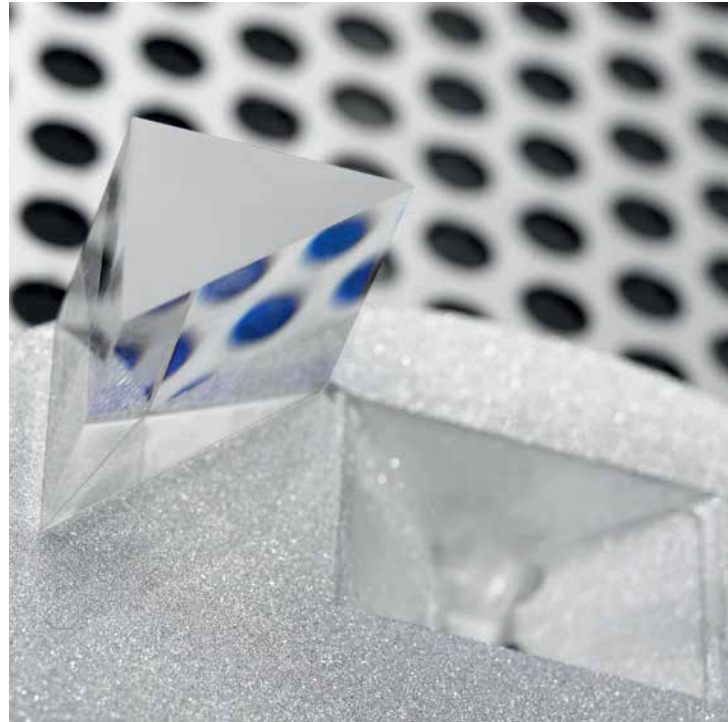


Precision optics.

- Microlithography (EUV, DUV)
- Sensors and filters
- Laser and mirror coatings
- Camera lenses and systems
- Night vision and distance control
- Microscopes and telescopes



A high-angle photograph of an astronaut in a white spacesuit floating in space. The astronaut is positioned in the center-right of the frame, with their body angled towards the viewer. They are wearing a white helmet and a suit with orange and blue accents, including a small American flag patch on the right arm. The astronaut's hands are visible, and they appear to be working on or near a large, dark, grid-like solar panel structure that occupies the bottom half of the image. The background is the deep blue of Earth's atmosphere, with white clouds visible. The top-left corner of the image is dark, suggesting the edge of the spacecraft or the void of space.

Precision optics. Our track record of pioneering achievement is unmatched.

As one of the world leaders in thin-film technology, we develop and manufacture vacuum deposition equipment for a broad range of applications.

A full-page background image showing an astronaut in a white spacesuit floating in space. The astronaut is wearing a helmet with a clear visor and has a large life-support backpack. The Earth's blue oceans and white clouds are visible in the background. In the bottom right corner, there is a close-up view of a solar panel array with a grid of dark blue cells.

Originally, the foundation for the Bühler Leybold Optics company's present-day success was laid by inventors Ernst Leybold and Wilhelm Carl Heraeus 160 years ago. Today, we are a globally active high-tech company, with the business area's headquarters in Alzenau (Germany) and subsidiaries in Cary (USA) and Beijing (China). Worldwide, we employ over 300 employees dedicated solely to thin-film coating applications. A top priority for us is innovation leadership in key areas such as sputtering, PECVD, plasma-assisted evaporation, machine automation and related software, as well as world-class customer service.

Precision optics coatings is Bühler Leybold Optics' classic domain. We are proud that our numerous technological breakthroughs shaped the entire industry through the last decades up to today:

- 1975** First optical monitoring system for layer control
- 1984** First box coater with fully-automatic optical monitoring
- 1992** Introduction of the Advanced Plasma Source APS
- 1998** Introduction of coating systems for production of telecom applications like DWDM filters for 200, 100, 50 GHz
- 2003** Introduction of plasma-assisted magnetron-sputtering (PARMS) process technology in the HELIOS machine
- 2003** Introduction of the NESSY magnetron-sputtering system for EUV applications
- 2004** Introduction of intermittent optical monitoring directly on the calotte
- 2010** Introduction of the LION 300, an RF ion-source for high-quality filters
- 2011** Commercialization of NESSY mass-production system for EUV applications
- 2013** Laser coatings for laser applications
- 2014** Introduction of two sputter machines:
 - DEIMOS for astronomical mirror-coatings
 - STARpro for smallest optical filter production sizes

As the leader in this field, Bühler Leybold Optics invests unparalleled resources in research and development for sputtering, PECVD and evaporation technologies.

Solutions for precision optics.

Customer benefits are our daily business.



As an important step toward expanding the Advanced Materials Business within Bühler with a strategic focus on environmentally friendly and energy-saving technology, Leybold Optics was acquired in May 2012. With this acquisition, Leybold Optics became part of a family-owned conglomerate of specialists and technology partners for plant, equipment and services for manufacturing advanced materials and for processing basic foods. Not only does Bühler now hold the leading market position in the field of aluminum die casting, transforming grain into flour and feeds, and making pasta and chocolate, but also in vacuum thin-film coating.

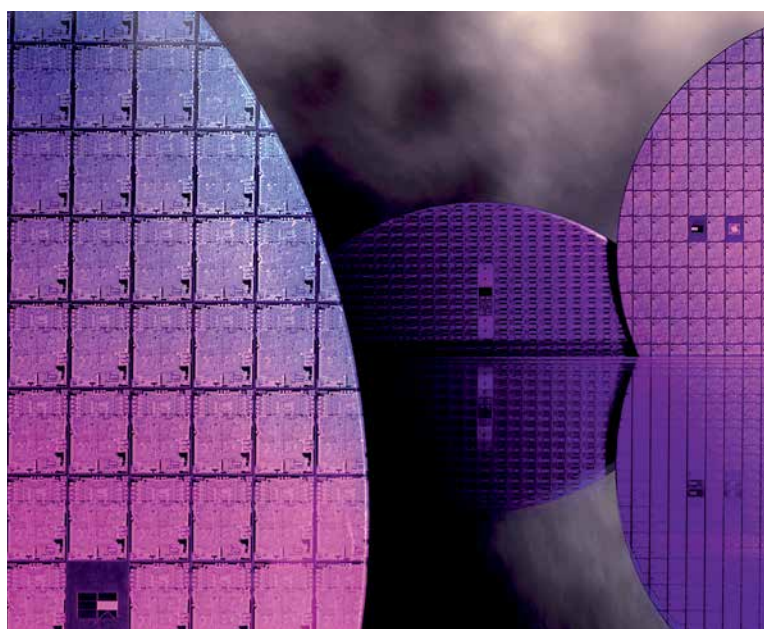
Within Bühler, we are stronger than ever and in an even better position to drive our most modern coating solution, process expertise and 1st class service and thus maintain our leading role in optical thin-film vacuum deposition equipment. Over the next few years, we want to focus on our existing expertise in emerging markets with our most eco-friendly coating solution and an outstanding cost-performance ratio. Additionally, we will invest in high-quality technology for developed markets to provide new applications.

