mahlo
trendsetting technology. worldwide.
since 1945

Measurement of thin coating on paper and film

Mahlo solves complex challenges with white light and infrared processes.

Self-adhesive notes, dark sun protection film or water-repellent sticking-plaster – coated film and paper products have widely different shapes and formats. Depending on the complexity of the products, several coating applications are necessary to utilise their full function. This is only possible, though, if all layers have the exactly required application quantity. Even smallest deviations from the defined tolerances in production result in malfunction and thus considerable losses due to rejects.

Coating facilities therefore often resort to measuring the basic weight on the running product web to determine the coating quantity. However, online measurement represents a major challenge especially with very thin coats, since it must be extremely precise.

Transparent adhesive film, as it is used in millions of households and offices, often consists of a PVC film with a thickness of 55 µm. During the production process, a primer is first applied to the carrier material to ensure the actual adhesive will adhere. This is followed by coating with the adhesive applied to the film only as thin as a hair. The individual coats are therefore only a few µm thick or weigh only a few grams per m². Systems such as Beta or X-ray differential measurement (accuracy typically approx. 1 to 2 g/m²) or thickness measurement using laser triangulation or light shading (accuracy approx. 5 µm) are often not exact enough here.

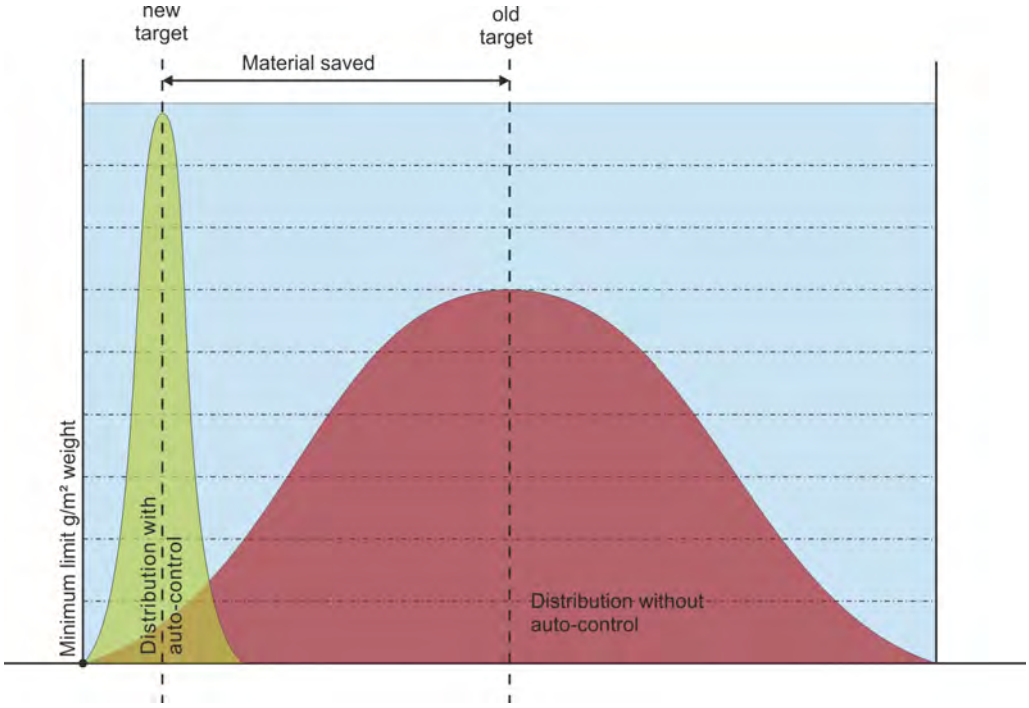


Fig. 1: The automatic basic weight control significantly reduces the spread of the basic weight and thereby ensure a more consistent end product.

