TECHNOLOGY

GSM

Optical monitoring for high precision thin film deposition

OPTICAL MONITORING TECHNOLOGIES

ENABLING OUR NEW WORLD!

- ACHIEVING MORE DEMANDING THIN FILM SPECIFICATIONS
- DRIVING DOWN UNIT COSTS

From the high reflectivity DBR mirrors required for maximizing light output in High Brightness LEDs (HBLEDs) to biometric sensing and the new capabilities for our next generation smart phones, our world relies on the cost effective deposition of optical interference coatings. The trend to ever more demanding levels of optical performance / repeatability from component to component combined with ever lower unit costs to satisfy manufacturing targets for mass market applications only looks set to continue. Within our next generation mobile networks and power devices too, thin film processes increasingly call for deposition of custom dielectrics or metal stacks at accuracies which traditional control techniques can't achieve.

Advanced Process Control Technologies (APC) like Evatec's GSM Optical Monitoring System are designed to do just that – improving precision in the deposition process for new levels of repeatability and production yield for the most demanding optical interference coatings.

OPTOELECTRONICS

- Ultrathin metal layers
- DBR reflector layers

PHOTONICS

- Multi bandpass filters, mirrors, laser coatings
- Photopic & bandpass filters

WIRELESS

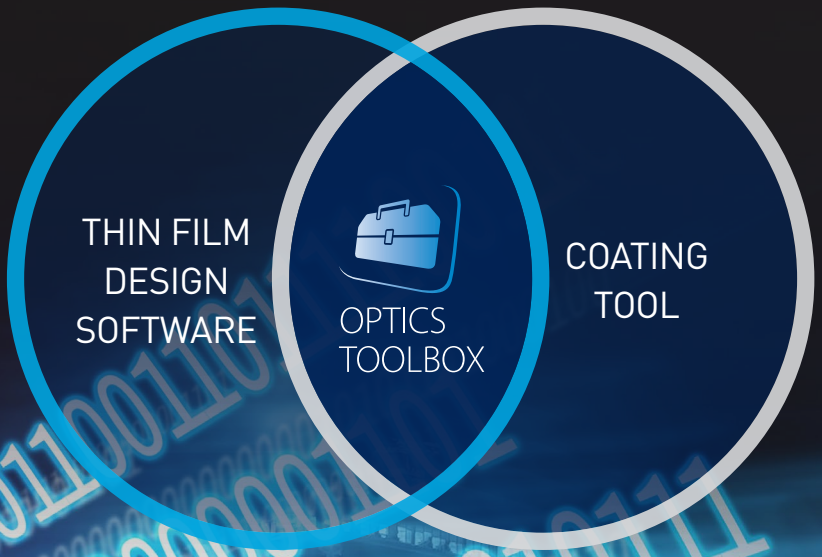
- Temperature Compensated Surface Acoustic Wave (TC SAW) filter

THE GSM1102
MAKING YOUR LIFE EASIER

- SPEEDING UP YOUR PROCESS DEVELOPMENT
- ENABLING TIGHTER MANUFACTURING TOLERANCES
- RAISING MANUFACTURING YIELDS
- LOWERING UNIT COSTS IN MASS PRODUCTION

Evatec's GSM 1102 Broadband Optical Monitoring System in combination with the Evatec's **Optics Toolbox** delivers accelerated process development and production capability for thin film monitoring in the UV, VIS or IR spectral ranges. Starting with industry standard thin film design software, **Optics Toolbox** integrates all the steps required generating a complete recipe with monitoring strategy for each layer and even uploading it to your coating tool ready for execution.

After a coating run, **Optics Toolbox** supports you to efficiently analyze the monitoring data of the deposition process - layer by layer.



THE GSM VERSATILITY COMES AS STANDARD

The GSM 1102 comes ready prepared for a wide range of coating tools and measurement modes, measuring on test glasses or direct on the substrate using a choice of monitoring algorithms.
Additional built in flexibility gives you the power to select quartz, optical monitoring or power / time as your termination method on a layer by layer basis.

Now with in-situ reoptimization

Advanced techniques like in-situ reoptimization offer automatic recipe tuning mid process to guarantee reproducibility and yield for even the most complex optical designs.

