Measurement of the thickness of thin foils and testing of the heat sealing of food and medicinal packaging

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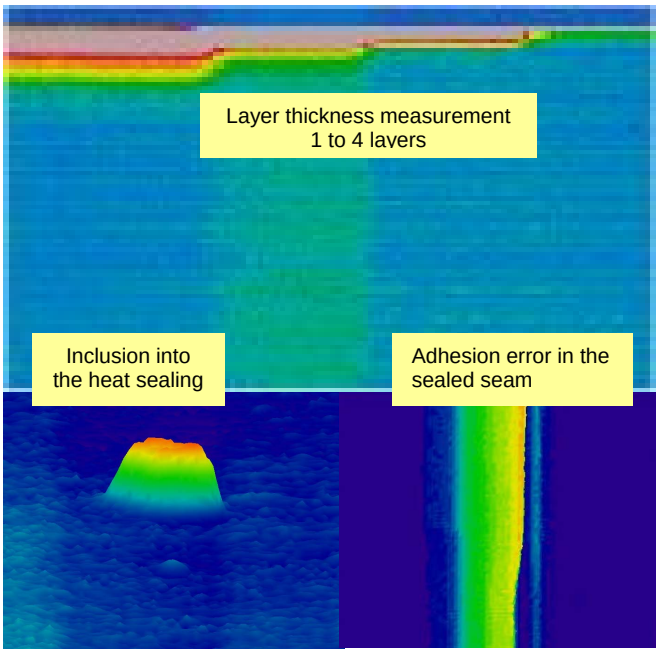


Thermal tracks are bringing it to light!

On top: Selective measurement of layer thickness
Bottom left: Inclusion into the heat sealing of the food bowl cover
Bottom right: Adhesion error in the bonding of a food bag

Introduction

The measurement of the thickness of a layer (foils, varnish, and paint) by several stacked layers is an unsolved problem in the industry. A test by the processing of the foil in packaging is necessary to guarantee the shelf life of the packaged item.

Changes in the thickness of a layer, glue failure, cold bonding, breakages in the seal, leakage in vacuum packaging and such are safely, rapidly, none destructively and very dependably determined with modern technology.

With PTR technology, arsenco ag has developed a new process technique which is used to solve the above described tasks.

If an energy pulse is forced upon a surface and at the same time detects the conduct of the energy timely and spectral with high dynamics, then all necessary signals for the

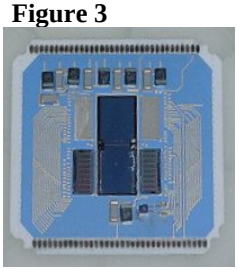
measurement of the layer thickness are present. The analysis of the data is carried out with a standard computer.

Layer thickness measurement device (pilot installation)

The gage head for the layer thickness measurement consists of the pulse source and the electronic circuit (figure 2, left). On the sensor chip (figure 3, right) 64 to 256 sensor elements are mounted in a row – the control of the sensors – as well as the electric circuit for each sensor. The sensor chip can be controlled and read out via a computer.

Figure 2

Figure 3

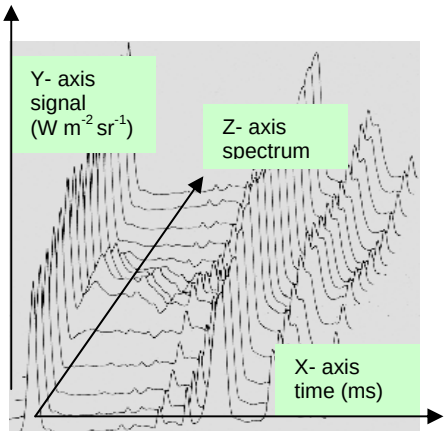


All components on the sensor chip (figure 3) are completely contacted. The operation via the interface to the outside is always guaranteed.

Depiction of the measurement results from a measurement attempt

The spectral or the thermal deviations provide the localization of the interface between two films. For the selective measurement of the film thickness on 3 layered constructed foils, the timely and spectrally scanned signal process after a shock like attached energy pulse is visible in figure 4. In figure 5 the signals are illustrated over a time period of several milliseconds.

