

Noncontact measurement of adhesive coating thickness

The coatings of vehicle components must be measured to the micrometre to avoid damage and complaints. Automobile parts supplier AAM has in the past used traditional methods based on microscopy and magnetic induction. But these methods have weaknesses. With support from Lord, the manufacturer of the rubber-to-metal adhesives Chemosil and Chemlok, AAM has switched the coating thickness measurement to the coatmaster technology - with success.

The exact measurement of the coating thickness is of particular importance in the automotive industry - especially for heavily loaded components, such as those found in the powertrain. Incorrectly coated components can wear out faster and eventually fail, which can result in costly repairs.

An example of such heavily loaded parts are the so-called torsional vibration dampers. These rotational elements sit on the crankshaft and protect the gearbox from peak loads that occur in the power transmission from the piston to the crankshaft. The torsional vibration dampers consist of an outer flywheel and an internal hub, which in turn is mounted on the crankshaft.

To effectively damp the vibrations of the crankshaft, a rubber layer is glued between the hub and the outer flywheel ring with a thin adhesive coating of just a few micrometres, via a vulcanization process. The adhesive is applied to the inside of the flywheel ring and hub prior to assembly of the torsional vibration damper. The thickness of the adhesive coating must be meticulously monitored: If the adhesive is applied too thick, the coating can

tear. If the coating is too thin, the adhesion strength is too low. If the rubber layer breaks loose, unwanted noise and damage to the car transmission occurs.

Process optimization thanks to non-contact coating thickness measurement

The monitoring of the coating thickness during production is therefore of fundamental importance. The automotive parts supplier AAM, headquartered in Detroit, Michigan, USA, has recently introduced in Lyon, France, for the production of torsional vibration dampers the reliable and non-contact measuring system coatmaster of Winterthur Instruments. With the coatmaster, the coating thickness is determined very quickly and without contact. To fully exploit the capabilities of the equipment for adhesives application, the new technology was fine tuned in close cooperation with adhesive manufacturer Lord and Winterthur Instruments, Switzerland. In the thickness measurement of the adhesive coating, the challenge is the rough surfaces of the hub and flywheel required to ensure adhesion.

This roughening creates a micrometre-fine "mountain and valley landscape". When using contacting inductive gauges, such surface irregularities (*Image 1*) lead to a strong scattering of the measured values, as the magnetic fields of the probes vary depending on the position of contact. This scattering leads to high uncertainty about the quality of the coating.

No more rejects

AAM therefore decided to monitor 100% of its production and to measure the coating thickness on each component. In this context, the Chemosil / Chemlok experts from Lord made AAM aware of the coatmaster technology. Meanwhile, the coatmaster has been working for AAM for more than four years (*Image 2*) - with success. Since every production part is controlled, deviations in the manufacturing process can be recognized immediately. "Whether it is a clogged nozzle when applying the adhesive or a change in the viscosity of the material: As soon as the coating thickness deviates from the target, the coating process can be readjusted. Thereby