We are centering our efforts on ensuring our customers' success by improving our core-component technologies with a strong focus on cost of ownership. Our advances, for example in architectural layer-stack design, aim not only for performance and reliability but also for cost efficiency.

Every year we spend a significant amount on basic research and applied development to further improve our technology with regard to quality and precision, sustainability, serviceability and the ecological footprint of our design and systems.

Sincerely yours

Antonio Requena
Managing director
Bühler Alzenau GmbH
Leybold Optics



Leybold Optics – portfolio overview.

Solutions for every challenge.



SYRUSpro series

Our SYRUSpro vacuum coater series sets the industry benchmark in production and R&D. This classic evaporation system produces excellent coatings at extremely competitive deposition rates and is also available in special configurations for infrared (IR) and ultraviolet (UV) wavelength regimes.

Page 8



ARES series

High productivity, lowest cost of ownership, production-proven... These are the highlights of the ARES series that has been developed to meet the requirements of mass-production-oriented markets, especially in Asia.

Page 14



STARpro

Based on a single-reactive magnetron configuration, the STARpro allows the manufacture of multiple-layer stacks consisting of SiO_2 and Si_3N_4 . Its versatility combined with its ultra-compact design makes it a perfect choice for small production runs.

Page 16



HELIOS series

The HELIOS series sputtering tool is a flexible platform for fast, precise and fully-automated thin-film coatings. It specializes in high-quality optical coatings featuring very low absorption and scattering.

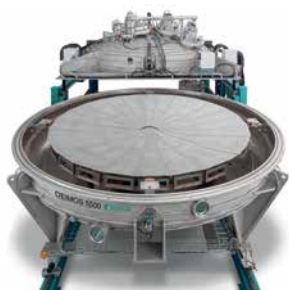
Page 18



NESSY series

The NESSY series is our latest-generation magnetron-sputtering system mainly used for the production of extreme ultraviolet (EUV) mirrors under ultra-high vacuum (UHV) conditions – for mass production and product development.

Page 20



DEIMOS

Astronomical substrates of up to 4.5 m in diameter can be precisely sputtered within DEIMOS coaters, achieving highest reflectivity and durability values. The ease of substrate exchange is another noteworthy advantage.

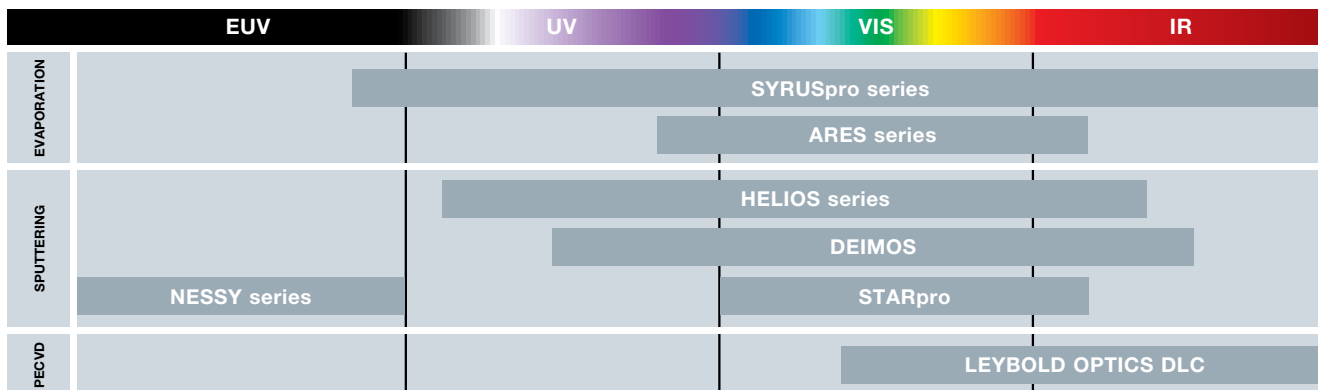
Page 24



LEYBOLD OPTICS DLC

This high-vacuum coater uses plasma-enhanced chemical-vapor deposition (PECVD) technology for material deposition. The diamond-like carbon coatings produced are mainly used for optical- and thermal-imaging systems.

Page 26



Principal application areas of Bühler Leybold Optics machines for precision optics

SYRUSpro series.

Unsurpassed performance and productivity.



1 Planetary systems, calottes or full-domes

2 Proprietary optical monitoring systems

3 Optimized heater assembly (bottom and/or top)

4 Ergonomic human-machine interface

5 Pre-installed processes

6 Network integration and remote access

7 Customized thermal evaporator setups

8 Proprietary electron-beam guns

9 Proprietary plasma sources

Applications:

- Edge filters (short and long pass)
- Notch filters
- Narrow bandpass filters
- Dichroic color filters
- Polarization beam splitters
- (Super) AR coatings

- Endoscopes
- Laser mirrors
- Cold-light mirrors
- TCO layers
- Self-assembled nanostructures

SYRUSpro series – the benchmark for 24/7 optical-filter volume production

The SYRUSpro series is quite simply the industry benchmark in production and R&D. Decade-long perfection of plasma-ion-assisted deposition (PIAD) technology enables excellent coatings at extremely competitive deposition rates from deep-ultraviolet (DUV) via visible spectrum (VIS) up to the infrared (IR) spectral range.

Based on a large variety of proprietary components and Bühler Leybold Optics process control, the SYRUSpro series is customized to meet the most challenging individual needs.

