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Inline coating control of entire surfaces

Thickness measurement for quality control in 3D and in real time for R2R and other coating systems – 'inline-QM-3D' for short

Thin layers of a defined thickness, and possibly also with internal structure, are key to many innovative products and applications, and the thickness of such layers varies from several nanometers up to a few micrometers. The ongoing refinement of thin-film production technologies increases the need for quality control of the applied layers: especially if it can be performed 'inline' during production. And until now, quality control could only be performed on the manufactured product at individual points across the surface in many cases.

So a fast measurement technology that can reliably determine coating thickness across an entire surface immediately after, or even during, the production process could help to significantly increase product quality, save coating material, reduce waste, and accelerate the development of new coating systems and materials.

Cooperation Offer

Dr. Ferdinand Bammer from the Process Engineering research group at the Institute of Production Engineering and Photonic Technologies is now able to provide such a compact, robust, cost-efficient and real-time quality control system. This is done in cooperation with various industries, so the process can be properly tailored for the specific requirements they face.

His measurement method can analyze the homogeneity and thickness distribution of thin coatings in-line and in-time for a variety of coating techniques, such as roll-to-roll (R2R), PVD, CVD, spraying and powder coating. The new technology allows the user to monitor the entire coating area: and as the actual surface parameters are analyzed in real time, the process parameters can, if necessary, be adjusted before thickness goes outside the desired target range. Precise measurement of the coating thickness and rapid feedback to the process control system can optimize both the use of material and the product quality.

For the specific needs of an industrial company, the first step is to test whether the process can provide a convincing solution and whether further cooperation is promising.

Inline measuring system without moving parts (basic concept)

Technology

The underlying measurement technology for this new system is ellipsometry, which has been tested and tried in a wide range of measuring applications. It allows recording the polarizing effect of a sample on incident light. The actual layer thickness is derived from this data with the help of a mathematical model of the layer structure stored in the system, which is based on reference measurements.

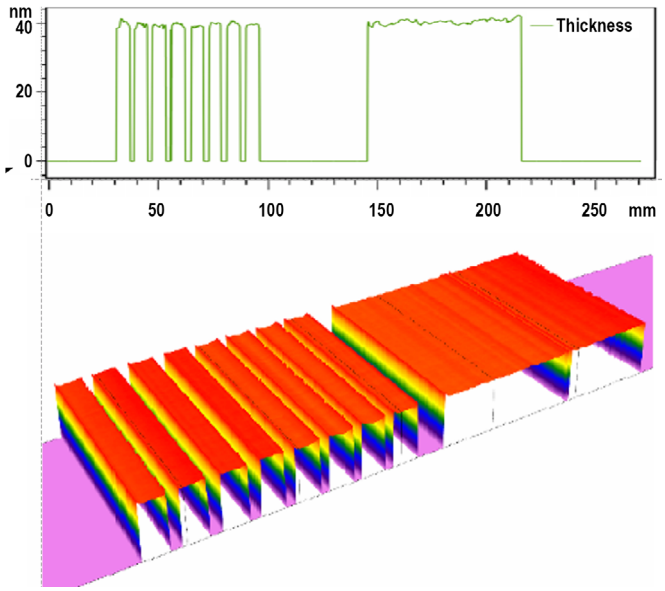
The measurement is carried out by illuminating the sample with polarized light at a specific angle of incidence. Adapted optics ensure a clean image of the object. The reflected light is captured by a polarization camera with a recording rate of up to 24 frames per second for the time being. The intensity curves and intensity ratios between different polarization states allow computation of the desired information regarding the thickness of the coating.

Such a measuring approach allows the layer thickness to be recorded over the entire surface with rigidly installed components, i.e. without moving the measuring head, so no errors are introduced by dynamic mass forces within the measurement system. Measuring along a roll provides a very stable process, and avoids errors caused by waviness or vibration of the film.

Results

The research team at TU Wien succeeded in developing an inline ellipsometer that is to be installed directly in coating systems and enables reliable quality control during ongoing manufacturing. The measuring device is capable to determine the layer thickness distribution in an R2R line in real time over a width of up to 2000 mm. Adaptation to smaller or larger widths is possible without any complications. The measurements with prototypes have so far focused on R2R as well as spray and plasma coatings.

In the case of R2R, the coating thickness identification is concentrated on one line across the moving band. The movement of the band adds the third dimension and thus the information about the complete surface area. For example, with a recording rate of 20 Hz, the thickness distribution of the active layer of organic photovoltaics with an average layer thickness of 250 nm can be identified within about 5% accuracy. About the same accuracy occurs when checking electrically conductive layers made of PEDOT (with a thickness of 40 nm) or gold.



PEDOT strips with a thickness of 40 nm on PET film

The measuring device can be used for thin layers made of almost all materials, as long as they are transparent or at least partially translucent – which is the case with extremely thin layers of a few nanometers to a tenth of a micrometer, even for most metals.

A wide variety of materials can be used as a carrier medium: flexible or rigid, opaque or transparent, such as thin films, including birefringent ones.

Applications

The new measurement system helps to improve product quality in many industrial sectors and reduce material consumption, especially in the following manufacturing industries:

- fuel cells, batteries
- displays, protective films
- electronics, medical, and pharmaceutical industries

Your Advantages

- a compact system for non-contact area measurement of the thickness of thin layers in real time – with up to 24 measurements per second, with each measurement taking place on 1,200 measuring points simultaneously
- for transparent and/or semi-transparent coating materials – including many metal coatings
- for controlling layer thickness in the nano to micrometer range
- increases energy and resource efficiency by avoiding rejects and reducing layer thickness
- no moving parts, small and robust, cost-effective by use of standard components

The TU Wien offers cooperation partners the opportunity to implement this innovative layer thickness control for their individual applications.

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