To obtain sure results and thus a product that satisfies manufacturer and customer, a sensor is needed that is able to measure the film thickness directly on the running product web with high precision. Mahlo GmbH + Co. KG from Saal on the Danube in Bavaria has developed two different sensors that meet exactly these requirements. Both sensors belong to the Qualiscan QMS quality measuring system, which measures and controls key parameters as it traverses over the running product web.

mahlo
trendsetting technology. worldwide.
since 1945

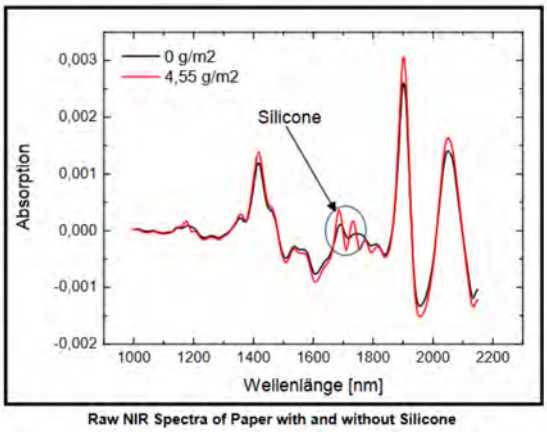
Infrared spectroscopy records all material components

Fig. 2: Principle of operation of Infrascope NIR

The first method utilises infrared spectroscopy. The Infrascope NIR sensor monitors the absorption of infrared light of all components on or in the web in the near infrared range. The underlying principle: The product is constantly illuminated by broadband infrared light (890-2200 nm). A spectrometer measures the infrared absorption, and the measurements are generated via an analysis algorithm. By simultaneously analysing the entire Infrascope NIR spectrum, the sensor is able to differentiate between multiple components in the material web.

When the substance to be measured absorbs IR light at a specific wavelength without overlay, e.g. of the substrate, the film thickness can be determined with very high accuracy. An accuracy of approx. 0.05 g/m² can be achieved. This method requires corresponding calibration of the sensor since, for example, the colour may also affect the measurement. Ideally, the calibration data is first determined in a laboratory test and then simply integrated in the system.

Application example of silicon release coating on paper



Raw NIR Spectra of Paper with and without Silicone

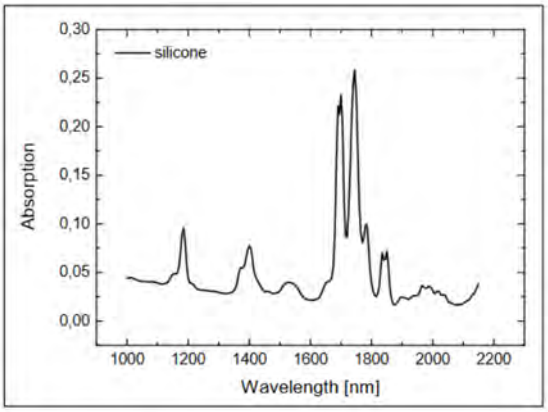


Fig. 3: The high spectral resolution allows differentiating between silicon absorption and paper absorption thus enabling the measurement of the silicon coat.

The online measurement of the basic weight of silicon on release paper has presented a major challenge to the industry so far, since the coating weight typically ranges only between 0.5 and 5 g/m². The Infrascope NIR allows measuring silicon coats of approx. 0.3 to 5 g/m². Thicker values practically do not occur in this application area. Other applications for measurement with infrared spectroscopy include, amongst others, silicon coating on fabric (e.g. for airbags), adhesive and polymer coating on paper and film as well as aqueous coats.

mahlo
trendsetting technology. worldwide.
since 1945

White light interference for transparent coats

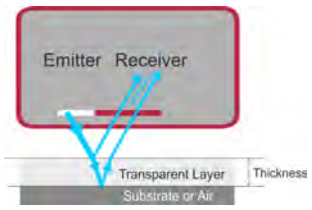


Fig. 4: Optoscope WLI principle of operation

However, determining the basic weight with near-infrared is not the only option Mahlo can offer its customers for the measurement of thin coats, especially with the particular challenge of transparent coats. They can be measured quite simply with the white light interference method, which the Optoscope WLI utilises.

