

FILMS / COATINGS



October 2010



Applications and Products

Applications of non-contact metrology in the field of films and coatings

Modern production methods for films and sheet materials are nowadays introducing an ever-increasing degree of flexibility. State-of-the-art techniques allow coating or finishing of a very wide range of different materials, with ever-more stringent demands being placed on materials and processes. These developments also create an increasing need for quality assurance and monitoring of production processes.

In particular, during film production at web speeds of up to 1600 m / min several hundred metres of film may be produced or coated within just a few seconds. Any flaw occurring not only means that the film produced is defective, but that high disposal costs are frequently also incurred. There is thus an urgent need for a measuring system which can detect such faults at a very early stage and deliver appropriate feedback signals.

This need is met by the in-line measuring system developed by the Mannheim-based company **ISIS sentronics**, which can measure the total thickness of a material as well as the thicknesses of its individual constituent layers, even at very high web speeds. Highly accurate measurements of coatings on all kinds of substrates, whether smooth, rough, reflecting, or almost non-reflecting are also feasible.

The interferometry-based **StraDex** sensor is an optical system and thus functions in a completely non-contact manner.



Thanks to its integrated autofocus system, the sensor is able to perform in-line measurements almost independently of distance.

Slightly »fluttering« of the film or unavoidable small angular errors in a traverse therefore have no effect on the quality of measurement. All measurements can be readily and intuitively automated with the aid of **StratoSpect** application software. No programming skills are required because automation is accomplished by a wizard in just a few mouse clicks. The results can be illustrated graphically and used in-line for direct processing or control purposes.

The StraDex sensor has numerous applications:

- Production and coating of films
- Blister packs (e.g. packaging for medicines)
- Medical tubing and catheters
- Coated paper (paper finishing)
- Coated glass
- Coated and finished (painted) metals
- Finished textiles or fabrics (coated)

Your advantages at a glance:

- Non-contact measurement in reflection mode
- Measurement at high web speeds
- In-line and off-line measurement with a compact sensor head
- Wide variety of materials measurable (independently of substrate)
- Liquid coatings such as adhesives are measurable immediately after application
- Measurement of multiple layers feasible at individual layer thicknesses of 5 µm and greater
- Layers down to 0.3 µm measurable
- No double traversing unit necessary
- Intuitive software gives fast results
- Individual graphic processing and control
- In-line data export to external control systems

Measurement of finished textiles with a StraDex sensor

ISIS technology also has practical applications in the areas of woven and non-woven fabrics.

Coated textiles as well as felt, fleece, drapery materials or other fabrics are often finished with a sophisticated and expensive coating.

In such cases a uniform and economical distribution of the coatings is absolutely essential. Excessively thin coatings fail to fulfil their purpose whereas excessively thick ones can endanger profit margins in the face of increasing raw material prices.

The coatings can fulfil various functions. On the one hand, dirt and water-repellent coatings are of special importance. On the other hand, different substrates can be joined together in a single production step with adhesive layers or hot laminated layers.

Due to his compact design and his auto focus capabilities, the **StraDex f2** sensor is also ideally suitable to fulfill the process requirements at production conditions. Measurements in reflection mode are a big advantage since the measured substrates might be strong scatters or even non-transparent like textiles. When combined with a traverse, reliable measurements across large web width are possible. No second traverse on the opposite side of the film web is required since the measurement is in reflection mode in turn enormous costs are saved.



Traversing measuring unit and a StraDex sensor head.
Reflection mode measurement has the added advantage that there is no need for a second traversing system on the other side of the web.



Measurement of an elastomer film prior to felt coating in in-line operation.



Measurement of adhesive layers and thin coatings

A special challenge is for example the measurement of thin adhesive layers or other coatings. These are often on a substrate, which does not differ from the layer material with respect of the optical properties, thus measuring is difficult. However strong reflecting substrates like aluminum are no problem for the sensor. Another advantage are thin layers by itself, when their thickness is in the range of 0.3 - 3 μm . Wet films as well as dry films are measurable.

