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Paper: **How Automatic Optical Inline Systems help you save money and time - New Methods for Quality and Process Control in Plastic Film Production**

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Introduction

Plastic films are produced for and used in a wide range of applications: food packaging, films for Li-batteries and fuel cells, flexible electronics (FPE), organic solar modules (OPV), OLEDs, and many more. The two characteristics all these applications have in common are the high requirements on the film materials and the complex layer configurations. As a consequence, precise control of the production process is essential to optimize the production costs. The presentation will focus on the control of film properties characteristic for these high-end products, via automatic optical inspection systems (AOI).

Basics of AOI Systems

AOI systems are mainly based on three components:
- Digital line cameras (CCD or CMOS technology)
- LED line illumination (several wavelengths possible)
- Evaluation electronics, comprising dedicated hard- and software

Their key applications are:
- Quality Control for the detection of local product irregularities to ensure that defective material is neither processed any further nor delivered to the customer (Fig. 1)
- Inline monitoring of material properties, such as thickness, gloss, opacity or surface topology, over the full width and length of the material.
- Process Control for optimization of the production process; here the challenge is the implementation of fast feedback on production parameters to react immediately (and even automatically) to process deviations detected by the AOI.

State-of-the-Art and Innovation

AOI systems are already applied in many production sites. Currently CCD line cameras (or recently also cameras based on CMOS technology) with increasing pixel resolution are combined with line illuminations. So far so good - but what is new, what are new capabilities pushing the envelope as regards saving money and time in plastic film production ?

Main new features of the latest AOI systems :

- Light sources are progressing rapidly. They feature rows of LEDs, now available in several different wavelengths. This makes it possible to inspect material using light of varying colors, which selectively increases the sensitivity of the inspection system for certain defects or material properties.
- To enhance the performance of defect detection and evaluation, the AOI system can analyse the same defect using multiple images acquired in a single scan (Multiple Image Defect Analysis – MIDA; see Fig.1). For example, MIDA enables looking for defects with multiple light sources (e.g. with different colors or different angles of incidence) in parallel. This helps to optimize the yield of a film production line, independent from the production process type (extrusion, cast, stretching, ….).

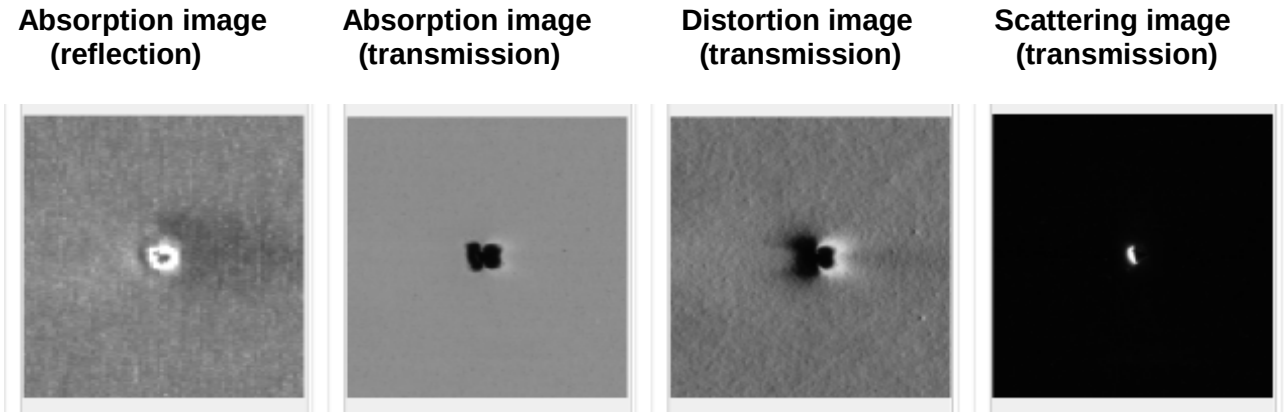

Fig. 1: Multiple Image Defect Analysis (MIDA) of the same defect (inclusion in plastic film)

- Simultaneously, modern AOI systems can monitor the homogeneity of film and coating properties and return their absolute measurement values for the full material width in-line; in contrast, standard optical process control systems monitor coating properties by measuring only a few spots on the material, mostly with a significant time delay after production of the material (Fig. 2).