When exposing clear or slightly opaque thin coats to white light, the light is reflected partially both on the upper and the lower boundary surface. This creates interference colours as colourful as a rainbow, known, for example, from soap bubbles. The frequencies of this interference are a measure for the film thickness and determined via an FFT algorithm. To allow determining the result unambiguously, the coat to be measured must exhibit a different refractive index toward the substrate coat. With these prerequisites, very high accuracy of up to 0.01 µm (10 nm) can be achieved.

Application example of varnish coat on 25 µm PET film

In the example of a varnish coat on 25 µm PET film the sensor determines a varnish thickness of 4.04 µm, a substrate thickness of 24.9 µm as well as a total thickness of 28.93 µm. Generally, the Optoscope WLI sensor is able to measure varnish coats down to a thickness of 0.4 µm. With adhesive coats on polymer film (e.g. PE, PP, PET) measurement of minute applications down to 1 µm is possible. Additional applications where the sensor is a good choice are PVDC on PVC, silicon release coating on PET and PE, mono film with extremely high accuracy and measurement of the total thickness of multi-ply film such as packaging film, were extremely high accuracy is also required.

What's more, the Optoscope WLI is able to determine even extremely thin coats in the nm range indirectly with aqueous or solvent-based applications on film, depending on the solids content. Another benefit for manufacturers is the option of single-sided measurement, which saves more space with installation and is priced more economically than a common O-frame.

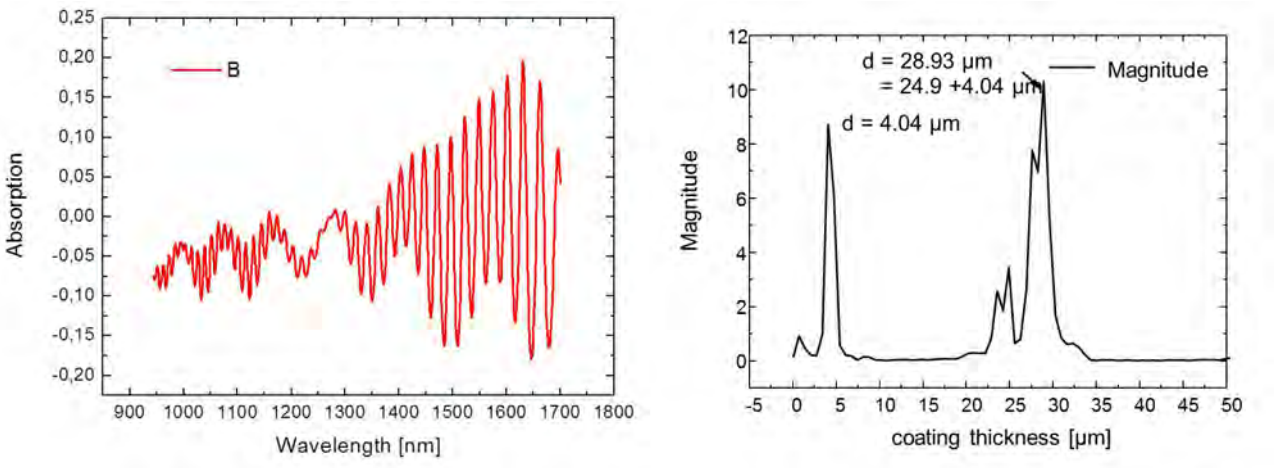


Fig. 5: Interference spectrum of a 25 µm thick PET film with varnish coating weighing 5.4 g/m². Total thickness and film thickness can be measured.

