Optical monitoring

now with even “broader shoulders”

Evatec’s GSM “broadband optical monitoring” system has been supporting customers with increased precision and repeatability in optical thin film deposition for over a decade. Evatec’s Principal Scientist, **Dr. Stephan Waldner**, introduces the latest tool with extended wavelength range for direct measurement up to 1700 nm. From laser bars to bandpass filters, the broad shoulders of the new generation GSM make it an ideal choice for applications demanding the highest level of precision in the near infrared.

The new GSM 1102 – the same flexibility with more capability than ever

Just like its predecessor, the new GSM with NIR extension is designed to work in transmission or reflection measurement modes on Evatec’s range of sputter and evaporation platforms, but the addition of a second spectrometer with InGaAs detector and light-splitting hardware in combination with new firm- and hardware for data acquisition and processing enables seamless direct measurement all the way from 380nm up to 1700nm. Just like previously, customers can work in broadband, monochromatic or hybrid modes and make use of in-situ reoptimization for “on-the-fly” tuning in production (Figure 1).

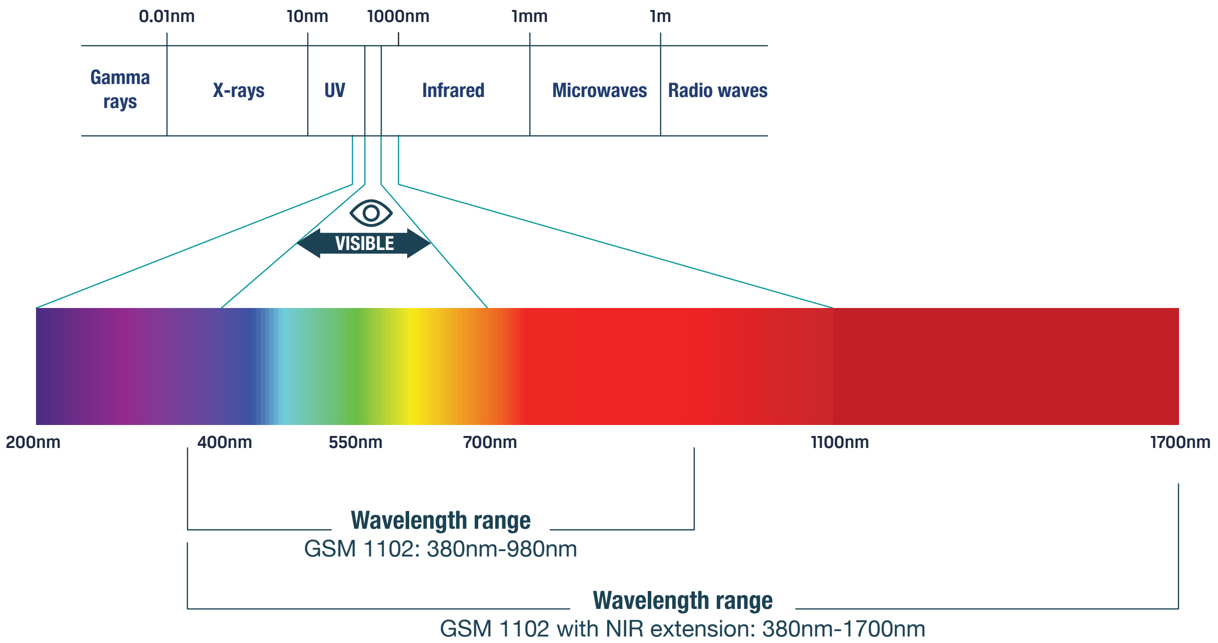


Figure 1: Comparison of the wavelength ranges of the GSM 1102 without (380 – 980nm) and with the NIR extension (380 – 1700nm).

Applicable Coating Tools	Measurement Modes	Monitoring Algorithm	Monitor Substrate
• BAK evaporation	• Transmittance	• Broadband monitoring	• Direct monitoring on substrate
• CLUSTERLINE® 200 BPM	• Reflectance	• Monochromatic monitoring	• GTC1100 test glass changer on BAK
• CLUSTERLINE® 200 PECVD		• Hybrid mode (broadband/mono)	• GTC621 test glass changer on BAK
• SOLARIS®		• In-process reoptimization	