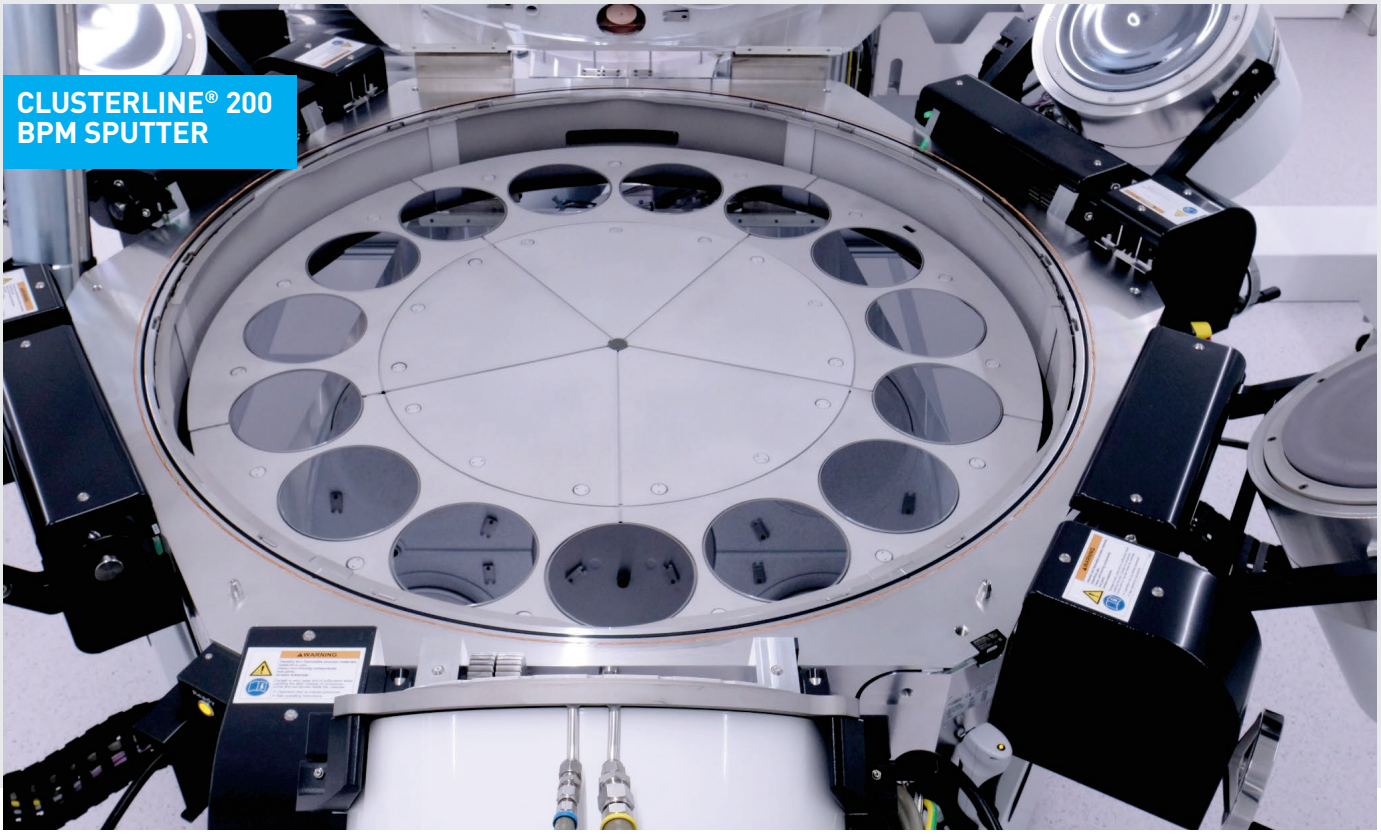
A CHOICE OF FIVE COATING TOOLS

BAK EVAPORATORS

CLUSTERLINE® 200 PECVD

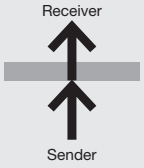
MSP SPUTTER SYSTEM

SOLARIS® INLINE SPUTTER



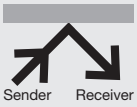
CLUSTERLINE® 200 BPM SPUTTER

A CHOICE OF MEASUREMENT MODES



TRANSMISSION

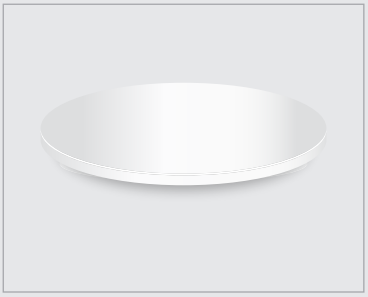
- Available on the BAK and CLUSTERLINE® 200



REFLECTION

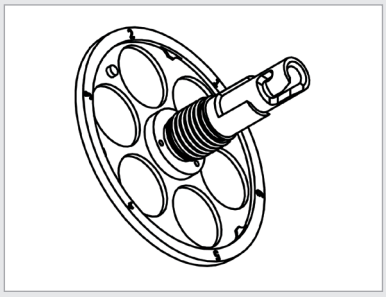
- Available on BAK, MSP, SOLARIS® and CLUSTERLINE® 200

A CHOICE OF DIRECT OR INDIRECT MONITORING



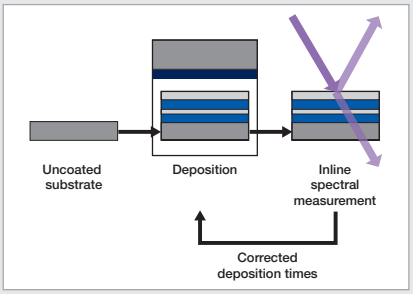
DIRECT MONITORING

- For BAK, MSP and CLUSTERLINE® 200
- Real time during deposition



TEST GLASS MONITORING

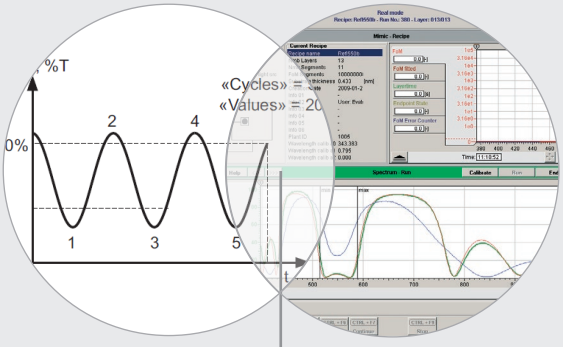
- Available for BAK
- GTC 621 with 6 glasses
- GTC 1100 with 140 heated glasses