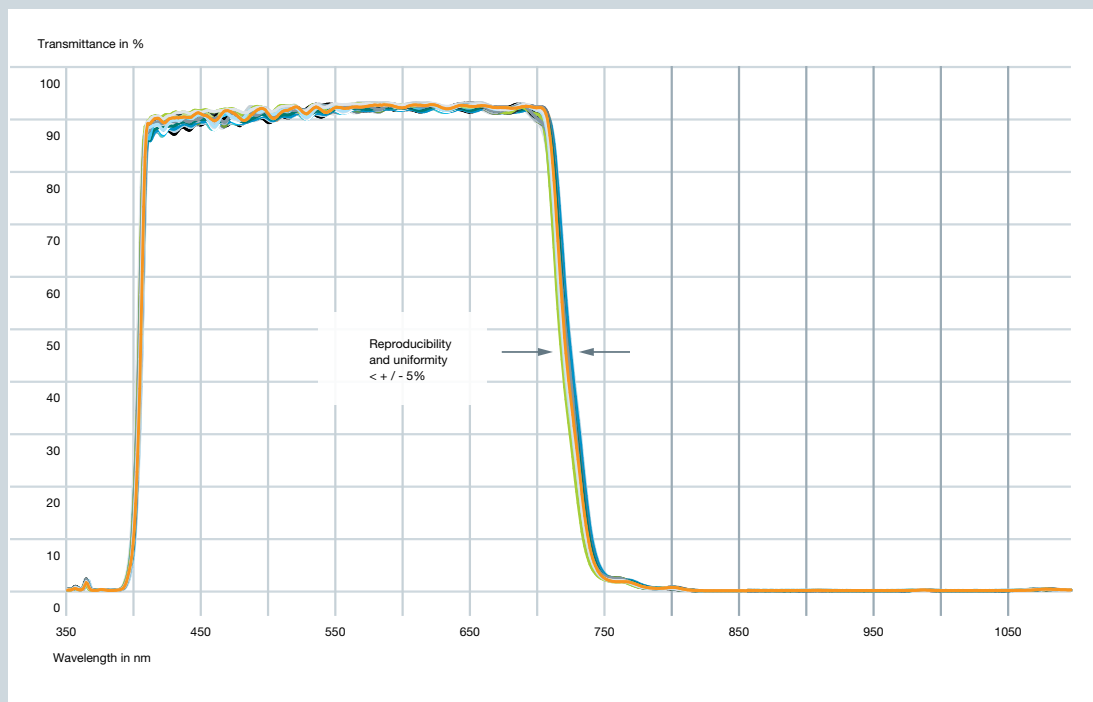
With optical and/or physical monitoring to control layer growth, Bühler Leybold Optics' SYRUSpro series delivers extremely high spectral performance and unmatched reproducibility at lowest cost-per-piece, thus maximizing the return-on-investment.

Key benefits:

- Far IR to deep UV wavelength spectrum
- Co-evaporation from two sources, with dual-rate and thickness control
- Leybold Optics LION and APSpro ion sources
- Integrated proprietary optical monitoring system
- Outstanding versatility through variety of options
- Eight different chamber sizes (700 up to 2800 mm)
- Substrates up to 1.1 m in size
- Fully modular and customizable concept
- Benchmark in cost-per-piece

Unique reproducibility and precision

Reproducibility and uniformity of 5 consecutive batches and 5 substrates for each run distributed over a single calotte of a UV-IR-cut filter produced in a SYRUSpro 1510.



The 25 different curves show only minimal deviations – a remarkable result.

SYRUSpro series.

Manifold options and peerless flexibility.



SYRUSpro series – a universe full of options

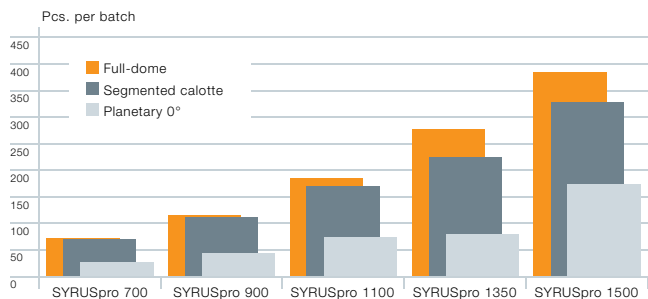
The enormous range of options in the equipment of a SYRUSpro coater is one of its key features that make the difference and allows a perfect match to customer needs. The process library and the company's experience with challenging specifications for IR, DUV and even extreme wavelength regimes are unrivaled in the industry.

Ultimately, it is the wealth of knowledge and experience that allows the Bühler Leybold Optics process experts to realize the one configuration that best matches the specific customer requirements. They understand the often complex interrelationships and come up with the ideal coater – almost always a SYRUSpro.

Broadest portfolio and experience in the market

Able to offer up to 8 different chamber sizes, Bühler Leybold Optics has the broadest experience to provide the perfect matching solution for any kind of business case.

Loading capacity Ø 65 mm lenses



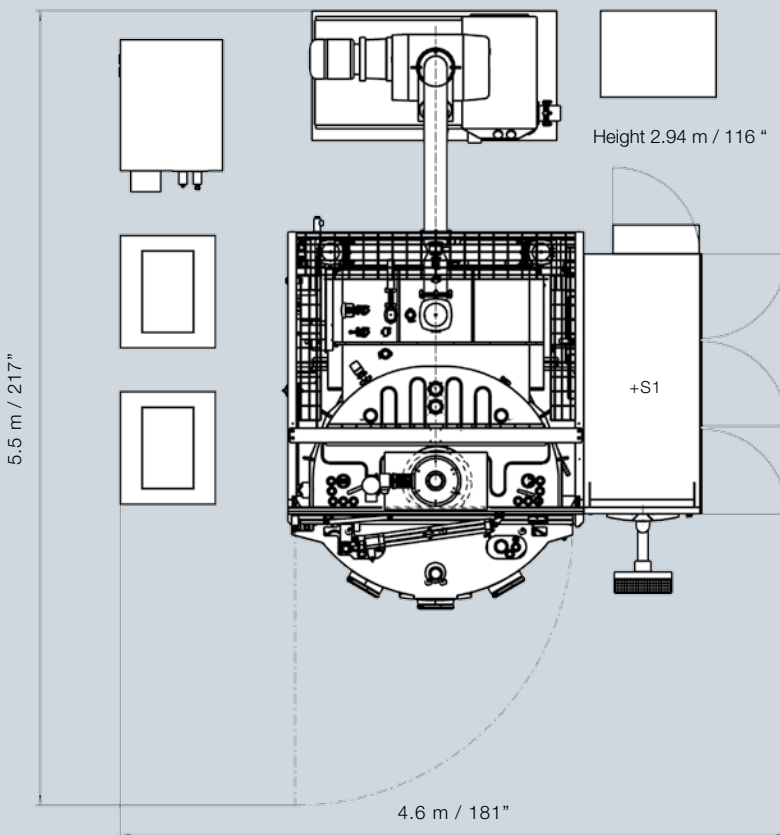
Enlargement of chamber size is only possible with adequate components so as not to compromise coating quality.

