UV, Visible and IR Optical Monitoring Systems for Successful Deposition of Complex Multilayer Optical Thin Films

EssentOptics develops and manufactures optical monitoring systems for installation in the vacuum coaters. The systems are successfully used for the *in-situ* control of the vacuum deposition processes where high process reproducibility and precise optical parameters are critical. The systems incorporate originally designed EOS spectrometers and M250 monochromators and are developed by our specialists having broad experience and extensive knowledge in the fields of thin film design, optical coating and development of the process control systems.

The developed systems are classified into two groups on the measuring method:

- AKRA series with monochromators
- IRIS series with spectrometers

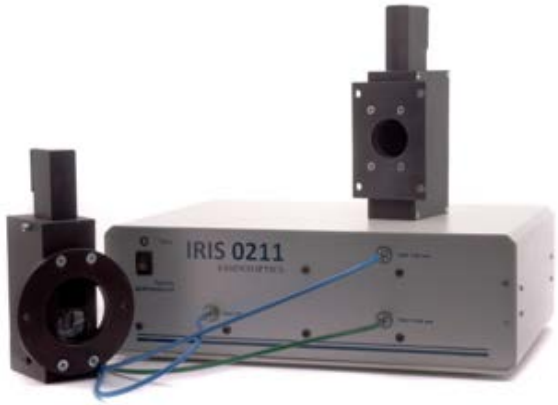
AKRA Single Wavelength Optical Monitoring Systems

AKRA Single Wavelength Optical Monitoring Systems are designed for single wavelength monitoring of the deposition processes of all major types of coatings in the spectral range from 200 to 5000 nm.

The final spectral control range can be chosen in accordance to the actual customer needs and applications. Additionally, the user can easily scan the entire measured spectrum after the deposition of each layer and compare the obtained spectrum with calculated one. Another important feature of the AKRA systems is the field-proven possibility to control the deposition process of the complex coatings in the infrared range - direct control in the range of 1,5-5,0 microns and using the second-order control - up to 14 microns.

IRIS Broadband Optical Monitoring Systems

IRIS Broadband Optical Monitoring Systems offer unmatched monitoring speed and are designed for the real-time full-spectrum control of the deposition of any coatings in the range from 190 nm to 2450 nm, depending on the chosen system configuration.



The use of the in-house designed EOS spectrometer allows to display the entire spectrum of growing layer on the system's control screen at any time. This opens new possibilities to high-yield production of the complex optical coatings – band-pass filters, cut-off filters, dichroic filters etc., including those in which required optical characteristics shall be obtained at specific wavelengths or within several spectral intervals. An important feature of the IRIS systems is a "from-process-to-process" high reproducibility of the optical parameters, as well as substantial cost reduction for R&D and small-volume production of sophisticated coatings.

Software Capabilities

The new software package meets the latest customers' requirements – now the system can be operated not only by thin film experts, but also by operators with initial knowledge of the deposition process. Also, the main process window has been designed to display the real-time monitoring with comfortable and friendly interface. In addition, EssentOptics specialists provide field training on system design, application

and service, as well as they share their best practical knowledge with our customers.

The software package includes the following main features:

1. Screen zooming of the photometric function (Oy) and spectral range (Ox)
2. Possibility to display up to 5 optical spectra on the process screen
3. Selection of the spectra color (up to 10 colors) for more distinctive and comfortable use
4. Layer-by-layer uploading of the calculated spectra and their comparison with the deposited spectra for correction and fine-tuning of the deposition process
5. Choice of the optimal measurement time, averaging criteria, as well as the level of sensitivity of the detector
6. Process report save and print-out function contains graphs, tabular values, time and date of the report, coating name, including necessary comments to any coating or completed process run
7. Process spectra can be saved as a graphic and/or text file for easy data and process analysis
8. Vast database of optical glasses is pre-loaded for calibration of control systems.
9. End-point detection capability
10. Real time re-calibration and direct broadband monitoring for production of multi-layer sophisticated coatings (for substrates placed on calotte)

Advantages of the IRIS and AKRA Optical Monitoring Systems

The installation of the optical monitoring system usually does not require any specific modifications to the vacuum coaters – we supply a complete set of connection flanges, fiber optic cables, and light modules. Both AKRA and IRIS systems are designed to fit into most of currently operated and newly build vacuum plants.

The IRIS and AKRA optical monitoring systems represent an affordable, reliable and convenient solution addressing the challenges of obtaining a high-quality optical coatings. The proposed systems offer the following important advantages and benefits:

For your company:

- Significant reduction in material costs and time for testing of new deposition processes and coatings
- New opportunities to develop more sophisticated coatings due to newly added extensive capabilities of the vacuum deposition equipment
- Proven successful application of the optical monitoring systems since 2004
- Fast system commissioning and customer training (just 2-3 days), short delivery period
- Two years warranty from the date of commissioning. Full service support and customer supervision, including system upgrade and modification based on Customer's new market activities.

For your coatings experts:

- Real-time visual monitoring of the deposition process
- Increased accuracy and stability of measurements using modulation of a light source
- Real-time process correction using layer-by-layer process supervision without venting of the vacuum chamber
- Easy and convenient system service, long trouble-free service life
- Usability tested interface with adjustable screen design allows the operator to receive accurate and relevant information at any time
- Save and storage of the thin film and process data for subsequent analysis and reproduction of the successful runs

For your customers:

- New opened possibilities to deposit coatings with the most complex spectral characteristics
- Substantial reduction of the defected coatings and runs, higher process yield

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IRIS Broadband Optical Monitoring Systems (with EOS spectrometer). Technical Specifications.

