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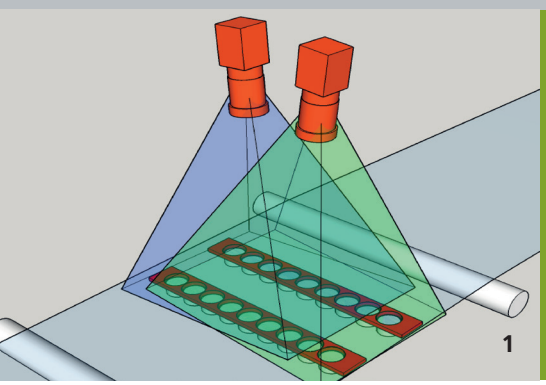

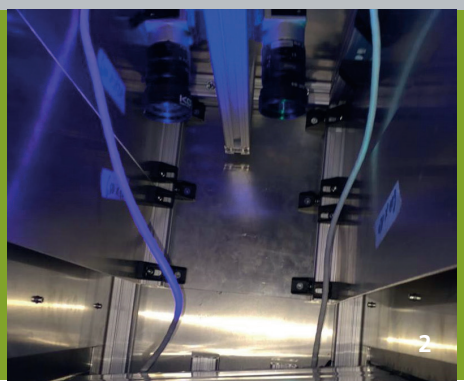

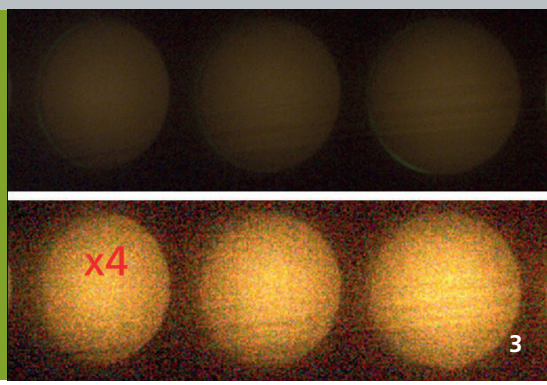


1 *Scheme of the detection system.*
2 *Detection system in a film converting machine.*
3 *Picture taken from a running film showing deliberate smear tracks in the coating (top as recorded, bottom amplified).*
4 *Scattering of green laser light in a green dye solution (right) and red fluorescence of a blue dye solution (left).*
5 *Relative thickness distribution.*

# PROCESS CONTROLL FOR ORGANIC COATINGS

## IN-LINE IMAGING OF THICKNESS AND CURING

### The challenge

Measuring the thickness distribution of thin transparent coatings on transparent materials is a challenge, especially as an in-line process control technique. The challenge becomes greater the thinner the layers or the more similar the refractive indices are. This challenge arises, for example, with sub-micron lacquer coatings on polymer films or impregnations such as siliconization.

### The solution

Fluorescent dyes in a very small concentration can be added to transparent coatings in order to enable the in-line measurement of the thickness distribution. The dyes are not visible by the naked eye and they do not influence the transparency nor other properties of the coating as mechanical strength.

### Our service

Our services include the design and installation of fluorescence-based in-line imaging systems including
- the selection of suitable dyes
- design of the optical system
- feasibility studies
- finding suppliers of the components
- installation of the system in the clients equipment
- troubleshooting

**Fraunhofer Polymer Surfaces Alliance POLO®**

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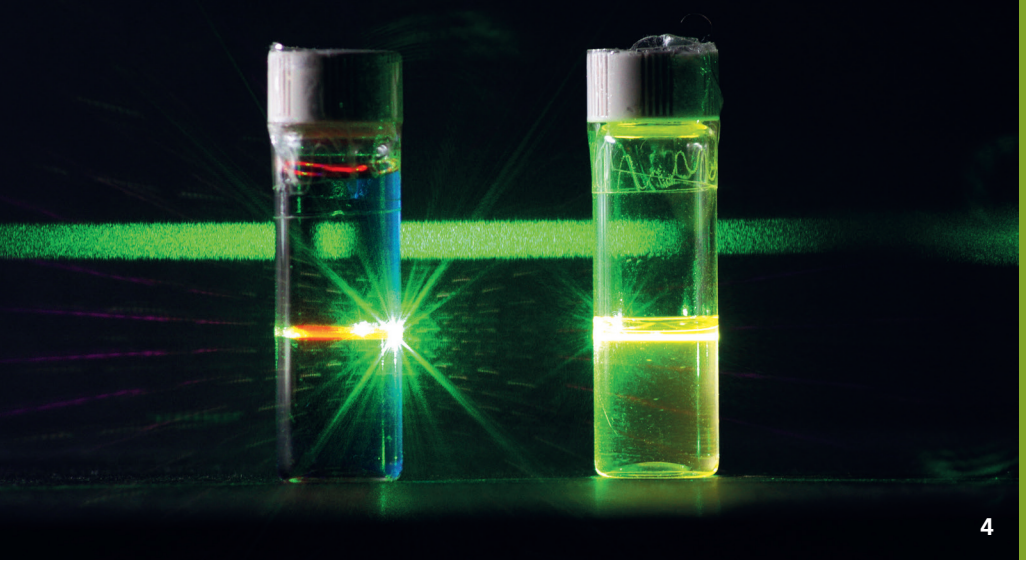

