Modern quality assurance for adhesion-promoting layers

The coating thickness measurement of adhesion promoters during the production stage in the manufacture of torsional vibration dampers meets the high requirements of the automotive industry, as the following article shows.

Winkelmann Group, headquartered in Ahlen, Westphalia, with branches in Poland, Turkey and China, has a turnover of more than EUR 500 million and employs almost 4,000 people. As part of the automotive division, Winkelmann Powertrain Components GmbH & Co. KG produces torsional vibration dampers used in vehicles with internal combustion engines in order to reduce radial vibrations

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These vibrations are caused by the intermittent power transmission from the piston to the crankshaft. They generate short-term torque peaks, which lead to noise and wear in the gearbox. In addition, they put stress on the crankshaft, which can lead to torsional fractures. The task of torsional vibration dampers is to suppress these vibrations. They consist of a vibration damper ring and a hub as well as an intermediate rubber element.

Typical torsional vibration damper from Winkelmann Powertrain

During production, the surfaces of the vibration damper ring and hub that come into contact with rubber are specially pretreated. Afterwards, these surfaces are coated with an adhesion promoter. The subsequent vulcanisation process creates a permanent bond between the vibration damper ring, the rubber coating and the hub.

Layer thickness of the adhesion promoter as a quality feature

The layer thickness of the adhesion promoter is typically in the micrometre range with a corresponding tolerance window. If layer thickness is below the tolerance window, it can lead to adhesion problems of the rubber-metal joints, and subsequently the functionality of the torsional vibration damper is not ensured. If the layer thickness is too high, cracks may even occur within the adhesion promoter layer under mechanical loading of the component. The coating thickness measurement during production is therefore an essential quality criterion for ensuring the operability of torsional vibration dampers. For mission-critical quality parameters, test equipment used must be critically assessed. For this purpose, the quality capability parameter c_g is introduced in the automotive industry. The c_g value is calculated according to Bosch Booklet 10 in accordance with the following formula:

$$c_g = \frac{0.2 \times T}{6 \times s_g}$$

with the tolerance band T (upper tolerance limit minus lower tolerance limit) and the standard deviation s_g (corresponds to the error of the individual measurement).

Search for a suitable measuring device

Only test equipment with a c_g value of more than 1.33 may be used in the quality assurance according to this standard. For example, with a tolerance window of ten microns and a single measurement error of 0.9 microns, a measuring device will reach a c_g value of 0.37 and may not be used in the quality assurance. In the past, eddy-current or magneto-inductive measuring devices were used to test the layer thickness of adhesion promoters. These typically have a standard deviation of several microns on pretreated and coated surfaces. This results in c_g values of well below 1.33 with tolerance windows of ten or twenty micrometres. These measuring devices are therefore not approved for quality assurance.

Suggestion for improvement gave the impetus

Under these prerequisites, the people in charge at Winkelmann were looking for a suitable measuring device. Harun Kelpetin, industrial engineer for operational quality assurance at the Ahlen plant: "We were not satisfied with the results of conventional coating thickness measurement methods. In the course of the continuous improvement process, we have looked around for an alternative. One employee's suggestion for improvement was to consider the WinterTur CoatMaster. We have implemented this proposal."

Since October 2014, Winkelmann Powertrain has been using this device, which is based on the process of thermal coating testing. An integrated light source heats the surface of the adhesion promoter by a few degrees Celsius for a few milliseconds. The surface temperature is determined via optical elements and an infrared sensor.

The technical data of the light source used are comparable to photographic flash tubes and pose no danger to humans

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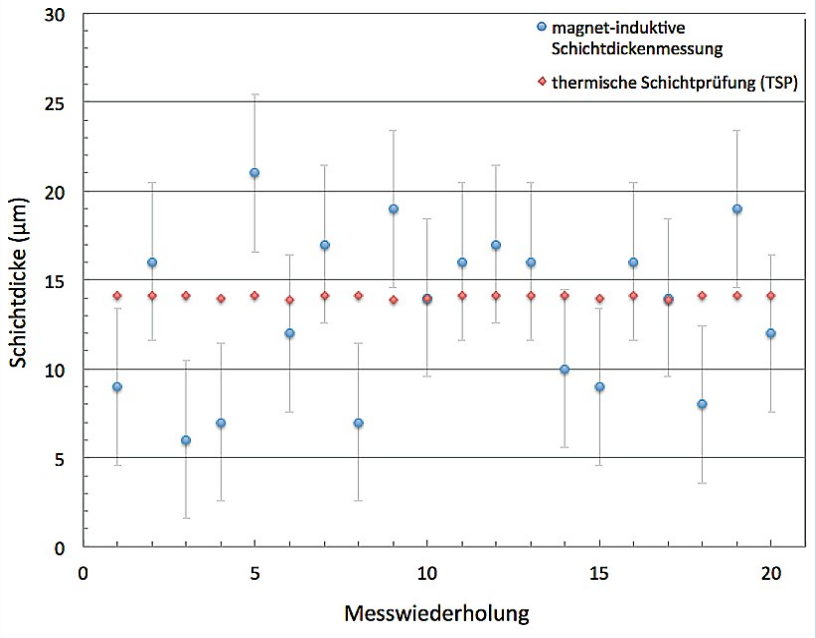
Coating thickness measuring device for random checks. Devices tailored for continuous use in the production line are also available.

or the environment. The use of questionable sources such as laser, beta or X-ray sources was deliberately avoided. On average, 100,000 temperature readings are analysed for each measuring process and the layer thickness is determined from these data.



Comparison of the layer thickness measurement according to the classical magneto-inductive method and the thermal layer testing with the CoatMaster. The measurements were determined on a vibration damper ring within a measuring

The measurement can be conducted with an adjustable measuring surface of two to fifty millimetres from a distance of up to one metre. The error of the individual measurement can be reduced to well below one percent, and measured values can be recorded with a frequency of one hertz.

Non-contact measurement with high accuracy

The CoatMaster allows non-contact layer thickness measurement of adhesion promoters with a measurement error of 70 nanometres (= 0.07 microns). This corresponds to a c_g value of 4.5 and thus meets the requirements of the automotive industry. In summary, it can be stated that the measuring device determines an important and quality-relevant parameter when used by Winkelmann Powertrain, and with very high accuracy.

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