CLOSED LOOP CONTROL

- Available for SOLARIS® and CLUSTERLINE® 200 PECVD
- Inline analysis and correction of deposited thicknesses

A CHOICE OF MONITORING ALGORITHMS



MONOCHROMATIC

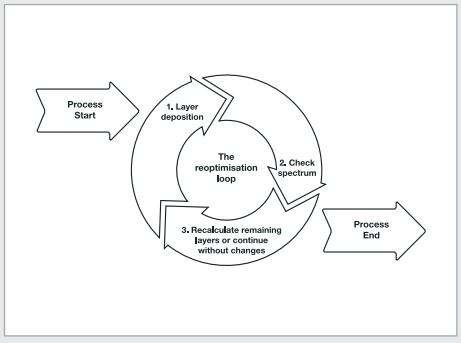
- Select single wavelength according to process / layer
- Compatible with existing, production proven processes

BROADBAND

- Spectrometer measures performance over spectral range
- Built-in compensation for variation in rate or refractive index

HYBRID MODE

- Select between monochromatic and broadband for each layer individually for most accurate and reproducible layer termination

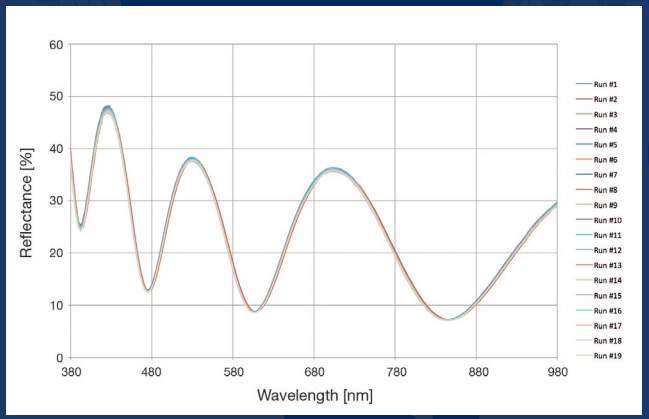


IN-SITU REOPTIMIZATION

- Real time adjustment mid process for enhanced yields
- Recover from unforeseen events e.g. power outage
- Reduce new process development times

OPTICAL MONITORING
PUTTING YOU AT THE FRONT OF THE PACK

Here are just a few examples of how Evatec platforms and deposition processes using optical monitoring can cut your production cost and keep you at the front of the pack. For more information about Evatec's Optics Toolbox, Optical Monitoring and how techniques like in-situ reoptimization can help you with fast track development of new processes or increase your coating yields take a look at the typical case studies on the next pages or contact your local Evatec sales and service representative.



SIO_2 LAYER

TYPICAL APPLICATION:

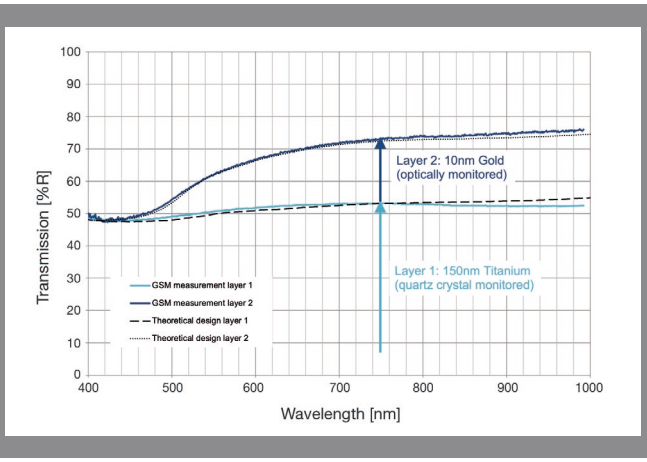
- TC-SAW for Wireless Applications

MEASUREMENT MODE:

- Direct on monitor substrate in reflection

KEY DRIVERS

- Critical accuracy of layer thickness and run to run reproducibility
- Reduction in production costs



THIN METAL LAYERS

TYPICAL APPLICATION:

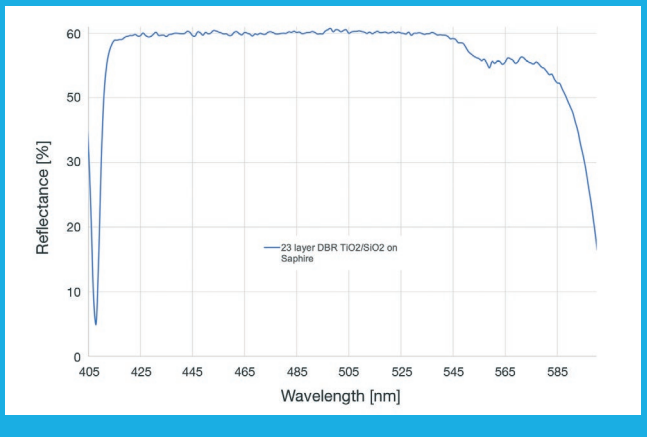
- Semiconductor & Optoelectronics

MEASUREMENT MODE:

- Reflection on test glass

KEY DRIVERS

- Significant change in reflection spectrum with small thickness variation of gold layer provides excellent production control
- Enhanced final device performance



DBR DIELECTRIC BROADBAND MIRROR

TYPICAL APPLICATION:

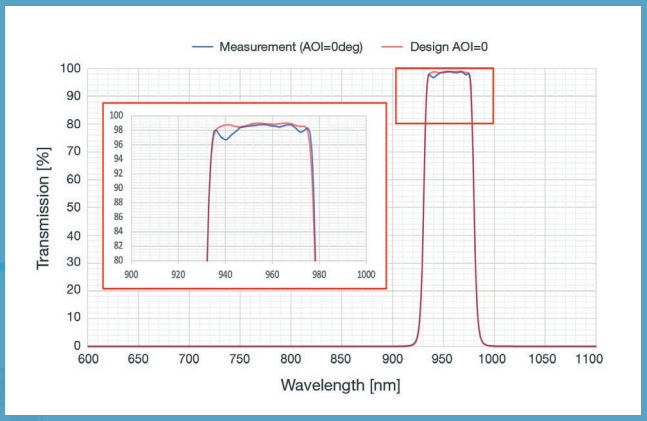
- HBLEDs

MEASUREMENT MODE:

- Reflection on test glass

KEY DRIVERS

- Run to run reproducibility
- Maximum reflection for enhanced device performance



NIR BANDPASS FILTER

TYPICAL APPLICATION:

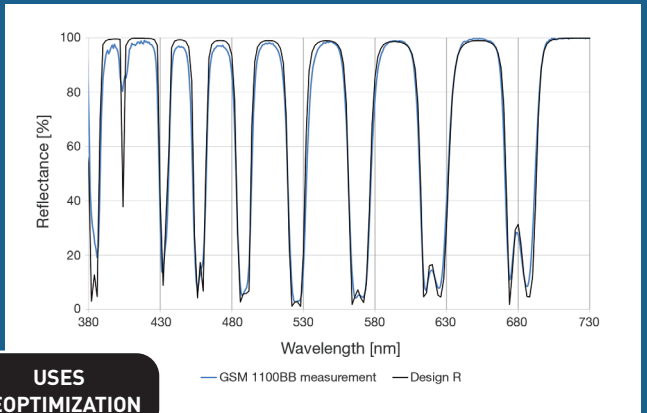
- Consumer electronics

MEASUREMENT MODE:

- Direct on monitor substrate in reflection

KEY DRIVERS

- Excellent run to run repeatability
- Enanced yields and throughput for reduced unit costs in mass production



USES REOPTIMIZATION

MULTI BANDPASS FILTER

TYPICAL APPLICATION:

- Consumer electronics

MEASUREMENT MODE:

- Direct on monitor substrate in reflection

KEY DRIVERS

- Shortened process development times for complex designs
- Yield management in production

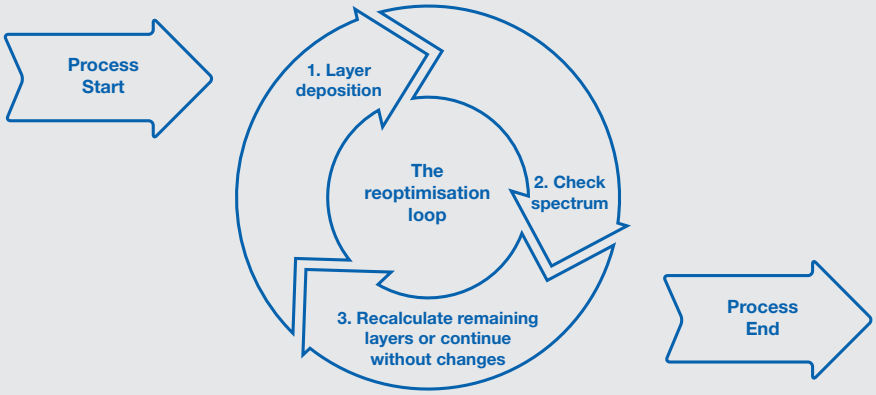
IN-SITU REOPTIMIZATION

- Maximizes yields for complex filter designs
- Batch recovery after unforeseen events
- Fully automated process according to user defined guidelines