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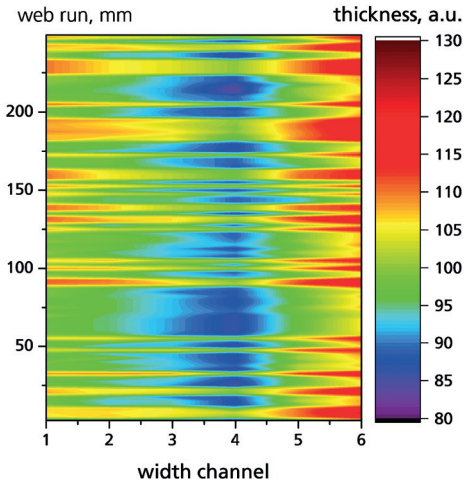


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## Fluorescence

Fluorescence means that the dye can absorb light of a particular wavelength (colour) and emit light with a longer wavelength (other colour). It can be measured with an extremely high sensitivity and, therefore, only a very small concentration (parts per million) of a dye is sufficient for its detection in a thin coating. Such a small concentration in a thin layer is not visible for the naked eye and it does not affect the properties of the coating material like its mechanical strength, modulus etc. Since the dye is dispersed in the coating on a molecular level, the fluorescence intensity is proportional to the thickness of the coating.

## In-line imaging

The fluorescence intensity of a dye dissolved in a layer can be recorded on a running web. The fluorescence intensity represents the thickness at each point. These data can be recorded and processed for the detection of the thickness distribution and defects.
A simple demonstration equipment is installed on one of our converting machines. We collaborate with manufacturers of inspection equipment to develop industrial scale machine including appropriate software.

## Benefits

The most obvious benefits result from a 100 % monitoring of a coating homogeneity, which can give rise to a new level of process stability and quality assurance. Problems in the coating process can be detected within a short period of time and it saves costs for deficient products and product recalls.
Beyond the monitoring, the data can be used to control the actual coating process and to make it more precise. The coating thickness can be adjusted to the lowest possible level to assure the intended effect. The return on investment can be very direct. For example, the thickness of a silicone coating could be reduced from 0.8 µm to 0.7 µm due to the reliable process control. This reduction directly reduces the costs for the coating material by 12 % and it also reduces the energy consumption of the drying process.
In the case of an EVOH oxygen barrier layer in a coextruded film the reduction of the thickness from 6 µm to 5 µm becomes feasible with 100 % monitoring of the thickness. The thickness reduction translates into costs savings about 80,000 € at a production of 10 million m² with 10 t EVOH.

## Application range

Implementing such a measurement system is beneficial in particular in application areas such as functional coatings and adhesive lamination, multilayer extrusion processes for food and pharmaceutical packaging, release liner for pressure sensitive labels, or multi-layered structures for technical functional films like high barrier encapsulation materials for organic electronics and others. The hardware for the measurements allows typical production speeds of > 400 m/min. Web speed and the required resolution together determine the parameters and the price of the measurement system.

## Under development

The measurement of the distribution of coating thicknesses and thin layers provides relative values in the simplest case. A multiplexing is under development and it will allow the monitoring of two or more layers or the monitoring of mixing ratios.
The development of calibration procedures will allow measuring absolute thicknesses. With special dyes it will be feasible to detect the curing or drying state of a coating or thin layer. Also this technology is still under development.