Technical data

SYRUSpro	710	900	1100	1350	1510	1950	2100	2810
Coating technology	Ion-assisted deposition (IAD), plasma-ion-assisted deposition (PIAD)							
Coating materials	Every commonly used material (dielectrics, metals, fluorides, sulfides)							
Chamber width [mm]	700	900	1100	1350	1500	1950	2100	2800
Chamber width [inch]	28	36	44	53	61	77	83	110
Floor space [m ²]	11.2	16.4	17.3	20	25.9	38	41	55
Floor space [sq.ft.]	121	177	186	215	279	409	441	592
Loading capacity Ø 65mm								
Calotte [pcs.]	71	115	183	277	384	*	*	*
Segmented dome [pcs.]	3 x 23	3 x 37	4 x 42	4 x 56	6 x 54	*	*	*
Planetary system [pcs.]	25	43	73	79	112	*	*	*

(*) To be defined in accordance with customer requirements

SYRUSpro 1510



Pumping systems:

- Fore-vacuum:
 - Standard pumps
 - Dry pumps
- High-vacuum:
 - Turbomolecular pumps
 - Diffusion pumps
 - Cryogenic pumps

Heating systems:

- Precise temperature ramp-up
- Optional:
 - Front or rear-side heating
 - Ceramic or metal heaters
 - Control via thermocouple or pyrometric, intermittent on substrate
 - High- or low-power sources
- High-temperature option (> 400° C)

Premium components for SYRUSpro.

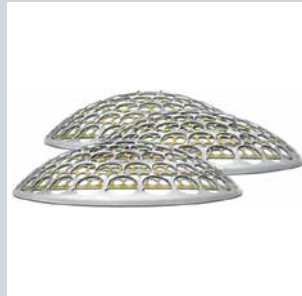
Substrate holders



Pallet substrate holders for flat rotation



Segmented domes in variety of configurations



High-precision full-domes for fast loading times



Planetary drive-systems with double-rotation

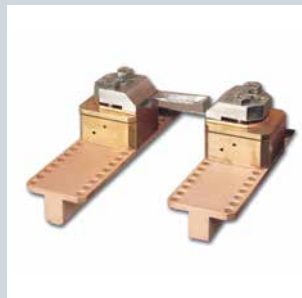
Evaporators



LEYBOLD OPTICS HPE 12/10 mid-size electron-beam gun



LEYBOLD OPTICS HPE 12 large-volume electron-beam gun



Single-boat thermal-resistance evaporator



Triple-boat thermal-resistance evaporator

Optical monitoring

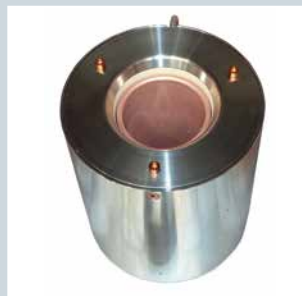


Single-wavelength monitoring system LEYBOLD OPTICS OMS 5100

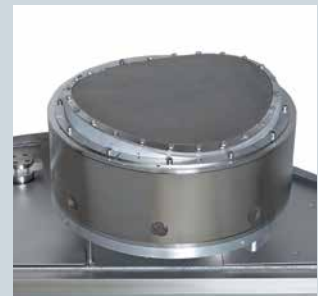


Broadband optical-monitoring system LEYBOLD OPTICS BBM

High-power plasma sources



LEYBOLD OPTICS APSpro with LaB6 cathode



LEYBOLD OPTICS LION 300 based on ECWR



ARES series.

Getting the optimum in value for your investment.



ARES series – cost-effective production with high performance

The ARES series is Bühler Leybold Optics' system for cost-optimized mass-production of optical components especially designed for East Asian countries.

The configuration is thoroughly streamlined according to the specific application, but never compromising on quality – a smart choice for the savvy investor.

- | | |
|--|-------------------------------------|
| 1 Quartz-crystal monitoring | 6 Compact footprint |
| 2 Optical monitoring system | 7 Proprietary ion sources |
| 3 Visualization in Chinese | 8 Proprietary electron-beam guns |
| 4 Network connection and remote access | 9 Optimized equipment configuration |
| 5 Fully-modular concept | |

Applications:

- AR coatings
 - Anti-fingerprint coatings
 - Color filters
 - Edge filters
 - Cold-light mirrors
 - Touch screens
-