THE PRINCIPLE

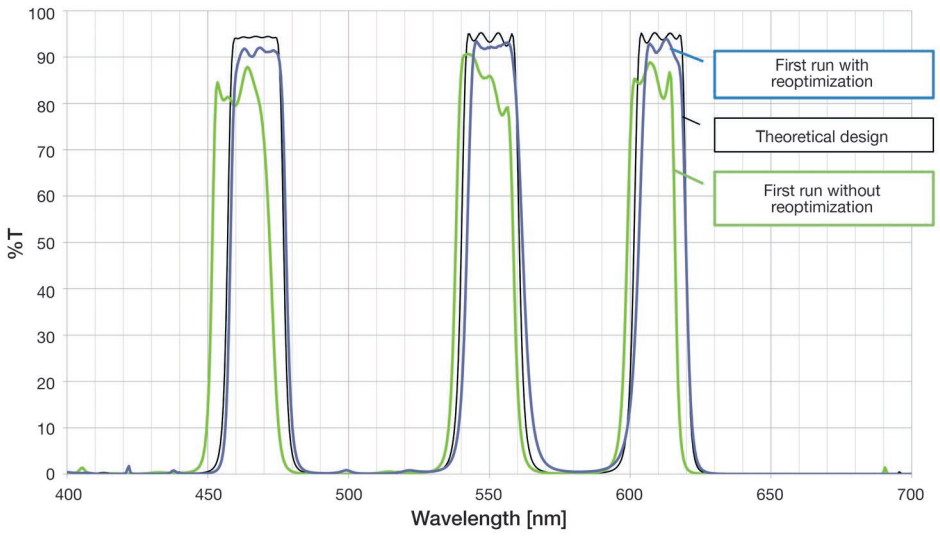
State-of-the-art deposition techniques like PIAD and magnetron sputtering allow for tight control of refractive indices and coating rate. Combined with optical monitoring for layer termination this enables reliable production of optical interference filters for a wide range of applications. However, the drive to ever higher specifications requires eliminating even small variations in deposition conditions which can then lead to significant yield improvements and cost reductions.

In-situ reoptimization uses broadband optical monitoring not just during the actual coating process but also after the deposition of each layer to ensure the final stack performance is as close as possible to the original theoretical design. The actual reflection or transmission spectrum measured after termination of a layer is compared with the theoretical performance. In the case of significant deviation, the remaining coating recipe is adjusted by recalculating the layer thicknesses and target spectra for the remaining layers to keep the coating process on track. The “reoptimization” process is repeated after deposition of each layer automatically until the whole stack is complete without any extension to the process time.



THE RESULTS

A triple bandpass filter

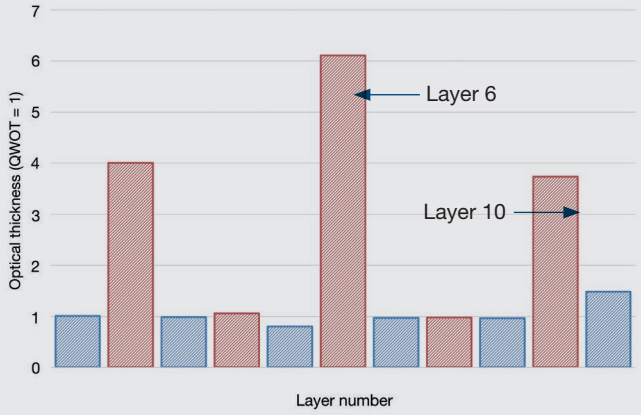


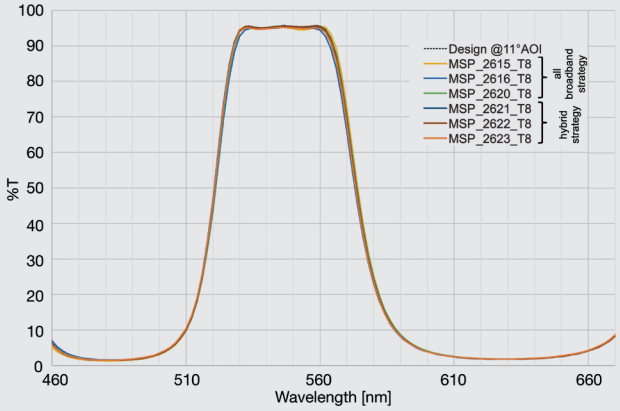
In-situ reoptimization enables the rapid development of complex coatings like multi bandpass filters. Small deviations in the deposited layers are detected and corrected during the coating process without any user intervention.

Case Study: Hybrid Mode Monitoring – The best of two worlds

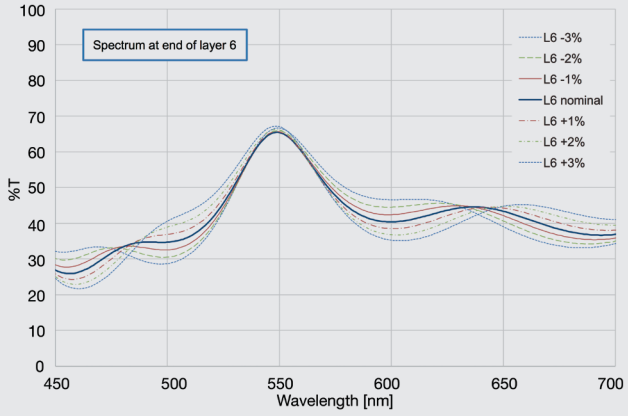
Is layer termination by broadband monitoring more accurate than using a monochromatic algorithm? Or is the opposite true? This case study illustrates that the combination of both methods leads to the best result.