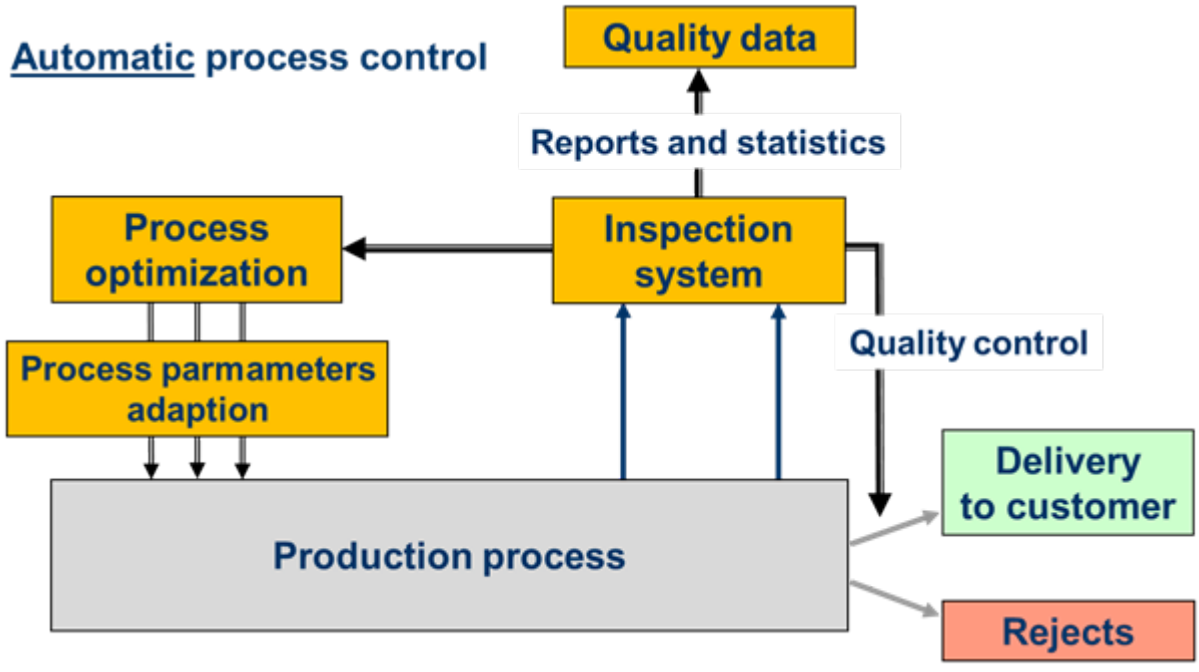

Fig. 2: Automatic process control of a production process by AOI data

- Additionally, enhanced quality analysis methods are described based on the evaluation of gray value distribution over the whole sample (e.g. by histograms, giving the spatial frequency of gray values within certain sub-areas of the material). This new approach allows sophisticated detection of defective areas even in/on plastic films with structured/textured surfaces.

Demonstration of Results

The presentation will demonstrate these methods and capabilities by showing results of defect detection and evaluation in/on various film materials, e.g. base material and coated films. This will include:

- Monitoring of haze, generated by film material properties and surface texture (application e.g.in BOPET production to control the stretching process) (Fig. 3)
- Analysis of density and homogeneity of metal coatings; optical densities (OD) up to OD 3 can be evaluated with camera based inspection systems (Fig. 4)
- Control of discontinuous (or patch) coating; application = films for Li-batteries and fuel cells. Here the main approach is checking the dimensions of the coating patch together with the inspection of the edges of the patch and defects inside the coated area (Fig. 5)
- Monitoring of the calendering of material and coatings. Calendering is an important step in coatings for Li-batteries and fuel cells; with the camera system the intensity and the completeness of calendaring can be controlled.

