Measuring Coating Thickness at an Early Stage

Saving Time and Reducing Rejects

Measuring the thickness of polymer coatings before they have been cured allows corrections to be made early in the process. This article describes process improvements of this kind using the example of different suppliers to the automotive industry and shows how measuring a polymer coating immediately after it has been applied helps to increase the quality of the coating and prevents parts from being rejected.

Variations in the polymer coating process often result in the polymer not being applied evenly. If inline measurements are made using the CoatMaster device from Winterthur Instruments, deviations in the process can be identified at an early stage and corrected by adjusting the process parameters.

Polymer coatings on plain bearings, seals and other metal components are an essential feature of the automotive industry. Without these coatings, the parts could not function without generating friction, because their surfaces are exposed to specific loads. For example, friction and, thus, the accuracy of the fit of plain bearings and pistons are extremely important for their function. If a coating is too thick, the component will no longer fit in its intended position. If a coating is too thin, it will wear away under load. As a result, the manufacturing process for plain bearings and pistons has to meet very high standards.

Identifying problems early

The CoatMaster device from Winterthur Instruments allows coating properties such as thickness, porosity and thermal resistance to be measured in real time using a non-destructive, non-contact method. This means that deviations in the process can be identified and corrected at an early stage. The result is a controlled process which remains within tight tolerances. The device has already been successfully used to measure plastic coatings in the production line, as the following two examples show.

Typical applications for polymer coatings in an engine manufactured to very high standards include the anti-friction coating on the side of a piston (dark grey).

Measuring wet coatings

A manufacturer of plain bearings needed to measure the polymer coating on the half bearings while they were still wet. Incorrect settings, together with ageing and wear of system components, can lead to the coating being applied outside the required tolerances. The existing magnetic induction measuring system used for quality assurance purposes has to come into contact with the coated half shells. This means that the coating can only be measured once it has dried, which wastes at least half an hour. As a result, by the time the reference measurement is taken to identify any problems with the process, at a production rate of 40 bearings per minute, around 1200 bearings will have passed through the coating process.

The CoatMaster will now be used to detect any deviations in the process immediately after the coating is applied, by measuring the thickness of the coating on the wet half shells.

Firstly, the thickness of the dried plastic coating is determined using the CoatMaster. The results are compared with those of a magnetic induction measurement in the same position. With an R^2 of 0.98, both methods cor-

respond very closely. The standard deviation is identified over five repeated measurements. For the CoatMaster it is 0.2 µm and for the magnetic induction method 0.5 µm.

This means that the results of the magnetic induction method have to be averaged over six measurements in order to achieve a comparable level of accuracy to that of the CoatMaster. The coating on the half shells is measured vertically and from the side at an angle of around 50° using the CoatMaster, which means that the thickness can be determined reliably at different positions on the half shell without having to tip up the measuring device. Therefore, significantly more points on the half shell can be measured in the same amount of time when compared with the magnetic induction method.

In order to allow problems to be identified at an early stage of the process, the CoatMaster measures the coating while it is still wet. Using the measurement of the wet film, the device predicts the thickness of the cured coating. For calibration purposes, a measurement is taken of a sample with a coating 8 µm thick, which is the target thickness. Then samples with thinner and thicker coatings are measured with this single-point calibration. The CoatMaster reliably detects deviations from the tolerance range, which enables incorrect settings, ageing and wear to be identified early and rectified immediately without wasting time or materials.

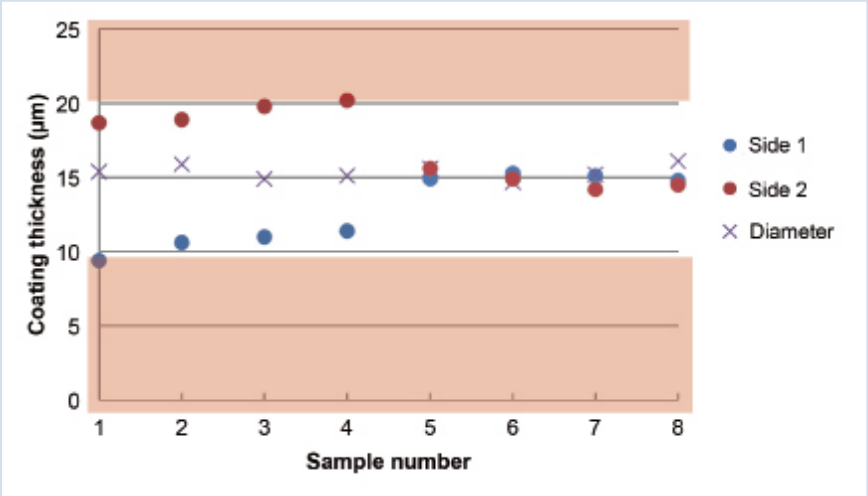
Documenting the coating process reliably

At a piston manufacturing company, the coating process is adjusted on the basis of measurements of the diameter of the dry piston before and after coating. However, it takes around two hours for the coated pistons to dry and to reach the correct temperature for the second diameter measurement. Using the CoatMaster, the thickness of the anti-friction coating on the piston can be measured while it is still wet, in order to save time.

The thickness of the coating on both friction surfaces is measured automatically for every piston and the results are shown on a display. The measurements indicate that the coating thickness is sometimes above and sometimes below the specified tolerance range. The tactile measurement of the diameter of the dry piston, which takes place two hours after the coating process and, therefore, two hours after the CoatMaster measurement, shows that the diameter is well within the tolerance range, but the asymmetrical distribution of the coating is not identified.

However, the measurements made by the CoatMaster enable the uneven application of the coating to be detected immediately and to be resolved by adjusting the coating system. After this, the thickness of the coating on both sides of the piston is within the tolerance range. The CoatMaster has helped to ensure that the coating is applied evenly on both sides of the piston and, therefore, that the piston is symmetrical.

This guarantees that the piston fits accurately in the plain bearing. In addition, the tolerances for the process can be made increasingly tight and the start-up time for the coating system shortened considerably, because the CoatMaster allows the thickness of the anti-friction coating on the test pistons to be measured while the coating is still wet. The ageing process of the doctor blades can also be monitored. This guarantees that they can be replaced before they become too soft and the coating too thick.



Inline measuring series with the CoatMaster on both sides of a piston (red one side, blue other side) with wet plastic coating. From the graph it can be seen that during the first four measurements the coating thickness exceeds or falls below the tolerance range (pink area). After the coating plant was readjusted prior to the fifth measurement, the coating thickness is within the tolerance range on both sides. The results of the diameter measurement (grey cross) are always within the tolerance range and do not allow any conclusions about symmetry.

Shorter production times and more accurate process data

Using the CoatMaster, companies that apply plastic coatings can respond rapidly to problems with their coating processes. This not only shortens the production time, but also ensures that the required quality standards are met. The coating process can be fully documented for every part. In addition, the CoatMaster reduces the time needed for process monitoring and quality assurance while increasing the accuracy of the process data. The examples described above demonstrate that using the CoatMaster for inline measurements of the thickness of both wet and dry plastic coatings is the ideal solution, also on curved and porous surfaces. ▮

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