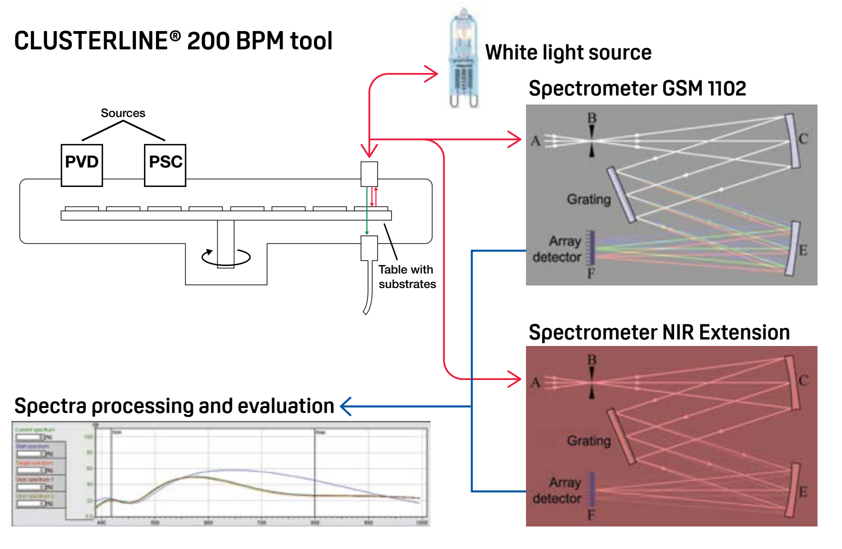


Figure 2: Schematic of the GSM 1102 with NIR extension integrated on a CLUSTERLINE® 200 BPM tool.

> **“The NIR extension is also available for retrofit on an existing GSM 1102”**

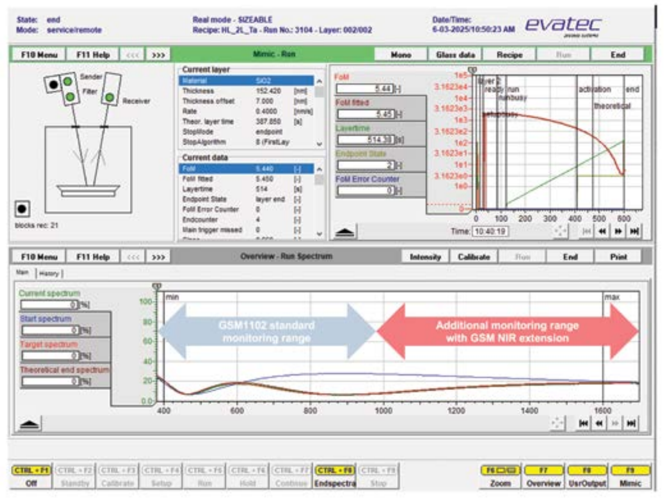
Case studies

Here we present some typical results for sputter deposition processes carried out on Evatec's CLUSTERLINE® 200 equipped with batch process module (Figure 2). The GSM was working in broadband mode measuring directly on the substrate in reflection at each rotation of the turntable every few seconds.

The screenshot in Figure 3 during a test run of a simple 2 layer process for Ta_2O_5 then SiO_2 on a quartz glass substrate illustrates what users see on the Graphical User Interface (GUI) during deposition.

Whilst in this case the defined monitoring range was 420nm to 1640nm, the full reflection spectrum was measured over the entire 380nm to 1700nm at every table rotation (3s).

The lower part of Figure 3 shows the noise-free, continuous spectrum measured over the full wavelength range (current spectrum, green) in excellent agreement with the simulated spectrum (theoretical end spectrum, brown). The Figure of Merit (FoM) curve over time in the upper right is perfectly smooth, indicating the stability of the reflection measurement.



State: end
Mode: service/remote
Real mode - SIZEABLE
Recipe: HL_2L_Ta - Run No.: 3104 - Layer: 002/002
Date/Time: 6-03-2025/10:50:23 AM

Current layer

Material	SiO2	
Thickness	152.420	[nm]
Thickness offset	7.000	[nm]
Rate	0.4000	[nm/s]
Theor. layer time	387.850	[s]
StopMode	endpoint	
StopAlgorithm	8 (FirstLay	

Current data

FoM	5.440	[-]
FoM fitted	5.450	[-]
Layertime	514	[s]
Endpoint State	layer end	[-]
FoM Error Counter	0	[-]
Endcounter	4	[-]
Main trigger missed	0	[-]

FoM: 5.44 [-]
FoM fitted: 5.45 [-]
Layertime: 514.33 [s]
Endpoint State: 2 [-]
FoM Error Counter: 0 [-]

Current spectrum: 0 [%]
Start spectrum: 0 [%]
Target spectrum: 0 [%]
Theoretical end spectrum: 0 [%]

Figure 3: Screenshot of the GSM user interface during a deposition process.