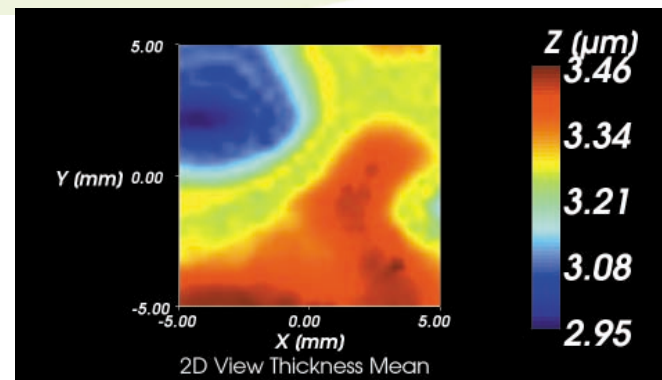
Wet films are often dried by use of easily flammable solvents. For this applications the **StraDex** sensor may be incorporated into a special housing, which is approved for explosive regions. With a cable length of up to 50 m it is possible to place the Control Unit in a separate room.

Here as well the sensor may certainly be mounted on a traversing unit, to measure across the whole web width.

Moreover, the **StraDex** sensor can be mounted on a traversing unit to perform measurements over the entire width of the web. Since measurement is undertaken in the reflection mode

there is no need for a second traversing unit on the opposite side of the web, which in turn translates into enormous cost savings.

With an additional x/y stage an area up to 100 x 100 mm² can be evaluated with highest precision. The complete system **SemDex F12** is very easy to use.



2D Thickness distribution of a 3 μm NeoCryl Coating over an area of 10 x 10 mm². The mean thickness over the measured area is 3.27 μm with a total thickness variation of 0.52 μm . Measured with **SemDex F12** and integrated **StraDex t6 - 60** sensor.

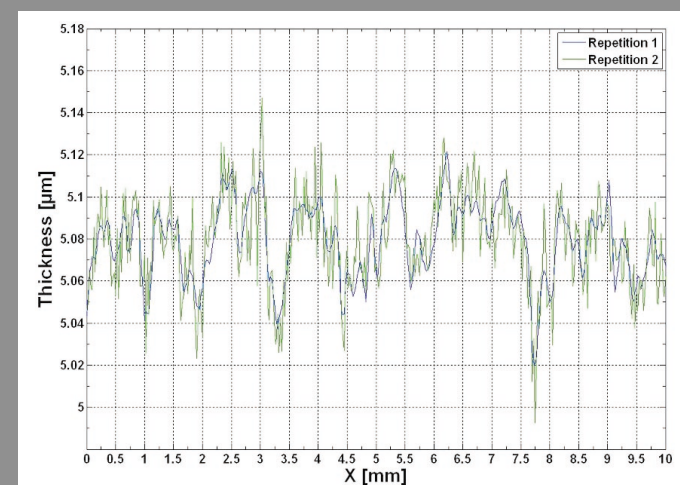
Measurement of barrier layers – use in cast-film or blown-film lines

Food packaging films contain so-called barrier layers to prevent premature spoilage of the packaged foods. These barrier layers consist for example of EVO which is an extremely expensive material. In the manufacturing process a certain minimum thickness stipulated for these barrier layers must be observed under all circumstances. So far application of excessive material should be avoided in order to keep costs under control.

Since a barrier layer is usually an intermediate layer, evaluation of its thickness will constitute a challenge for many measuring systems.

The **StraDex** sensor permits measurement of the layer of interest through several other layers because the barrier layer usually differs from the adjacent layers in its chemical and hence also in its physical properties. So, both PE-EVOH-PE and PA-EVOH-PA have a readily measurable layer structure.