Figure 4 The smallest deviations in the radiation from the measuring point are quickly and easily determined by a scanning in the function of the time and the function of the spectrum. W m^{-2} sr^{-1} = Watt per m2 and Steradian)



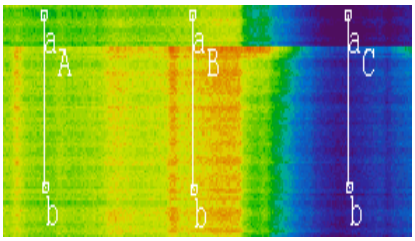
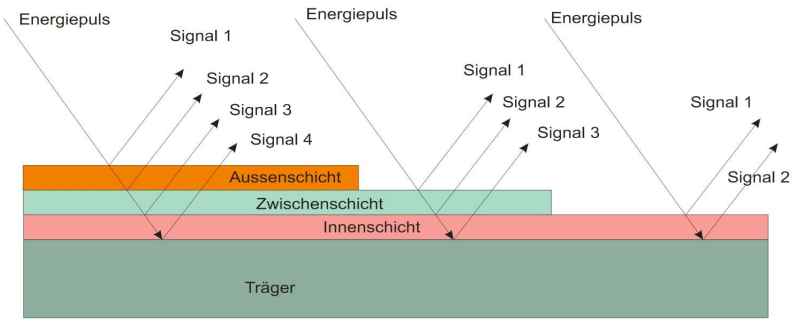


Figure 5 The pulse energy for a very thin layer (blue area) is transmitted to a large part. In a broad spectral area the radiation procedure changes only slightly.

Figure 6 Cohesion in a 3 layered film integrated on a carrier



Aussenschicht = external layer
Zwischenschicht = Interface layer
Innenschicht = internal layer
Träger = carrier

The pulse energy is influenced by each interface and leads to a time delayed process of the energy distribution on the outside of the foil.

As the layer thickness increases it becomes apparent that a large part of the pulse energy is absorbed and the reply function appears temporally with an increased delay. By thin layers the thickness of each individual layer can be reproducibly determined with high precision.

Analysis program

From the timely process of the thermal pulse, the analysis program provides an inference to the carrier on which the layer is applied as well as to the material data of a layer and finally to the layer thickness at the measuring point.

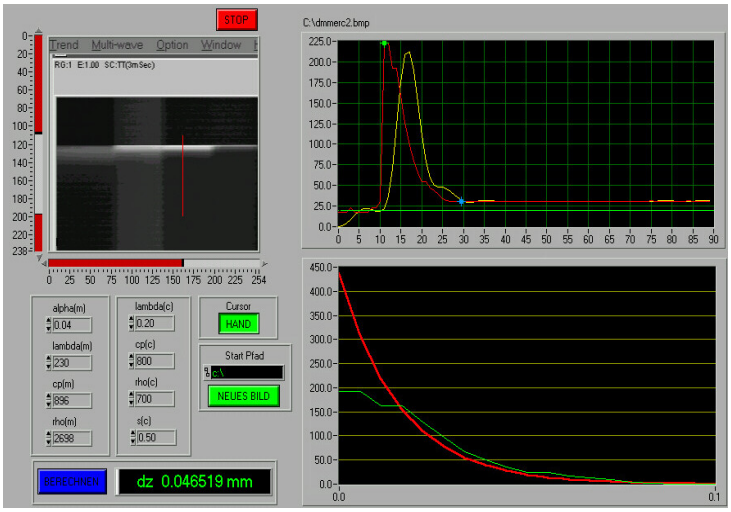
Several trial measurements were conducted to test the reproducibility. The timely and spectrally screened radiation technical behavior is reproducible after a thermal pulse.

Due to the hitherto conducted measuring attempts tests and experiences it can be demonstrated that the total thickness and the thickness of each layer by several superimposed layers can be measured with a sufficiently large accuracy.

Measured are:

- Impact of the carrier (aluminium, steel or plastics)
- Physical impact factors of the coating material.
- The total coating thickness.
- The thickness of each mono layer by several superimposed layers (hitherto confirmed up to 4 layers).

Figure 8 Analysis mask constructed under lab view. The thickness of the layer is calculated from the radiance process in the function of the time (figure in the mask top left).



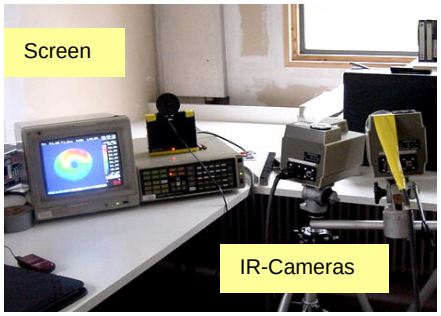
Because of the hitherto conducted trials a calibration for the analysis was waived.

Setting of tasks from practice:

The thickness of each position in a film consisting of 3 layers should be measured without contact and the result should be recorded.