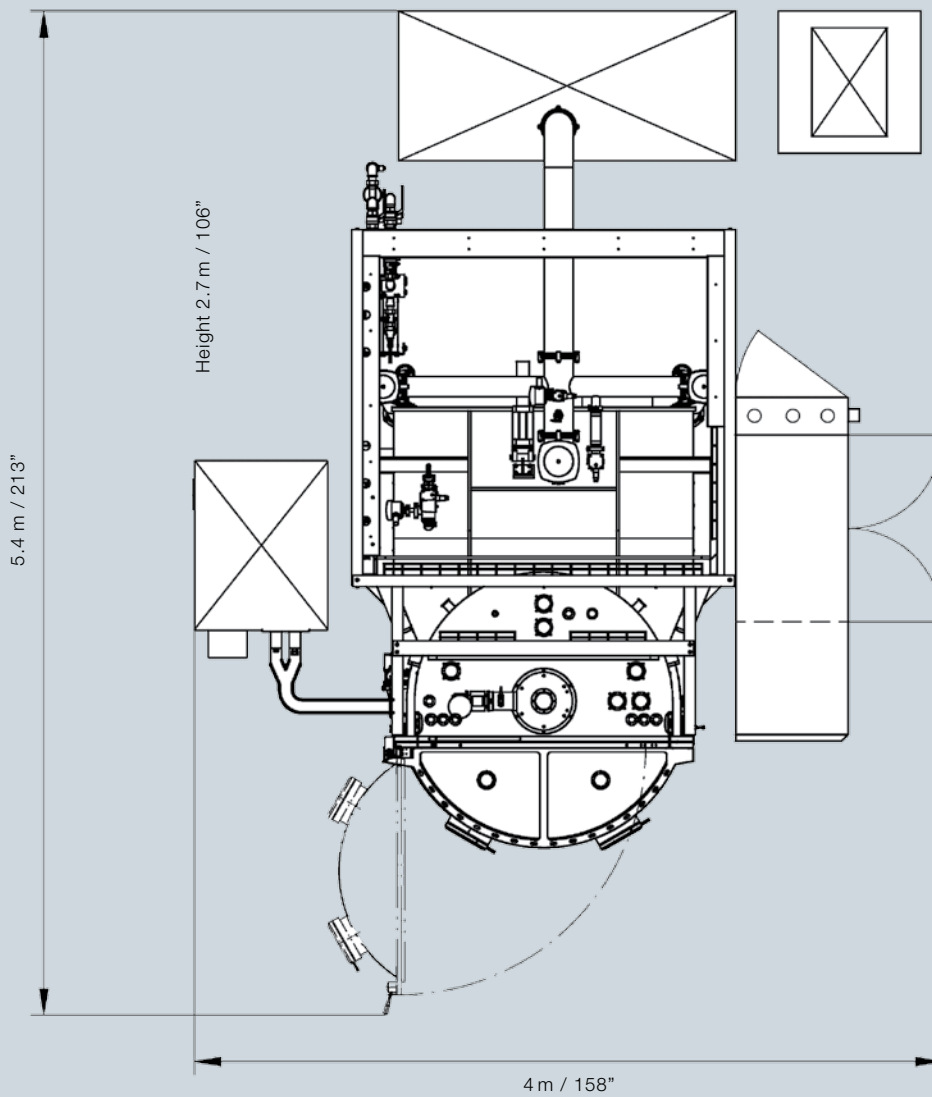
Key benefits:

- Optimum CAPEX performance ratio
 - Optimized for East Asian requirements
 - High throughput
-

Technical data

Systems	ARES 1350	ARES 1500	ARES 2000
Coating materials	All commonly used dielectrics, metals, fluorides, sulfides		
Coating technology	Ion-assisted deposition (IAD) Plasma-ion-assisted deposition (PIAD)		
Chamber diameter [mm]	1350	1500	1950
Site requirements			
Line voltage	400 V, 3-phase, 50/60 Hz		
Electric power	100 kVA	100 kVA	125 kVA
Footprint	20 m ²	26 m ²	38 m ²
Weight	4500 kg	8000 kg	15000 kg

ARES 1350



STARpro. Versatile coating system for small-batch optical filter production.



Small, fast and precise

Bühler Leybold Optics' STARpro is a reactive single magnetron-sputtering system that covers a wide range of applications through the use of Si_3N_4 and SiO_2 multi-layers. The system is very easy to install and operate. Moreover, the STAR achieves spot-on accuracy and high reproducibility throughout the entire target lifetime via the implementation of the premium optical monitoring system LEYBOLD OPTICS OMS 5100.

Applications:

- Anti-reflection (AR) coatings
 - Bandpass filters
 - Edge filters
 - Dielectric mirrors
 - Dichroics
-

Key benefits:

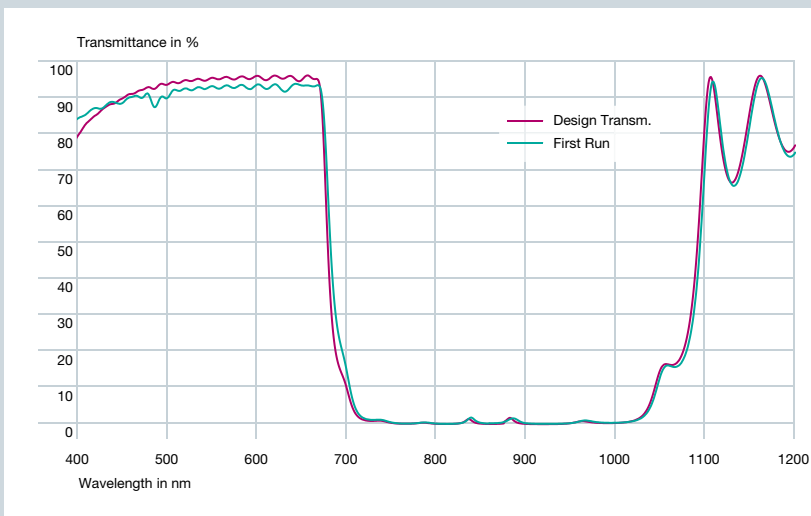
- Separate load-lock chamber for:
 - higher process stability
 - low particle contamination
 - Adjustable sputter distance
 - Planetary system for high uniformity
 - High deposition rates of up to 2 nm/s
 - Plug-and-play:
 - Extremely easy to install and operate
 - Very compact footprint (~1 m²/11 sq. ft.)
 - All components in one base frame
-

- 1 Separate load-lock
- 2 Adjustable sputter distance
- 3 Ergonomic graphical user interface (GUI)
- 4 Integrated cooling water system
- 5 Three gas cylinders can be incorporated