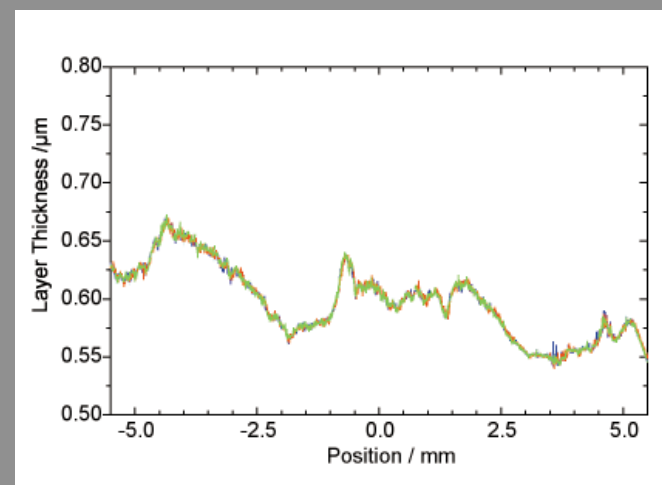
In a cast-film line the **StraDex** is mounted on a linear traversing system and thus permits measurement over the entire web width of the film. On use in a blown-film line the sensor is mounted on an annular traverse for measurement through a full 360° circle.



Measurement of a thin layer with the StraDex f2-80 and a traversing unit

A layer thickness profile of a ca. 5- μm adhesive film was recorded 2x over a given path.

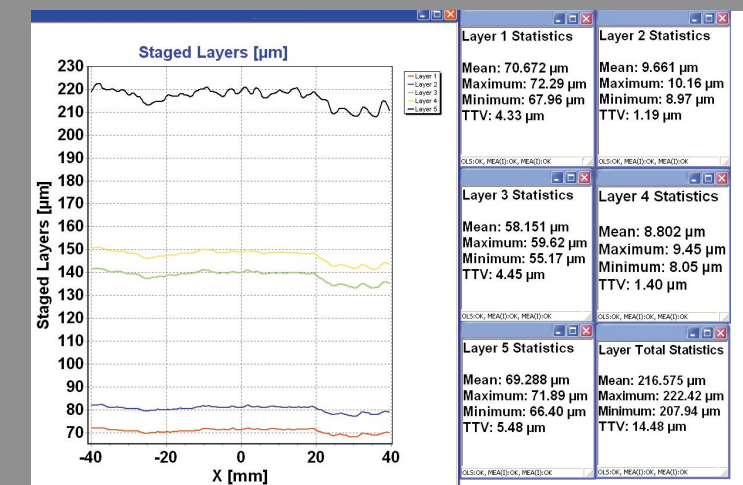
The mean deviation was only 0.1 μm , thus underscoring the repeatability of the overall system.



Thickness measurement of a 0.6 μm NeoCryl(R) coating on a PET cast film. Five repetitions along a 10 mm line scan illustrate a repeatability of 2 nm.



StraDex f2 - 300 sensor on an annular traverse for film production on a blown-film line.



Measurement of a multilayer film with StraDex f2 - 30 sensor. Layer 4 is a 9 μm thin barrier layer.

Nominal layer thicknesses = 70 μm (Layer 1), 10 μm (Layer 2), 58 μm (Layer 3), 9 μm (Layer 4), 70 μm (Layer 5), **215 μm (Total)**



Systems and potential of ISIS technology in the field of films/layers

ISIS sentronics supplies sensors for in-line applications and stand-alone systems for off-line monitoring or pertinent development work. **StraDex** sensors can readily be retrofitted into existing plant both because they are very robust and because their autofocus feature allows a tolerance of several mm when they are installed in an existing mechanical system. The sensors can also be optionally fitted with air or water cooling if the ambient temperature exceeds 70°C.

The **StraDex** sensor is available in different configurations. There are configurations with three different wavelengths:

- 400 - 750 nm (model 60) for the detection of ultra thin films (down to 300 nm)
- 830 nm (model 80) for recognition of single layers down to 5 µm
- 1300 nm (model 300) for the reliable acquisition of layers with total thickness up to 300 µm and also capable for opaque layers

The standard sensors **StraDex f2 - 300** are well suited for thick and scattering layers up to 300 µm, while the sensor **StraDex f2 - 80** is used for thinner layers between 5 and at least 150 µm. Beyond that ultra thin layers/coating down to 0.3 µm can be determined by **StraDex t6 - 60**.