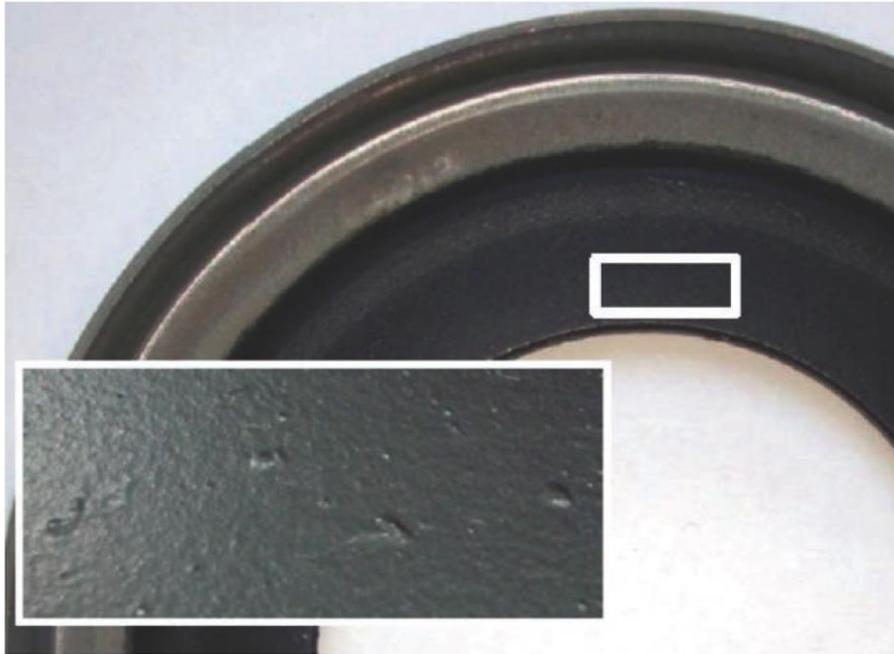


Image 1 > Rough surfaces of the adhesive layer lead to high scattering on contact measurement.

AAM virtually eliminates rejects today," says Andor Bariska, Member of the Directorate of Winterthur Instruments. For Guillaume Carré, Manager of Application Engineering at Lord, the partnership with Winterthur is a win in many ways: "Today, our customers can easily meet their customers' requirements. We are very pleased that our customers can optimally apply and measure our product thanks to the coatmaster. "

The coatmaster instruments measure the thickness of a coating by heating the surface from a distance with a light source and using an infrared sensor to measure the time it takes for the coating to heat up and cool down. The thicker the coating, the slower it will cool off.

The devices operate at a speed of up to one measurement / second (1 Hz). As a result, several measurements can be carried out on the same part. Thus, even with rough surfaces, an overall and reliable picture of the coating thickness quickly results. Compared to the coatmaster, traditional measuring methods have several disadvantages.

For example, the microscopic method provides only point information from that small region, which was extracted from the component. As *Image 3* shows, the overall coating thickness is not clearly derivable from the local measurements.

In addition, the process is very time consuming. The sample must first be embedded into a carrier resin and then polished so that a clean layer cross-section is available for the analysis. This can take several hours or even days and is therefore not suitable for process control.

Better than magnetic-inductive methods

The coating industry today also uses the manual magnetic-inductive gauges. In this case, a magnetic probe is positioned on the coated metallic component. The thickness of the coating changes the magnetic field, which makes it possible to deduce the coating thickness from changes in the magnetic fields. However, using these gauges for rubber-metal adhesives has the following two problems:

- on the one hand the high scattering on the rough surface, as described above;
- on the other hand, at the time of measurement, the layer is still elastically deformable.

In the contacting measurement, the coating is indented, whereby the measured values are falsified. As has been shown in comparative studies, the measured values of the magnetic-inductive process scatter significantly more than in the non-contact measurement with the coatmaster.

Also for Guillaume Carré of Lord, the possibility to measure without contact is one of the great advantages



Image 2 > At AAM Lyon every produced torsional vibration damper is measured with the coatmaster. The layer thickness and other production parameters are lasered as a QR code.

of the devices. "It's also possible to measure coating thickness from a distance with high tolerances on distance and angle, which greatly facilitates the integration of the coatmaster into a production line. "

In addition, the devices are very easy to operate and calibrate - without requiring special knowledge. Further, the measurements are fast, which makes possible the complete monitoring of all products.

Automobile manufacturers must be able to rely on the fact that the coating thickness measurements are correct. This is especially true for critical components. Methods that are used for the measurement on such components are therefore specially tested. The control measure c_g was introduced in automotive industry for this purpose.

This value relates two important parameters of the measurement setup - firstly the tolerance range of the coating process, which indicates how large the allowed range of the coating thickness is and secondly the scatter of the measuring instrument itself, measured by the standard deviation with repeat measurements. The ratio of the tolerance of the coating process and the spread of the measurement instruments should not be below a given threshold.

The ratio is specified by the c_g value, which is a measure of the reliability of a method. For use in the automotive industry

the c_g value of the coating thickness measurement must be at least 1.33 which corresponds to a ratio of the tolerance range to instrument spread of at least 40. For a given process, the coatmaster reaches values up to 4.5, whereas the magnetic induction method formerly used at AAM, in turn, reaches a c_g value below 0.4. Thus, it becomes clear that this method is not suitable for process control.