Technical data

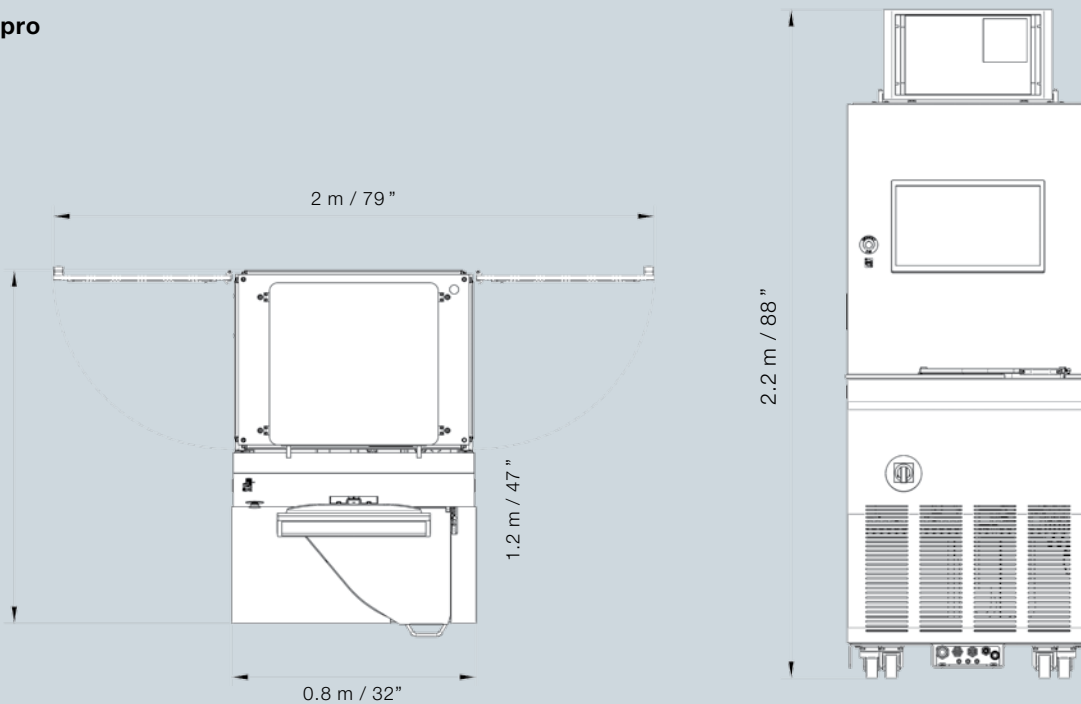
General features		Components	
Loading capacity	4 substrates	Cathode	LEYBOLD OPTICS PK150
Max. substrate Ø	80 mm / 3.51"	Sputter target	Silicon (Si)
Process gas N ₂ , O ₂ , Ar	Incorporated	Sputter power supply	DC pulsed
Optical monitoring	LEYBOLD OPTICS OMS 5100	Sputter rate SiO ₂	1.2 - 2.0 nm/s
Remote access	LAN / WLAN / air card	Sputter rate Si ₃ N ₄	0.7 - 1.2 nm/s

IR-cut filter

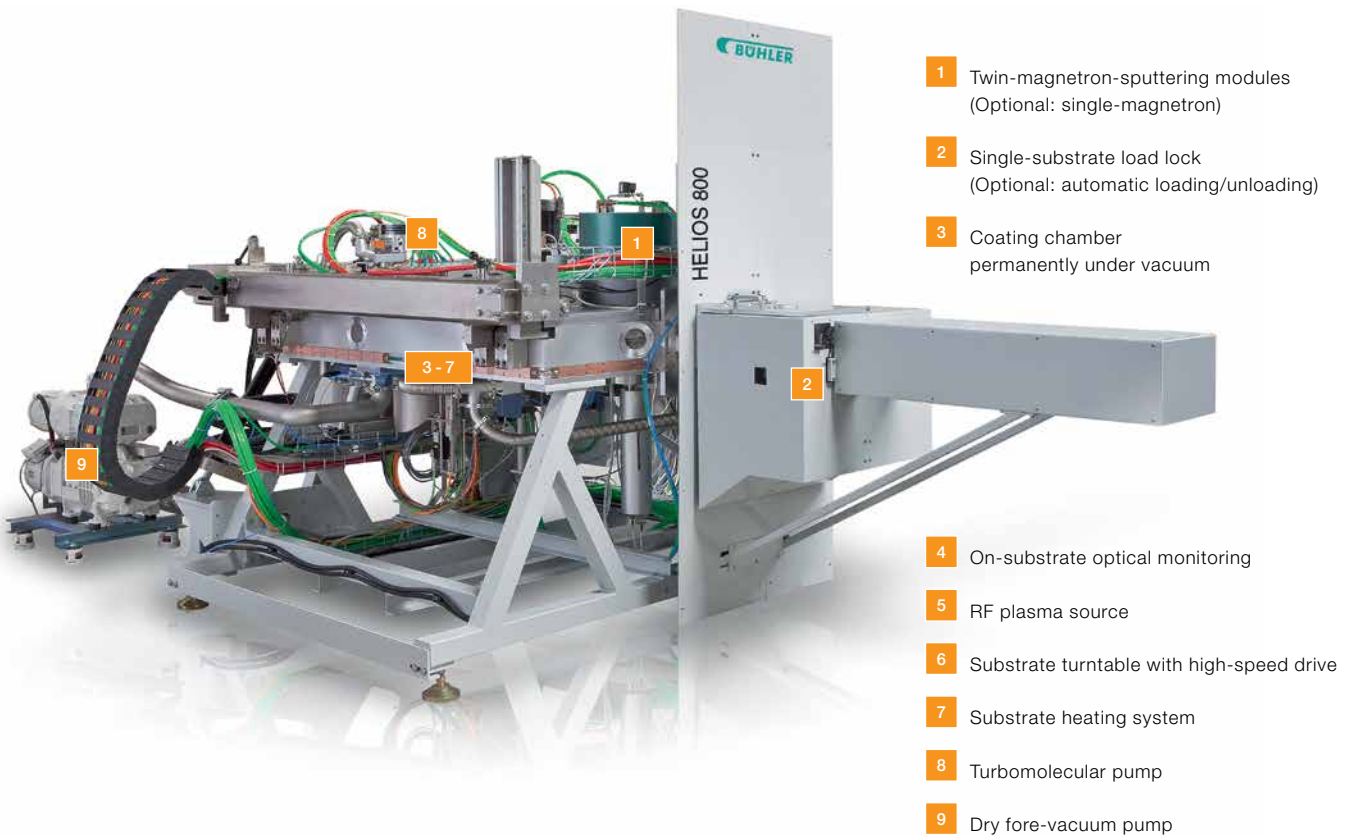


Excellent performance with the first run due to LEYBOLD OPTICS OMS 5100 in-situ optical monitoring system.