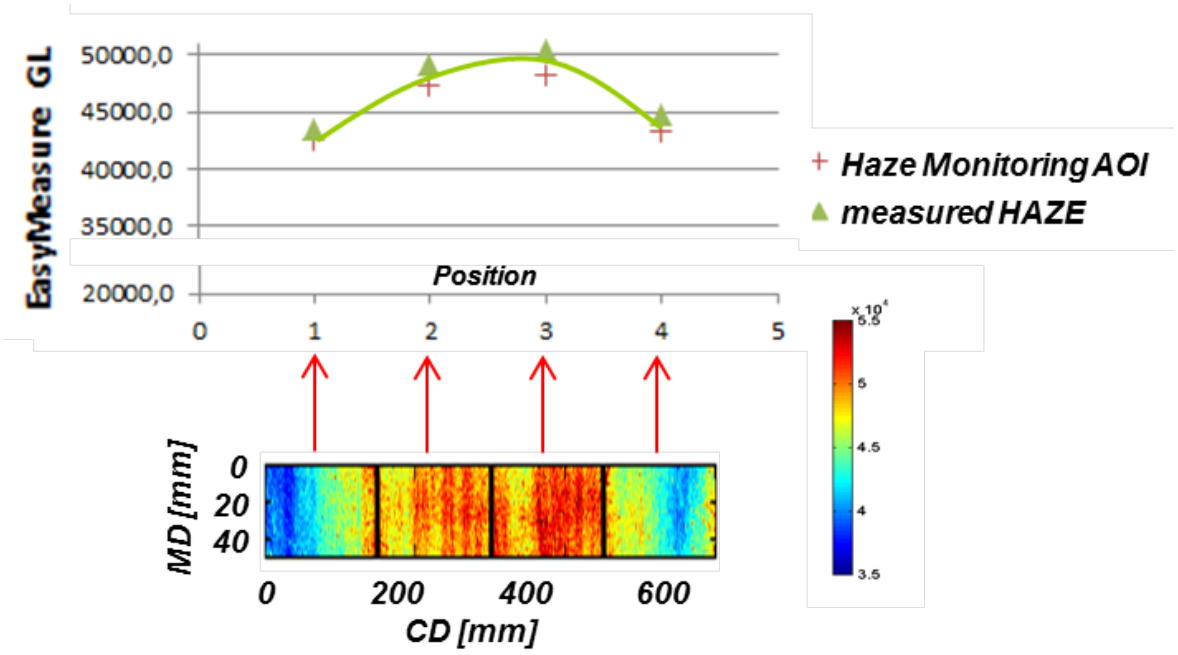

Fig. 3: Monitoring of haze

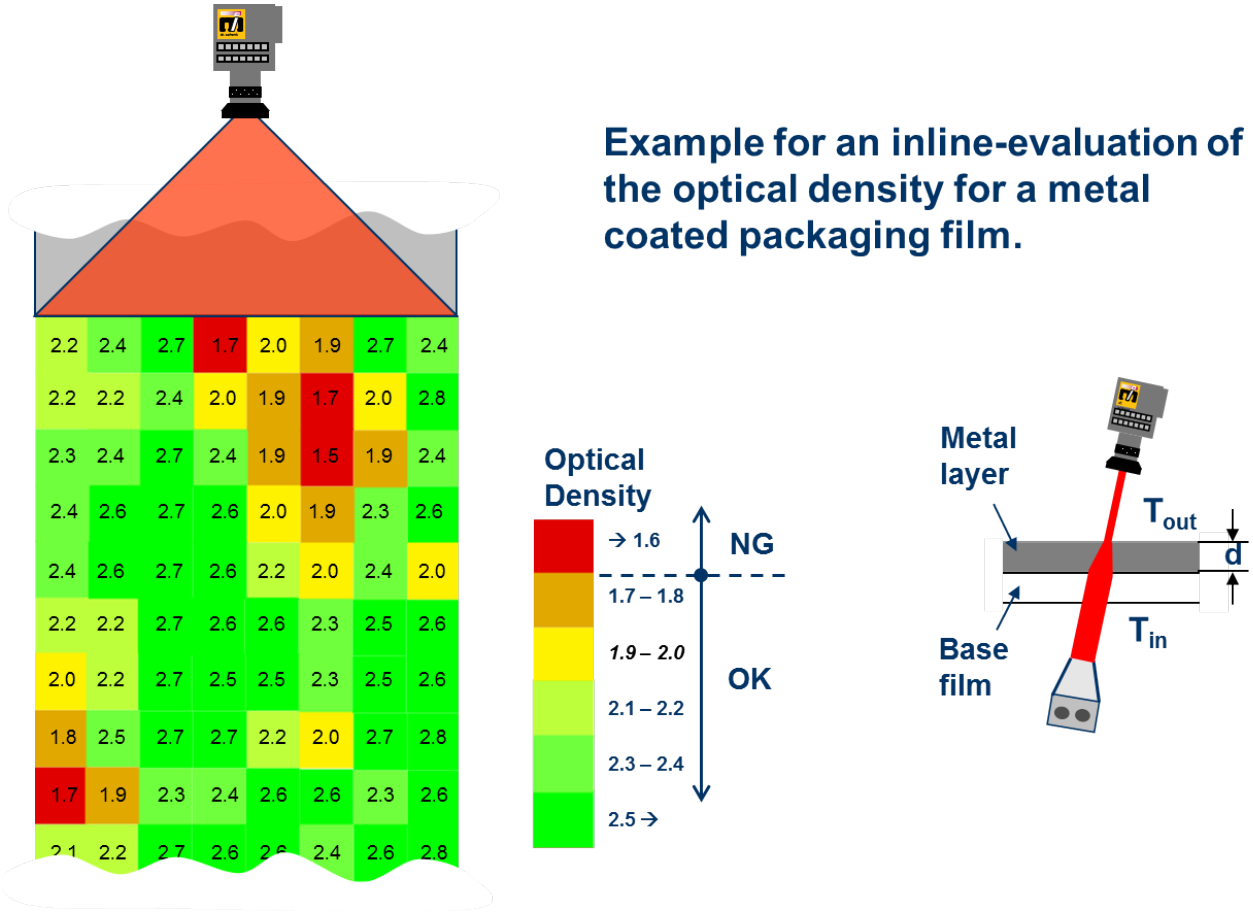

Fig. 4: Monitoring of coating thickness (i.e. optical