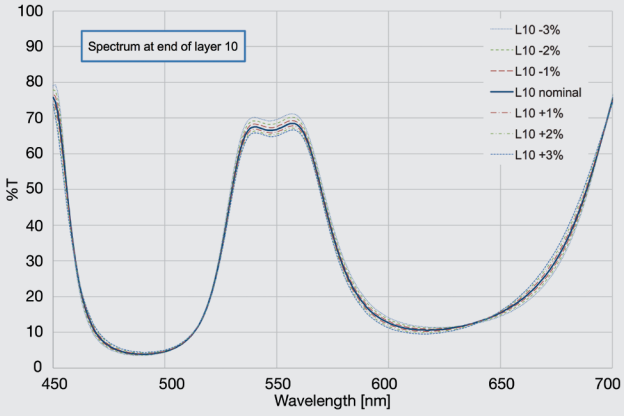
The example bandpass filter consists of 11 layers with the three spacer layers 2, 6, and 10.

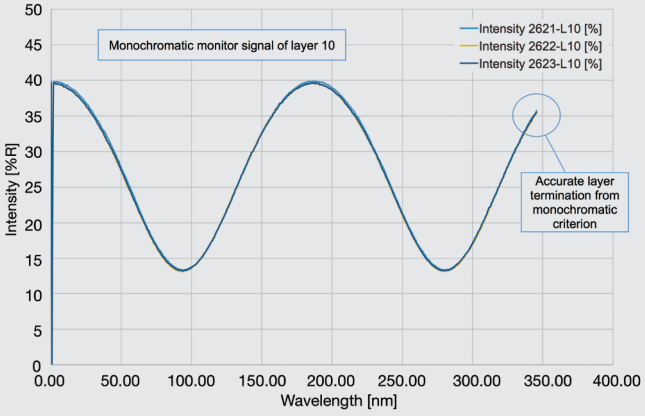




The spectra at the end of layer 6 with the thickness varied by ±3% shows a big change all over the spectral range. Here broadband monitoring will do an excellent job. On the other hand, the spectra at the end of layer 10 only show a small change in the range 450…700nm. However, the monochromatic signal at 550nm over the layer thickness is suitable for accurate layer termination.