Results

Three typical coating designs for the NIR range were chosen: A broader as well as a very narrow bandpass filter, and an antireflective coating were deposited on a CLUSTERLINE® 200 BPM tool equipped with GSM 1102 and NIR extension using Ta_2O_5 and SiO_2 as coating materials and evaluated afterwards using spectrophotometry.

1. Design 1: 33-layer Bandpass filter at 1310nm with 40nm bandwidth

The transmittance measurements of two coating runs show an excellent reproducibility as well as agreement with the theoretical design spectrum.

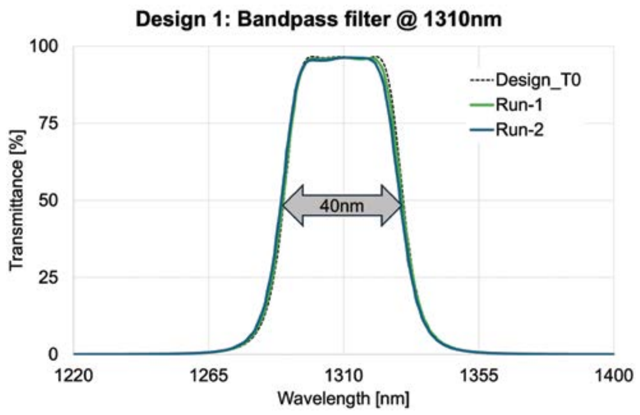


Figure 4: Transmission spectra of two coating runs of the bandpass filter measured ex-situ in a spectrophotometer. Thanks to the direct monitoring with the NIR extension, an excellent agreement with the theoretical design is achieved.

2. Design 2: 27 layer bandpass filter at 1530nm with 3nm bandwidth

The high resolution and low noise level of the spectrometers in the GSM 1102 and the NIR extension allow accurate monitoring of even very narrow bandpass filters. Note that 3nm bandwidth corresponds to as little as 0.2% of the center wavelength 1530nm.

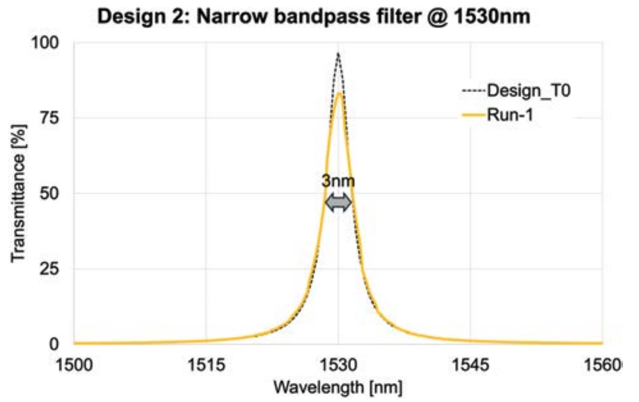


Figure 5: Transmission spectrum of a coating run of the narrow bandpass filter measured ex-situ in a spectrophotometer.

3. Design 3:
4-layer AR design at 1550nm

Still, the most widely used optical coating designs are antireflective coatings. The 4-layer AR coating deposited on both sides of a quartz substrate leads reliably to transmissions >99.95% at 1550nm.

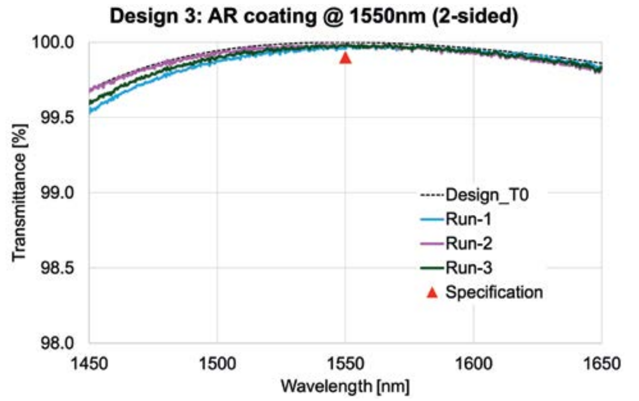


Figure 6: Transmission spectra of three substrates with an anti-reflective coating applied on both sides. Transmission >99.95% at 1550nm was achieved reproducibly.

Why not upgrade your capabilities now? The new GSM extension is available not only on new tools but also as part of a retrofit package for existing GSM 1102 users. If you would like to know more, simply contact your local Evatec sales and service organization.