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2-dimensional In-line Inspection for Coatings

Layer thickness measuring for real-time quality control in R2R and other coating facilities

Many innovative products and applications are based on thin, structured layers that require homogeneous coating of a defined thickness. Thickness may range from a few nano metres up to some micro metres. A continuous growth of thin-film technologies increases the demand for solutions for an in-line quality control of applied layers. Up to now, merely the finished product is subjected to quality checks in most cases. A quick measuring technique for determining the layer thickness directly after or during manufacturing contributes to considerably reducing scrap.

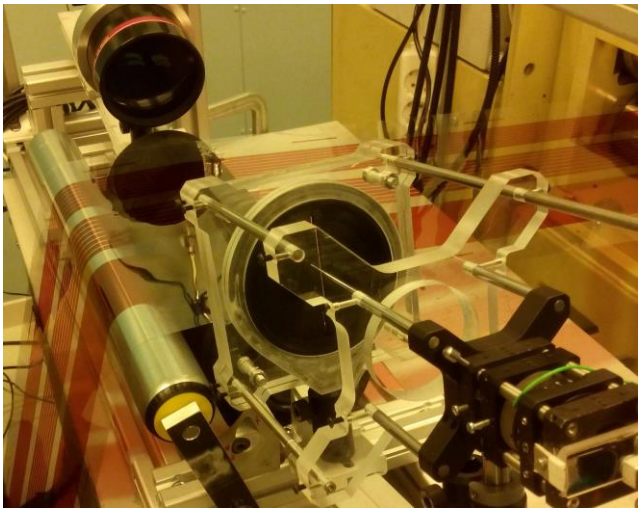
Objective

Developing a compact, robust and cost-efficient real-time quality control system was the aim of Dr. Ferdinand Bammer and his colleagues of the optics and laser development research group at TU Wien. The measuring system aims to capture the homogeneity and 2-dimensional thickness distribution in-line and in-time of thin coatings for a number of coating techniques – such as for example roll-to-roll (R2R), PVD, CVD, spraying as well as powder coating. As there is no simple solution for this problem yet, this procedure is to bridge a gap in the market.

The new technique will allow the user to monitor in-line how actual values develop and to correct the process parameters if required by means of relevant settings before target values are violated. This will decrease scrap and increase product quality. By exactly controlling the layer thickness, material consumption may be monitored and reduced to a different extent.

Approach

The measuring technology is principally based on ellipsometry, i.e. on capturing the sample's polarising characteristics on incident light. This data is then used to determine the actual layer thickness by means of a mathematical model of the layer system stored in the system.



Installation in an R2R facility

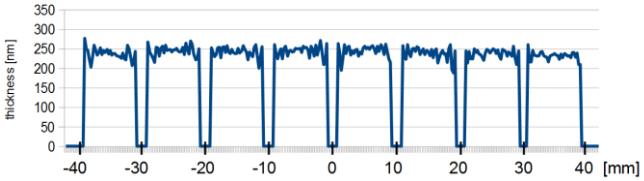
Measuring is carried out through area illumination of the sample with parallel light of different polarisations. A quick switching of the light's polarisation state constitutes the core of the technology. With each illumination type, telecentric lenses produce an image with two or four exposures within 10 to 100 ms depending on the mode of operation. The intensity development in these images or the intensity relationship between the images reveals the desired information about the sample's polarising characteristics.

Results

The TU Wien research team successfully developed the “in-line ellipsometer”, a device that may be integrated directly into coating facilities and that allows for reliable quality control during productive operation. The measuring system determines the thickness distribution in an area of 300x50 mm within a matter of milliseconds. Adaptation to smaller or larger areas is easily possible. Previous measurements with the TU Wien prototype concentrate on R2R as well as spray coatings. In the case of R2R, layer thickness determination is reduced to one line via the active band. The band's movement produces the information about the area.

With a sample rate of 20 Hz, the thickness distribution of the active organic photovoltaic layer (P3HT-PCBM) could be determined across a width of 300 mm with 5% accuracy. The mean layer thickness was 250 nm. Similarly, monitoring was realised for a PEDOT transport layer with a thickness of 40 nm.

The measuring system may be used for thin layers of almost any coating material as long as it is transparent or at least partly translucent – which applies even to extremely thin metal layers measuring only a few nanometres. Also flexible, transparent or birefringent material may be used as a carrier medium.



Thickness-distribution of P3HT:PCBM-stripes on PET

Almost all areas of production offer possible applications for the technology – from fuel cells and battery technology to display technology, medical engineering and the pharmaceutical industry.

Presenting the inspection device to industry professionals

Your benefit

- First compact and simple solution for contact-free and 2-dimensional capturing of thin layer thicknesses in real-time (10 - 100 measurements per second – and more)
- Suitable for transparent and semi-transparent coating materials on rigid, flexible, transparent and birefringent materials (e.g. plastic foil)
- Increased energy and resource efficiency by avoiding scrap and reducing layer thickness
- Suitable for layer thicknesses from nm to µm
- Excellent value for money due to cost-efficient components and robust measuring principle

Notes

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