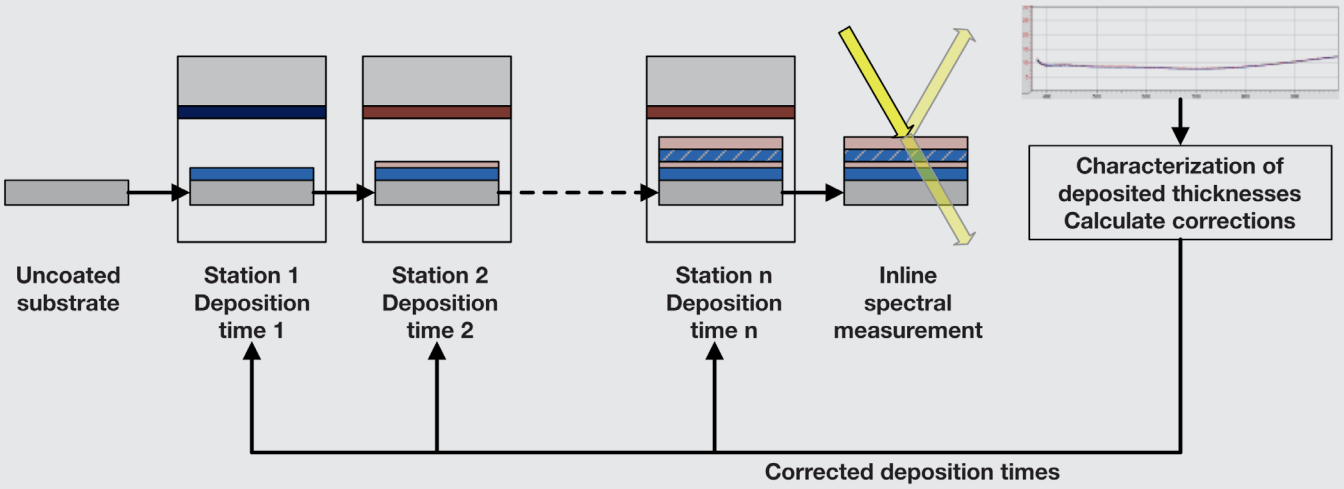




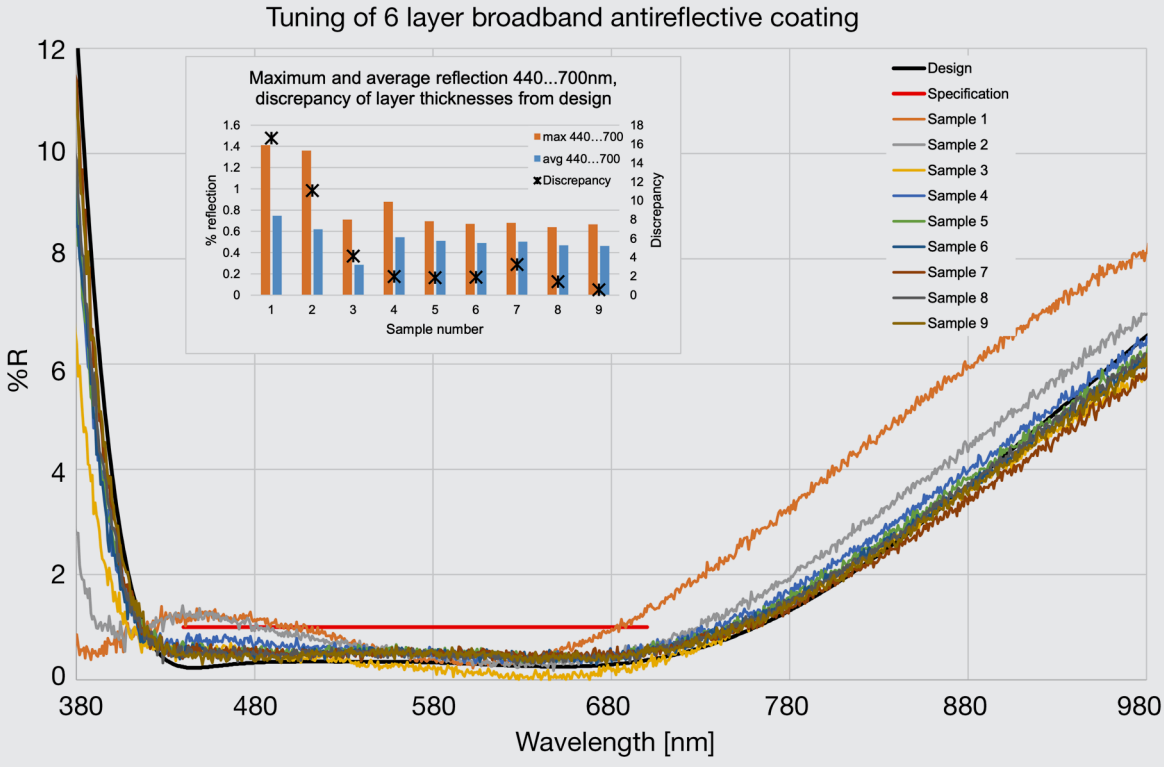
Reverse engineering of the deposited thicknesses from 3 purely broadband and 3 hybrid strategies revealed highly reproducible results for layer 6 (broadband), whereas layer 10 showed a variation of ±1% for the broadband layer termination and less than ±0.1% for the monochromatic termination.

Case Study: Closed Loop Thickness Control

In the inline deposition tools SOLARIS®, the GSM is used to measure the reflected spectra after deposition of all layers. These spectra are analyzed with the help of the OptiReOpt library, resulting in sets of characterized layer thicknesses. The SOLARIS® process control then uses these thicknesses to adjust the deposition times and therefore to correct the layer thicknesses of the subsequent coatings.



This technology was applied to the continuous production of a 6-layer Nb_2O_5/SiO_2 broadband antireflective coating. The first two samples at production start-up did not fulfill the reflection specification but the third sample was already within specification and all the further samples remained well within the allowed tolerance.