Production with a closed control loop

The coatmaster facilitates production at AAM in many ways - for example regarding the traceability of torsional vibration dampers. Today, AAM embosses all components with a QR code that contains important characteristics of the component - including the coating thickness measured with the coatmaster. "If there are complaints, you can easily verify that a component does have the correct layer thickness," explains Andor Bariska. In other cases one can determine whether or when in production

Live webinar for non-contact coating thickness measurement

In the individual live webinars of Winterthur Instruments, the details of non-contact measurement of layer thicknesses are explained in detail:
<https://coatmaster.ch/akademie/webinare>

Registration: info@coatmaster.ch

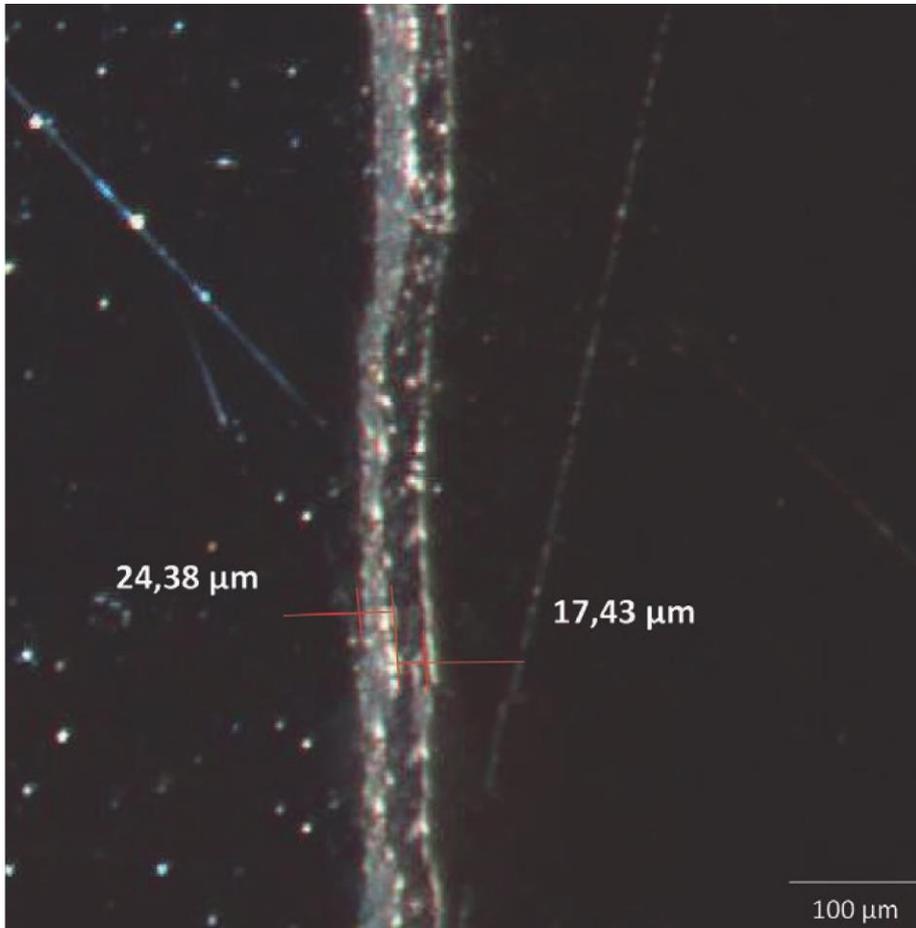


Image 3 > The microscopic cross-section image of a two-layer adhesive coating shows that the local layer thickness measurement is subject to a high fluctuation.

an error has occurred. According to AAM's Jean-Philippe Caillot, another strength of the coatmaster is that production can be operated in a closed loop: "At AAM Lyon, we use the coatmaster to ensure the traceability of our products. The in-line coating thickness measurement is integrated into a closed loop, which immediately corrects process deviations. This is part of the continuous evolution to adapt our production to the standards for Industry 4.0".

Inclusion of the procedure in the official standards is imminent

The integration of coatmaster into production at AAM went smoothly, Bariska emphasizes. "With reference standards measured in an accredited laboratory, AAM can adjust the devices themselves. On request, we also issue calibration certificates, which prove the reliability of the devices." Also in the official

Norms, the measurement principle of the coatmaster will be introduced in the near future. It has been decided by the standardization bodies that the procedure will be adopted with the amendment of the DIN ISO 2808 norm as an approved method for coating thickness measurement. This is a confirmation that the coatmaster provides a reliable method to measure adhesive layers on very different parts - not limited to torsional vibration dampers. //

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