Parameter	IRIS 0204	IRIS 0207	IRIS 0211	IRIS 0407	IRIS 0411	IRIS 1017	IRIS 1017ex	IRIS 0417
Wavelength range, nm	190 - 380	190 - 740	190 - 1100	380 - 740	380 - 1100	950 - 1700	950-2450	380 - 1700
Spectral resolution, nm	0,8	0,8 (190 - 380 nm) 1,6 (380 - 740 nm)	0,8 (190 - 380 nm) 1,6 (380 - 1100 nm)	1,6		3,2	10	1,8 (380 - 1050 nm) 3,6 (950 - 1700 nm)
Reproducibility of wavelength, nm	0,2	0,4				0,8	3,2	0,4 (380 - 1050 nm) 0,8 (950 - 1700 nm)
Accuracy of wavelength setting, nm	0,4	0,8				1,6	6,8	0,8 (380 - 1050 nm) 1,6 (950 - 1700 nm)
Photometric functions	T% / R% *							
Spectrometer	EOS UV	EOS UV-VIS	EOS UV-IR	EOS VIS	EOS VIS-IR	EOS IR	EOS IR	EOS UV-IR / IR
Measuring range: T%	0,01 – 120%							
Light source	Deuterium lamp	Deuterium lamp / Halogen lamp		Halogen lamp				
Measurement accuracy	<0,01 x T **							
Reproducibility of measurement	0,005 x T **,							
Stability of baseline	0,01 x T/hour							
Scattered light level	0,01 x Tmax							
Communication port	USB 2.0							
Full range measurement time, ms	from 10 ms, recommended full range measurement time is 40-80 ms							
Power consumption, Wt	50			30				
Power supply	100-240 VAC, 50/60 Hz							
Net weight, kg	10	12	14	10	12	16	10	

* Measurement of reflection and transmission is possible either with change of the light source or with ordering of the two light source units in the set of supply.

** After 30 min warm-up of the deuterium lamp and 10 min warm up of the halogen lamp.

Other configuration options are always possible based on individual customer requirements.

AKRA Single Wavelength Optical Monitoring Systems (with M250 monochromator). Technical Specifications.

Parameter	AKRA 0211	AKRA 0411	AKRA 0217	AKRA 0417	AKRA 0426	AKRA 1550	AKRA 0450
Wavelength range, nm	200-1100	380-1100	200-1700	380-1700	380-2600	1200 – 5000	380 – 5000
Spectral resolution, nm * Diffraction grating 150 l/mm, slit 200 micron						9,6 (3000 - 5000 nm)	9,6 (3700 - 5000 nm)
Spectral resolution, nm * Diffraction grating 300 l/mm, slit 200 micron			4,8 (1050 - 1700 nm)	4,8 (1050 - 1700 nm)	4,8 (1050 - 2600 nm)	4,8 (1500 - 3000 nm)	4,8 (1000 - 3700 nm)
Spectral resolution, nm * Diffraction grating 600 l/mm, slit 200 micron	2,4	2,4	2,4 (200 - 1050 nm)	2,4 (380 - 1050 nm)	2,4 (380 - 1050 nm)		2,4 (380 - 1000 nm)
Reproducibility of wavelength, nm	0,25				0,5	1,0	0,5 (380 - 1000 nm) 1,0 (1000 - 5000 nm)
Accuracy of wavelength setting, nm	0,5				1,0	2,0	1,0 (380 - 1000 nm) 2,0 (1000 - 5000 nm)
Photometric functions	R%, T% **					T%	
Measuring range: T%	0,01 – 120%						
Light source	Deuterium lamp / Halogen lamp	Halogen lamp	Deuterium lamp / Halogen lamp	Halogen lamp		IR source	Halogen lamp, IR source
Measurement accuracy	<0,01 x T ***						
Reproducibility of measurement	0,005 x T ***					0,01 x T***	0,005 x T (380 - 1700 nm) 0,01 x T (1650 - 5000 nm)*
Stability of baseline	0,01 x T/hour						
Scattered light level	0,005 x Tmax					0,01 x Tmax	0,005 x T (380 - 1700 nm) 0,01 x T (1650 - 5000 nm)*
Receiver	PMT, Si	Si-detector	PMT, Si, IGA	Si, IGA	Si, PbS	PbSe	Si, IGA, PbSe
Communication port	RS-232						
Time of measurement: at single wavelength complete range	from 100 ms 60 – 150 sec	from 100 ms 20 – 30 sec	from 100 ms 60 – 150 sec				from 100 ms 150 – 300 sec
Power consumption, Wt	80	50	80	50			
Power supply	100-240 V, 50/60 Hz						
Net weight, kg	20	16	20	17	17	16	17

* Typical configurations of diffraction grating and slit are shown. Final configuration is subject to Customer's specifications.

** Manual change of the light source

*** After 10 min warm-up of the halogen lamp and 30 min warm-up of deuterium lamp

Other configuration options are always possible based on individual customer requirements.