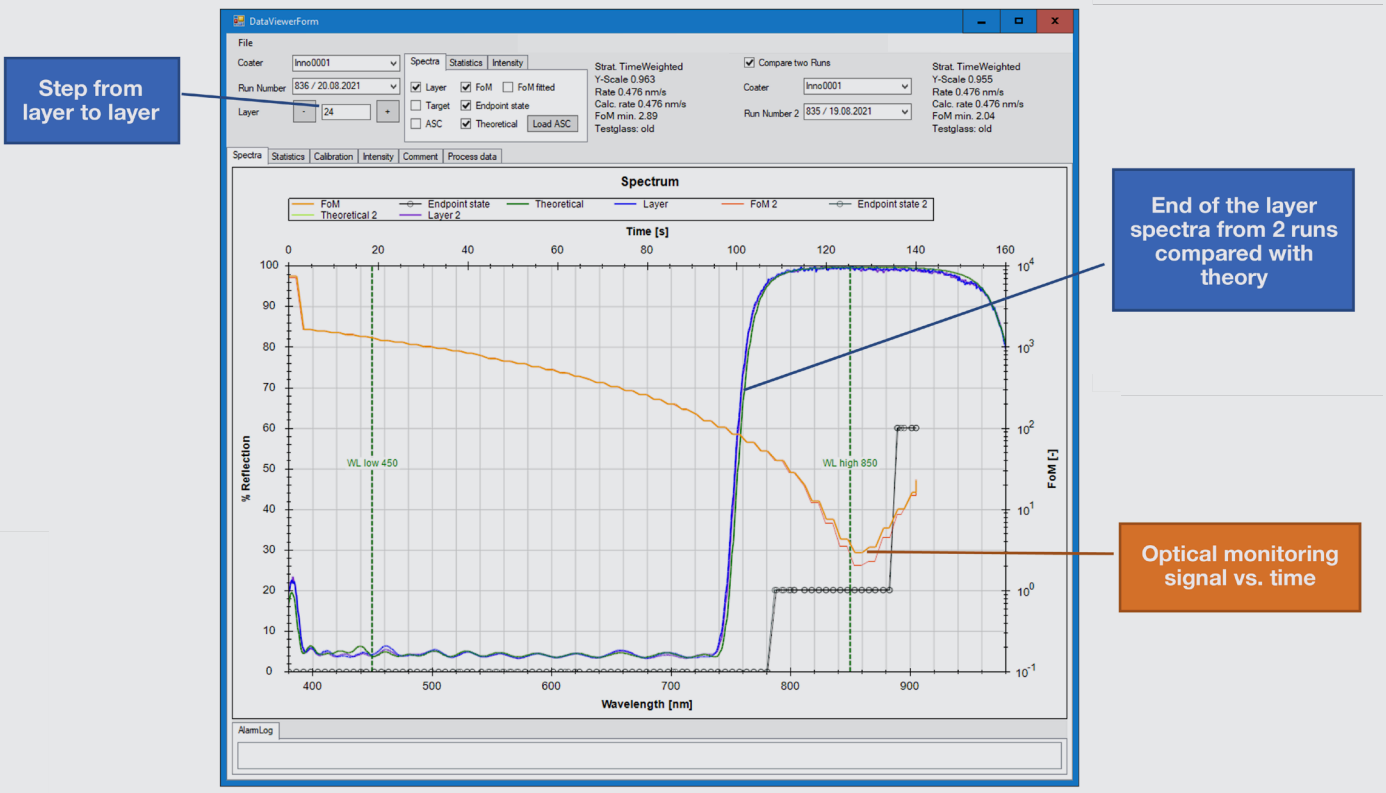


The closed-loop control here ensures a rapid tune-in at production start as well as the effective control of long-term drifts.

Case Study: Analyze your coating with the DataViewer

OPTICS TOOLBOX

Finished your coating and can't wait to see the coating result? While waiting for the result of the ex-situ spectral measurement, you can already analyze the optical monitoring data in the "DataViewer".



As a part of the optics tool box, "DataViewer" allows you to walk through the end-spectra and the optical monitoring signal layer by layer. Also, the most important characteristic data and information on the chosen monitoring strategy are right at hand. The data of a second coating run can be displayed for direct comparison against two other coating runs.

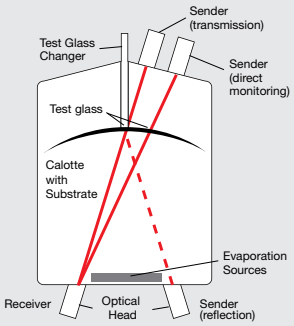
Such an efficient analysis is especially useful when developing a new coating process and monitoring strategy.

With this tool at your side you already know a lot about the outcome of your coating even before you get the result back from the measurement lab.

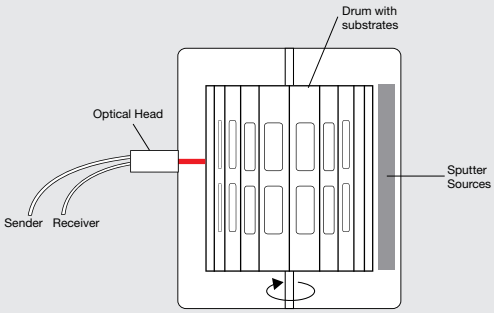
GSM OPTICAL MONITORING

Typical coating tool layout

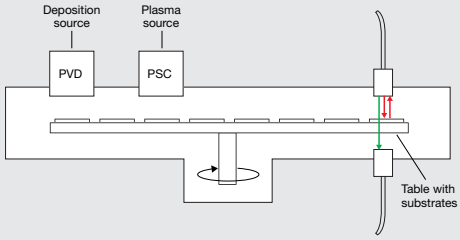
BAK Evaporator



MSP Sputter Tool



CLUSTERLINE® 200 Cluster Tool



System Data	
Light Sources	2 Quartz-Tungsten Halogen lamps, Plug & Play, 6000hrs life, control of optional external light source
Detectors	Temperature stabilized, CCD array, 1024 pixels
Wavelength Range	Standard: 380nm to 980nm Custom: According to customer specification
Measurement Modes	Reflection, transmission on test glass or directly on substrates
GTC 621 test glass changer	6 measurement positions, transmission or reflection
GTC 1100 test glass changer	140 heated test glasses, mixed measurement, transmission or reflection
Monitoring algorithms	Monochromatic, Broadband, Hybrid (mixed) mode, in-situ reoptimization
Communication interfaces	Profinet, HSMS (Ethernet)
Synchronization	Electronics for accurate synchronization of measurement to table / drum rotation

ABOUT EVATEC

Evatec offers complete solutions for thin film deposition and etch in the Advanced Packaging, Power Devices, MEMS, Wireless Communication, Optoelectronics and Photonics markets.

Our technology portfolio includes a range of advanced sputter technologies, plasma deposition & etch as well as standard and enhanced evaporation.

Our team is ready to offer process advice, sampling services and custom engineering to meet our customers individual needs in platforms from R&D to prototyping and true mass production.

We provide sales and service through our global network of local offices. For more information visit us at **www.evatecnet.com** or contact our head office.

evatec process systems

Evatec AG
Hauptstrasse 1a
CH-9477 Trübbach
Switzerland

Tel: + 41 81 403 80 00
Fax: + 41 81 403 80 01
info@evatecnet.com
www.evatecnet.com

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