STARpro



HELIOS series. High-precision, high-yield coaters for top-grade products.



- 1 Twin-magnetron-sputtering modules (Optional: single-magnetron)
- 2 Single-substrate load lock (Optional: automatic loading/unloading)
- 3 Coating chamber permanently under vacuum
- 4 On-substrate optical monitoring
- 5 RF plasma source
- 6 Substrate turntable with high-speed drive
- 7 Substrate heating system
- 8 Turbomolecular pump
- 9 Dry fore-vacuum pump

HELIOS series – the ultimate sputter coaters

This flexible sputter platform is ideal for fast, precise and fully-automated thin-film deposition. It specializes in high-quality optical coatings, featuring very low absorption and scattering. Unsurpassed optical performance is ensured by the extremely dense, smooth, stoichiometric, and amorphous layers. Ultimate precision in layer-growth control is facilitated by an optical monitoring system for in-situ on-substrate measurements.

Key benefits:

- PARMS process technology
- No arcing and μ -arcing
- High and stable deposition rates
- On-substrate optical monitoring
- Extremely high process stability
- Thickness precision down to ultra-thin layers
- Filters with over 200 layers and 20 μ m thickness
- Optimal film oxidation, high density and low loss
- Co-sputtering for intermediate index tuning
- Rapid prototyping and short time-to-market
- Fast (un)loading without breaking the vacuum
- Compatible with SEMI standard

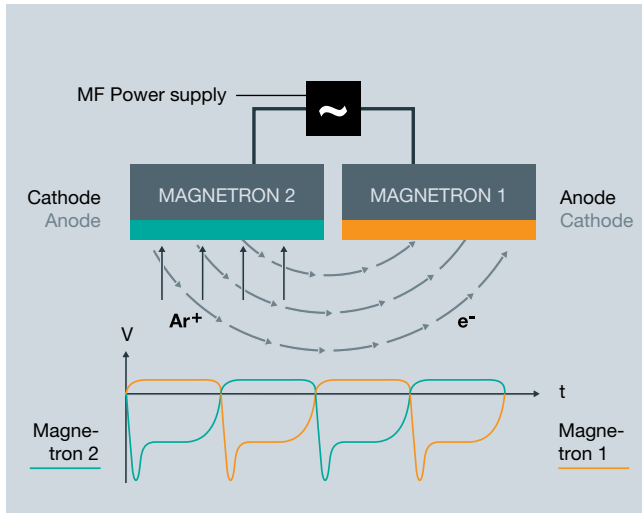
Applications:

- Laser-line filters
- Steep-edge filters
- Single- and multi-notch filters
- Laser mirrors
- Chirped mirrors
- Thin-film polarizers
- Beam splitters
- Bio sensors

PARMS process technology

The plasma-assisted reactive magnetron-sputtering (PARMS) technology allows for the deposition of metal oxides with high- and low-refractive indices by combining mid-frequency (MF) and radio-frequency (RF) sputter technologies over two magnetrons.

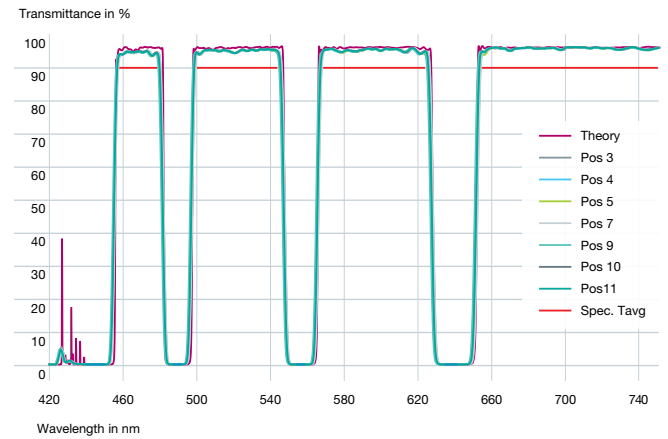
PARMS technical principle:



On-substrate optical monitoring

The LEYBOLD OPTICS OMS 5100 is the premium tool for in-situ optical monitoring. The optical thickness of the coated layer is measured either on a stationary test-glass or – for more accuracy – directly on the substrate via intermittent mode.

4-fold-notch filter, AOI = 10°



One example of how theory and prototype coating of an advanced notch filter perfectly matches when produced with HELIOS coaters.