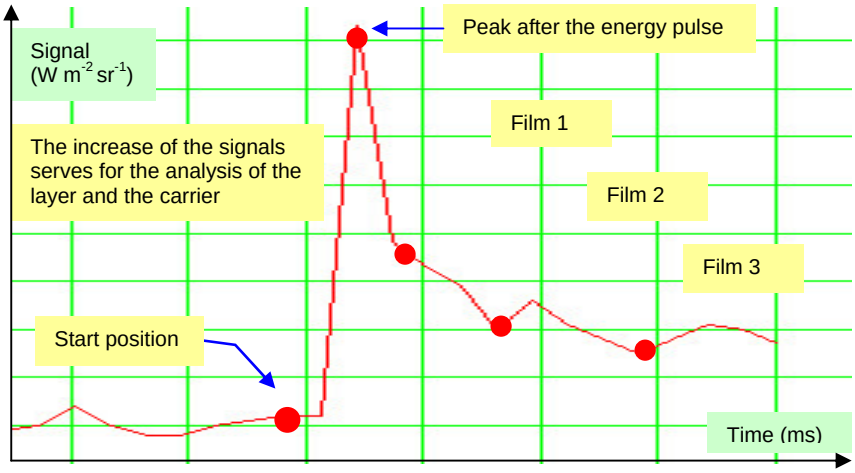
The PTR process is based upon the fact, that an energy pulse is forced upon the surface and that the radiance behavior (spectral absorption and emission) is measured with high speed with the IR - sensor. As required, the radiance behavior is spectrally and timely screened. The spatial surface which forms from the signals of the timely and spectral radiance of the foil is analyzed. In the following figure a trial construction is illustrated in which simultaneously two infrared systems with different spectral sensitiveness (short time and long time) as well as the application of a gas discharge source as a pulse source are used.

Measurement area consisting of IR – systems and analysis unit.
Data collection at a high speed, the spectral flexibility, a pulse source adjusted to the IR - sensor-array are the essential components of the layer thickness measuring device respective of the testing facility.



The measurement results will be transferred to a computer and analyzed there. By a gap of 10 cm between the measure point and the object a geometric resolution of ca. 0.5 mm per pixel is yielded.

Figure 9 An individual measuring line from a series of 100 measuring lines.



For the measurement, the foil is mounted in front of the measuring head. The space between the measuring head and the foil is between 5 cm and 10 cm. After the energy pulse from the radiances in the function of the spectrum and the time the layer thickness of each individual film can be calculated at the measuring point.

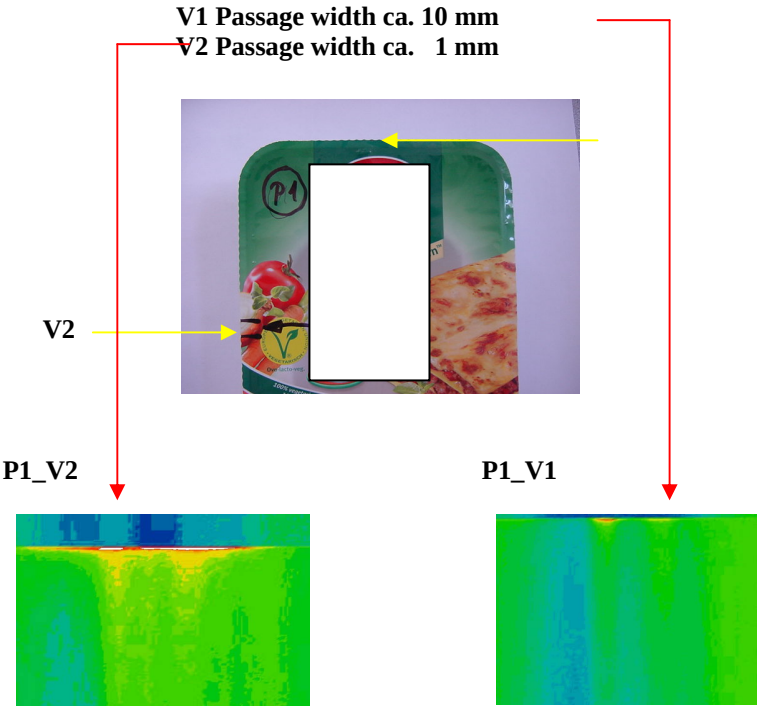
Based on the radiation technical start up condition the process of the absorbed energy, as well as the timely, and as required the spectral process also of the radiation will be measured. The separation layer between two foils is shown on a change in the timely and/or spectral radiance.

Determination of defects in the bonding of packaging:

Defects in food and medicinal packaging are the cause that the shelf life of a product can not be guaranteed as planned. Changes in the thickness of a layer, glue failure, cold sealing, breakthroughs in the seal, leakage in vacuum packaging and such are safely, rapidly, non destructively and very dependably determined with modern technology.

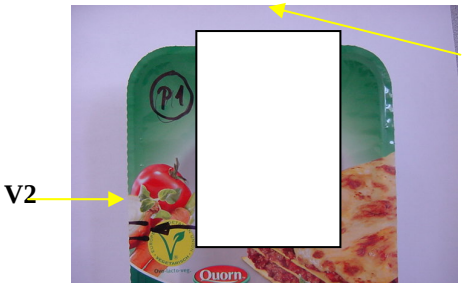
The foil covering of a tray is systematically measured in such a way, that defects in the sealing of the foil with the body of the tray can be determined without destruction and contact. The two figures show a pulse source with integrated sensor and the tray to be tested.