Advantages of StraDex sensors over other non-contact methods:

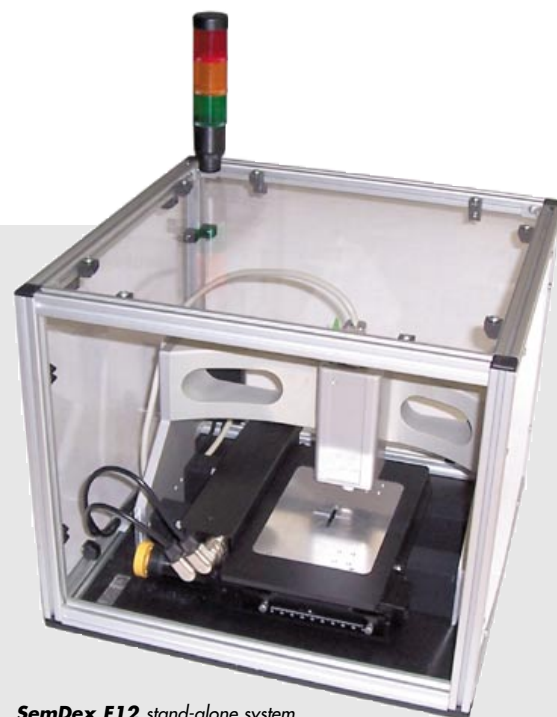
- Extremely high accuracy coupled with pronounced ruggedness (also due to the autofocus feature)
- Reflection mode, meaning that an ABA layer structure is recognised as such, and not as 2xA + B
- Coatings on all kind of opaque substrates can be measured
- No need for a double traversing system, meaning considerable cost savings

ISIS sentronics has also developed an off-line stand-alone system known as the **SemDex F12** for rapid and straight-forward measurement of films measuring up to 100 mm. It incorporates one of the StraDex sensors described here. The StratoSpect software supplied with the instrument permits immediate evaluation of samples. All values can also be exported in different formats.

The operator can load the system with certain measuring protocols for the various samples in a highly intuitive way, i.e. without any special programming skills, thus making the instrument ready to evaluate the relevant samples at the push of a button. Since the same software controls the sensors, no »rethinking« is necessary between in-line and off-line applications.



StraDex t6 sensor head
The control unit is not shown; this may be located at a distance of 20 metres or more.



SemDex F12 stand-alone system.
for off-line measurements (without control unit).
All **StraDex** sensors can be integrated.

Specifications at a glance:

StraDex f-Series sensors for individual thin layers (f2-80) or thick multiple layers (f2-300)

	StraDex f2-80	StraDex f2-300
Measuring wavelength	830 nm	1300 nm
Working distance	2 - 22 mm	
Measuring spot size	8 µm	12 µm
Layer thickness range (glass, film)	5 - 200 µm	12 - 300 µm
Layer thickness range (silicon)	2.5 - 60 µm	7 - 350 µm
Repeatability (silicon, glass)	< 100 nm	
Repeatability (film)	< 300 nm	
Acquisition rate	16 kHz / 4 kHz	4 kHz
Sensor dimensions	61 x 61 x 120 mm ³	

StraDex t-Series-Sensors for very thin layers (down to 0.3 µm)

	StraDex t6 - 60
Measuring wavelength	400 - 750 nm
Working distance (through focusing)	6 - 11 mm
Size of measuring spot	~ 100 µm
Layer thickness range (glass, film)	0.3 - 15 µm
Layer thickness range (silicon)	0.2 - 8 µm
Repeatability	< 1 nm
Acquisition rate	4 kHz
Sensor dimensions	61 x 61 x 120 mm ³

SemDex F12 - Stand alone system for off-line measurements

Sensor	StraDex f2 - 300, f2 - 80, t6 - 60
Layer thickness range (glass, film)	0.3 - 300 µm (depending upon sensor)
2D traversing range	100 x 100 mm ²
Lateral positioning	2 µm
Max. movement speed	30 mm/s
Max. acquisition rate	4 kHz
Dimensions	410 x 410 x 310 mm ³