density) of metal layers

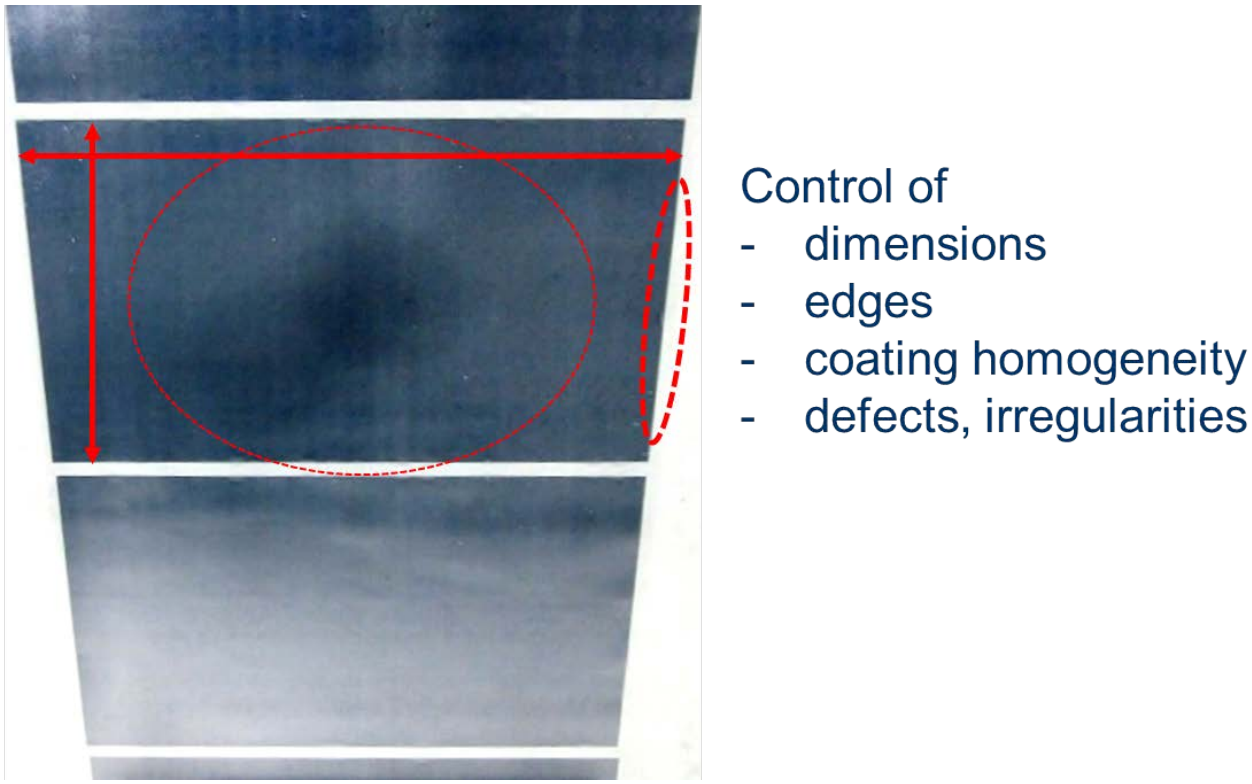

Fig.5: Control of coating patches (dimensions, edges and defects inside the coated area)