simple and robust principle. The coating is heated briefly by a few degrees Celsius using a pulse of light and the lifetime of the wave of heat in the coating is measured by infrared sensors. This measurement is then converted into the coating thickness. As the heat always travels vertically through the coating, the measurement is largely independent of the orientation of the measuring device and therefore of the operator.

Manual measurement of electrocoatings within tight tolerances

Electrocoating is an electrochemical process that involves coating components in an immersion bath. It is ideal for parts with complex structures that are being coated in large quantities. Electrocoating is the standard process used to provide vehicle bodies with corrosion protection.

Many of the properties of electrocoatings are directly influenced by their thickness. On the one hand, thicker coatings create a more effective diffusion barrier against substances that cause corrosion, such as water and oxygen. On the other hand, the mechanical strength of the coatings is reduced as they become thicker. For this reason, there is an ideal thickness that needs to be achieved within very tight tolerances. A suitable measurement device must have a standard deviation of less than one fortieth of the specified tolerance range. For example, a tolerance window of 4 micrometres has a standard deviation of less than 0.1 micrometres.

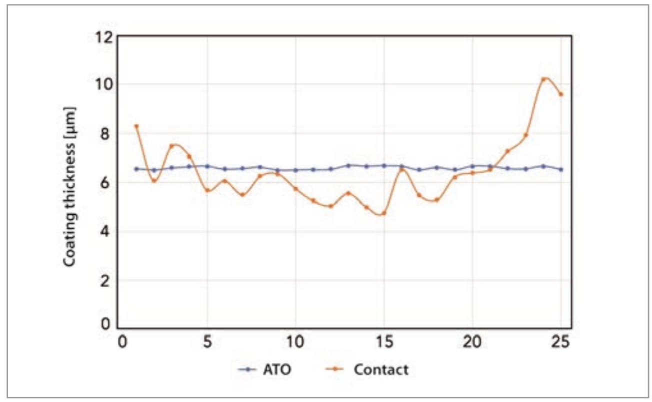
For the purposes of comparing a conventional contact coating thickness measurement device and a non-contact system based on ATO technology, the thickness of the coating on a square electrocoated steel panel with an edge length of 100 millimetres was measured. The steel panel was 500 micrometres thick. An image of a cross-section of the electrocoating indicated that its thickness was between 6 and 7 micrometres. *Figure 1* shows the coating thickness as measured by the hand-held coatmaster Flex device that uses ATO technology.

A total of 25 measurements were made along a diagonal line on the test panel with the contact and non-contact measurement devices. The measurements are summarised in *Figure 2*.

The standard deviation of the contact coating thickness measurement device is 1 micrometre, which makes it unsuitable for measuring thin coatings and for tight tolerances. At the edges of the panel, the contact device has a tendency to show increased thicknesses. Edge effects occur when the electromagnetic field of the magnetic induction probe exceeds the geometrical limits of the sample being measured. The coating thickness is generally below the range of 6 to 7 micrometres identified in the cross-section. This indicates that the coating is being slight-

© coatmaster

Figure 1 > Coating thickness measurement with the hand-held measuring device based on ATO technology.



© coatmaster

Figure 2 > Contact (orange) and non-contact (blue) coating thickness measurements on a diagonal line across the test panel.

ly compressed during the measurement process.

The standard deviation of the non-contact measurement device is 0.1 micrometres. The average coating thickness measurement of 6.4 micrometres corresponds with the cross-sectional image. Edge effects of the kind that occurred with the contact measurement device were not observed with the non-contact measurement system.

In summary, it is clear that ATO is a suitable technology for measuring electrocoatings with tight tolerance ranges. Because the technology is not dependent on the geometry of the parts, it can also be used with complex shapes, for example parts of vehicle bodies. In addition, it can measure coating thickness in gaps and cavities. The adjustable measurement range makes it possible to make measurements on textured panels and bolts. Furthermore, because this is a non-contact technology, it can measure the thickness of electrocoatings while they are still wet, before the drying process starts. This allows problems in the coating process to be identified and resolved quickly.

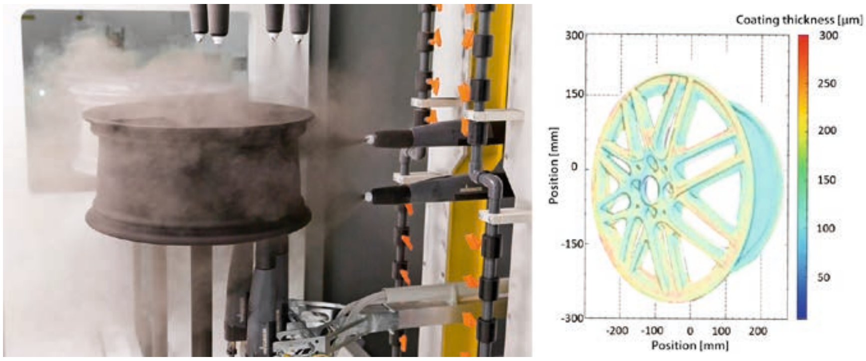
Highly automated process for coating wheel rims combined with image-based coating thickness measurement

The powder coating process for wheel rims in the automotive industry has to meet increasingly stringent requirements. Customers expect customised solutions for more and more complex rims with challenging shapes, very high-quality finishes and a wide variety of colours. One key quality criterion for the coating process is the distribution of the coating thickness across the wheel. In order to provide seamless documentation and quality assurance information, it must be possible to demonstrate the quality of the coating at any stage of the application process. At the same time, the costs of the measurement process must be kept to a minimum to avoid having a negative effect on the unit costs. In addition, challenging productivity targets have to be met.