Test 1

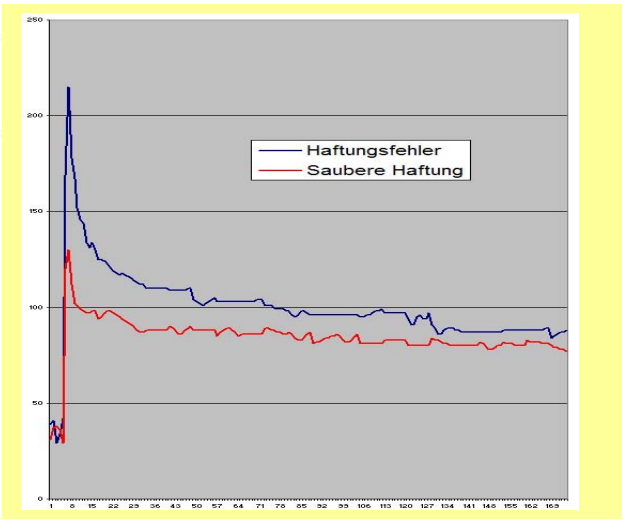


Interpretation and analysis

Data set recorded and analytically analyzed. The signal characteristics clearly show the adhesion defect on the marked area.

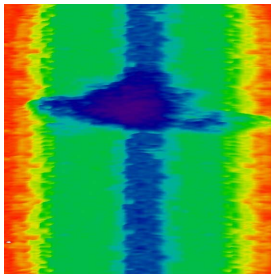


The adhesion defect between packaging tray and the cover foil is photothermally easy to prove.
The signal process in the function of time is illustrated for the V2, in the left graphic.

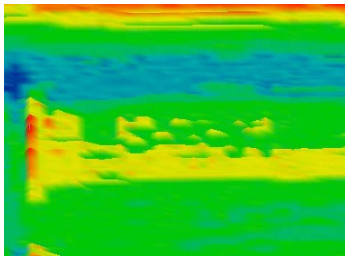


Different defects figuratively represented (about 200 lines are represented).

Defective sealing

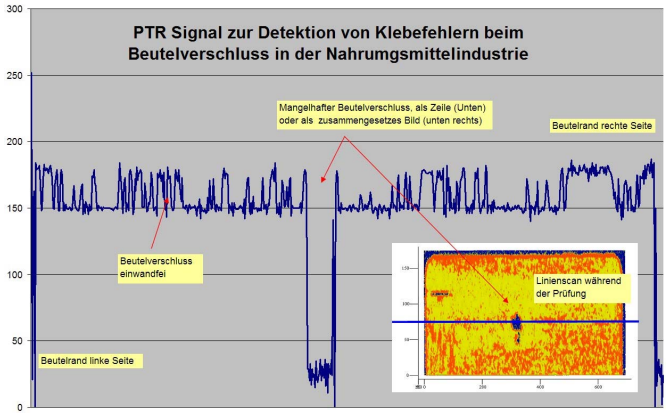


Food products – inclusion



In the PTR figure, the defective heat seal as well as a food product inclusion are quickly and dependably detectable. The sensing of the PTR - signals takes place with more than 100 Hz by a pulse frequency of 50 Hz.

A defect representation of individual line scans (blue line) and about 150 scans, which were represented consecutively (figure bottom right).



Mangelhafter Beuterlverschluss…..	Defective bag seal as a line (bottom) or as a compounded figure (bottom left
Beutelverschluss einwandfrei	Bag seal perfekt
Beutelrand linke Seite	Bag edge left side
Beutelrand rechte Seite	Bag edge right side
Linienscan während ….	Line scan during the test

Summary

Tests on covers of various samples (pockets, pouches, trays, and peal off covers) have shown that the PTR – technology is suited to test the adhesion of a foil without destruction and contact free. The smallest defects or leaks in seals were detected in the lab. Microscopic tests on different samples have verified the procedure's dependability. They document the feasibility of the non destructive and totally contact free testing of any type of heat sealing of packaging.

Additional information:

Request additional information and documentation about the contact free and non destructive layer thickness measurement from our company.

Case study	Results from applied measurements in the ongoing production.
Pulse thermograph	Internal technical description in English.
Photo thermal test	Internal technical description in English.
Technical report	Seeing below the surface. SPIE`s OE Magazine 2003
Quantum leap the layer thickness by multi layered	Selective measurement of coating (internal writing).
Sensor	Description of the IR - Sensor (internal description for the new sensor array).