Clear presentation

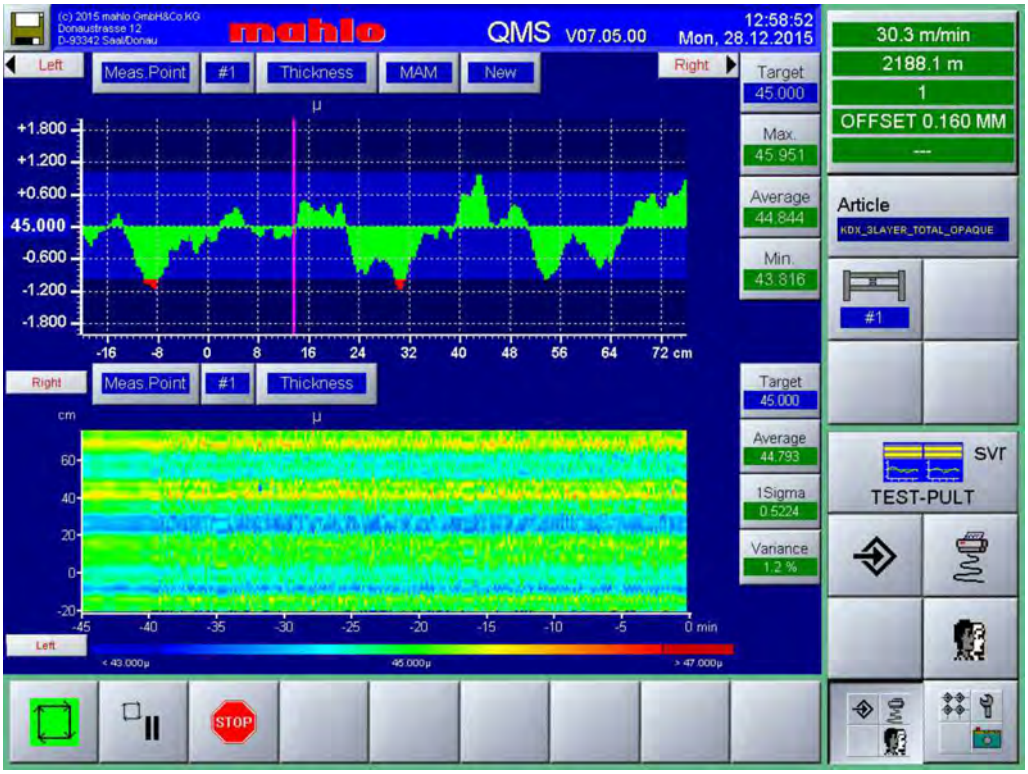


Fig. 6: Clearly arranged presentation on the control monitor

The results of the Infrascope NIR or Optoscope WLI measurement are presented to the user at a glance on the control monitor through uncluttered software display. Amongst others, the user can analyse the determined values and, if necessary, make changes to the affected machines and save the data. This documentation is not only helpful in the production process but also serves as record for the communication between suppliers and customers.

Mahlo possesses comprehensive experience and a wide range of measuring technologies. Eleven different sensors are available for the Qualiscan QMS quality measurement system using also, in addition to the methods mentioned, beta and X-ray transmission, laser triangulation or light band shadowing. This enables the team of experts to develop the right concept for nearly any application.

Fig. 7: Qualiscan QMS with Uniscan M measuring frame and sensor

Abstract

The online measurement of thin coats on paper and film has always presented a major challenge to manufacturers since the basic weight of the coat is typically only a few grams per m². Mahlo has developed two sensors that are able to measure even small values with maximum precision. The Infrascope NIR sensor monitors the absorption of infrared light of all components on or in the web in the near infrared range. By simultaneously analysing the entire Infrascope NIR spectrum, the sensor is able to differentiate between multiple components in the material web. The Optoscope WLI sensor, on the other hand, utilises the white light interference method. When exposed to white light, clear or opaque coating reflects the light in interference colours. The frequencies of this interference are a measure for the film thickness. An accuracy of up to 0.01 µm (10 nm) can thus be achieved.