J. Wagner GmbH (Germany) has developed a highly automated solution for coating wheel rims. When combined with the image-based coating thickness measurement system using ATO technology from coatmaster AG (Germany), it brings further benefits for users. The measurement (*Figure 3*) takes less than 500 milliseconds and, on a wheel with a diameter of up to 24 inches, it can determine the coating thickness with a local resolution of two millimetres and a very high repeatability. Because the device does not have to be positioned at a specific angle, it can also take measurements in undercuts. The measurements of the coating thickness distribution can be divided into rings and assigned to individual spray guns, which can then be adjusted to achieve the best possible coating results.

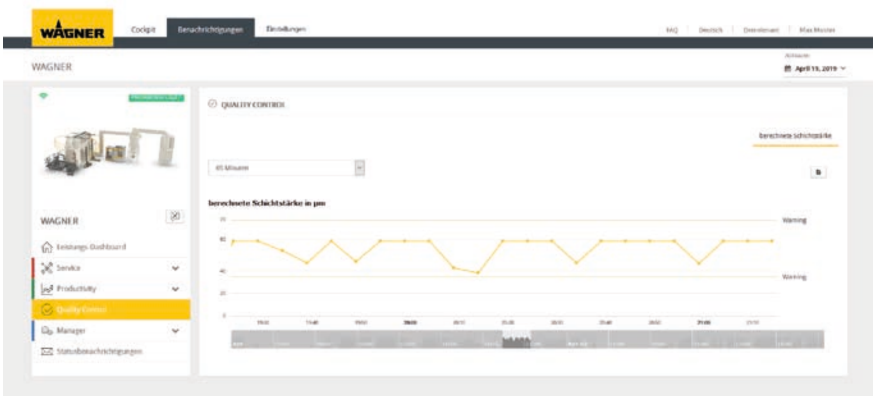
Both systems can be displayed on the Coatify information and management platform from Wagner. Coatify is a web-based Internet of Things system that allows for the intelligent visualisation of coating systems and measurement devices (*Figure 4*). It increases the transparency and reliability of industrial coating processes, while also improving system availability and productivity. This ensures that the operator remains in close contact with the coating systems and is always well-informed about the current status of the machines.

The C-Line powder coating system from Wagner was developed specifically for coating wheels in the automotive industry. The key design criteria included a very small footprint to allow for easy integration into existing production lines. The system is constantly being developed further and adapted to meet customers' needs. Its compact design, which includes a booth that is only two metres in length, means that it takes up one third of the space of the comparable systems that are currently available on the market. The coating booth comes fitted with filters, a cyclone and pipe systems. It not only saves space, but also typically reduces energy consumption by 50 percent compared with conventional coating systems. The coatmaster measurement system, which is marketed by Wagner under the name Layer Check, makes the ideal complement to this solution. As well as measuring the thickness of the coatings, it also provides a constant log of the coating quality. This allows for seamless process documentation, which is an essential quality assurance tool in the automotive industry. Therefore, deviations from predefined limits can be identified at an early stage and the coating thickness can be



© J. Wagner

Figure 3 > Coating and image-based thickness measurement on one wheel.



© J. Wagner

Figure 4 > The system visualises information about the current production and quality status. System messages and warnings highlight the need for adjustments to the system.

© J. Wagner

Figure 5 > The powder coating system, which has been developed specially for wheels, is configured and controlled via a touch screen.

adjusted, if necessary. As a result, reworking can take place before the powder coated rims are cured.

The control system of the C-Line is intuitive and user friendly. The parameters are entered entirely in visual form, with the guns being assigned to their positions using a visual teach-in method (*Figure 5*). Individual jobs can be set up and changed over quickly. The coatmaster sensors identify whether the coating thickness is set correctly to achieve the required level of quality. Overcoating is prevented, which ensures that material consumption remains low. In addition, when new powder coatings or wheel designs are introduced, the configuration time, which is the period needed to adjust the machine parameters, is much shorter.

The modern C-Line application system, combined with the coatmaster device, guarantees a high level of transfer efficiency and consistent coating thicknesses even on wheel rims with complex shapes. During the coating process, the 3D axis system moves all the powder guns through the booth at the same time as the wheel. The guns are arranged opposite each other in order to make the best possible use of the effect of the moving powder cloud. This means that even at high throughput speeds a wide and stable powder cloud is produced, which leads to outstanding coating results.

The increasing quality standards for wheel coatings in the automotive industry require future-proof solutions that are easy to operate and reliably produce surfaces of a consistently high quality. The combination of two leading technologies – the Wagner C-Line and the coatmaster measurement system – provides users with a high level of automation and reproducible results that meet these demanding standards. //

Authors

Professor Nils A. Reinke, Co-CEO
coatmaster AG, Winterthur (Switzerland)
info@coatmaster.com
www.coatmaster.com

Mario Oesterle
Senior Product Manager, Industrial Solutions
J. Wagner GmbH, Markdorf (Germany)
mario.oesterle@wagner-group.com
www.wagner-group.com