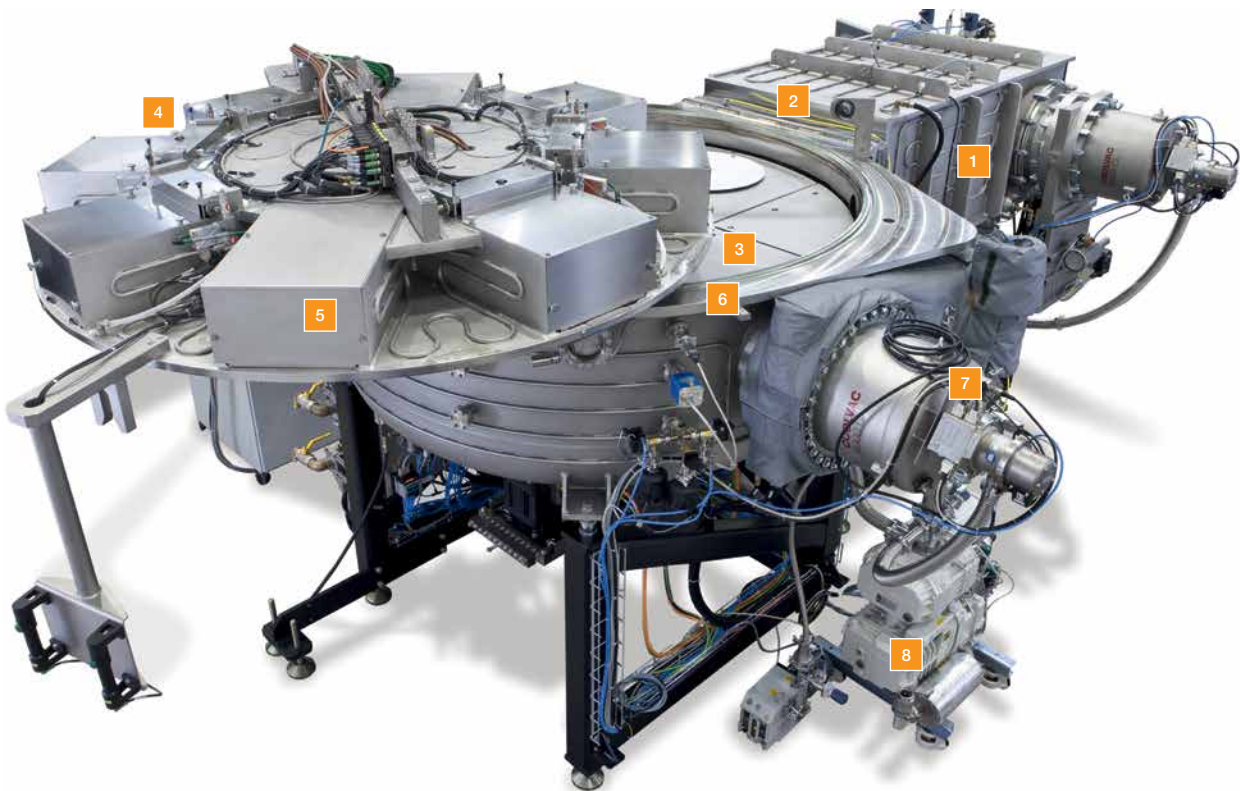
Technical data

System		HELIOS 400	HELIOS 800
Technology		Plasma-assisted reactive magnetron-sputtering (PARMS)	
Applications		DC sputtering (optional: HF sputtering)	
Coating material		SiO ₂ , Nb ₂ O ₅ , Ta ₂ O ₅ , ZrO ₂ , HfO ₂ , AlO ₃ , Si ₃ N ₄	
Capacity		12* pcs. at Ø 125 mm / 5"	12* pcs. at Ø 200 mm / 8"
Source positions (max. 4)	1 and 2 (standard)	Twin-magnetron	Twin-magnetron
	3 (optional)	Single-magnetron	Twin-magnetron
	4 (standard)	RF plasma	RF plasma
	Coating Ø (standard)	≤100 mm / ≤ 4"	≤ 200mm / ≤ 8"
	(optional)		≤ 150mm / ≤ 6"
Layer monitoring	Time control	Yes	Yes
	Optical monitoring	LEYBOLD OPTICS OMS 5100 LEYBOLD OPTICS BBM	LEYBOLD OPTICS OMS 5100 LEYBOLD OPTICS BBM
Dimensions	Width x length x height	5.7 m x 3.4 m x 2.6 m 223" x 134" x 102"	7.3 m x 6.2 m x 3.0 m 288" x 242" x 118"
Site requirements	Electric power	46 kVA	110 kVA
	Line voltage	400 VAC, 50/60 Hz	400 VAC, 50/60 Hz
	System weight	3420 kg	4200 kg

(*) One substrate less when optical monitoring is used

NESSY series.

The sputter equipment for EUV applications.



- | | | | |
|----------------------------------|--|--|---------------------------|
| 1 Heated load lock | 3 Planetary substrate drive with sub-rotation and speed profiles | 5 Magnetron-sputtering cathodes PK 600 | 7 Cryo pump |
| 2 Handling for loading/unloading | 4 Chamber lid for ease in service | 6 Adjustable sputter distance | 8 Dry pre-vacuum pump set |

Key benefits:

- Extremely consistent layer-thickness uniformity
- UHV base pressure: $< 9 \cdot 10^{-9}$ mbar
- Outstanding, defect-free film quality
- Statistical layer precision in subatomic range (e.g. 7 nm \pm 0.25 %)
- Suited for numerous materials (including Mo and Si for EUV mirrors)
- Advanced layer functions (e.g. diffusion barrier and capping layers)
- Adjustable sputter distance
- Substrate height including carrier up to 240 mm
- Substrates sizes up to \varnothing 660 mm

**NESSY series –
sputtered layers with ultimate precision**

This magnetron-sputtering system used for ultra-high vacuum regimes (UHV) excels with unmatched levels of layer precision through its unique substrate handling with double rotation. Thus it is an ideal tool for the production of mirrors in the x-ray or extreme-ultraviolet (EUV) spectral range. The reflectance values realized on multi-layer stacks come close to the theoretical threshold with economic cost-per-piece ratios in parallel. As such the NESSY platform is equally suited for both series production and for product development at the technological limit.

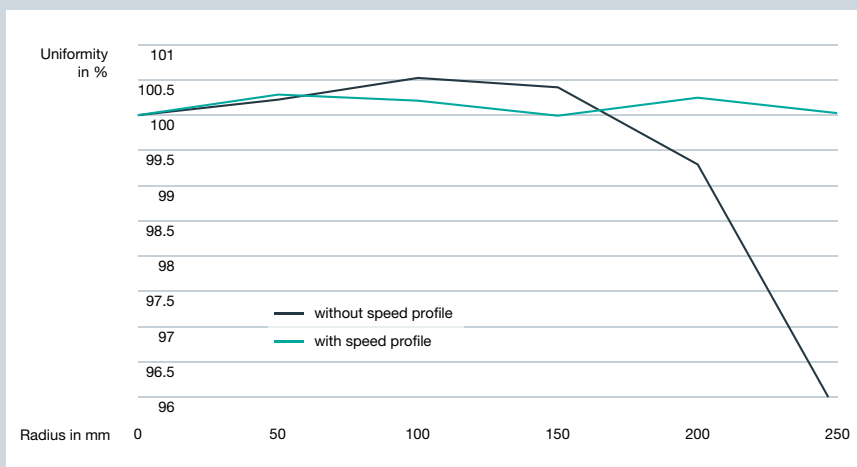
Application potential

Extreme layer specifications like molybdenum/silicon multi-layer mirrors with maximum reflectance at a wavelength of 13.5 nm, which are of crucial importance as condenser or projector mirrors in lithography equipment, can be realized using the NESSY series. The potential of the NESSY series, however, stretches way beyond this highly specific use. The wide variety of sputtered materials, together with the ability to handle large or complex-shaped substrates, makes the NESSY series ideally suited for the development of novel applications and components. If you have ideas and requirements at the edge of today’s technological feasibility, just contact us – we’ll accept the challenge!



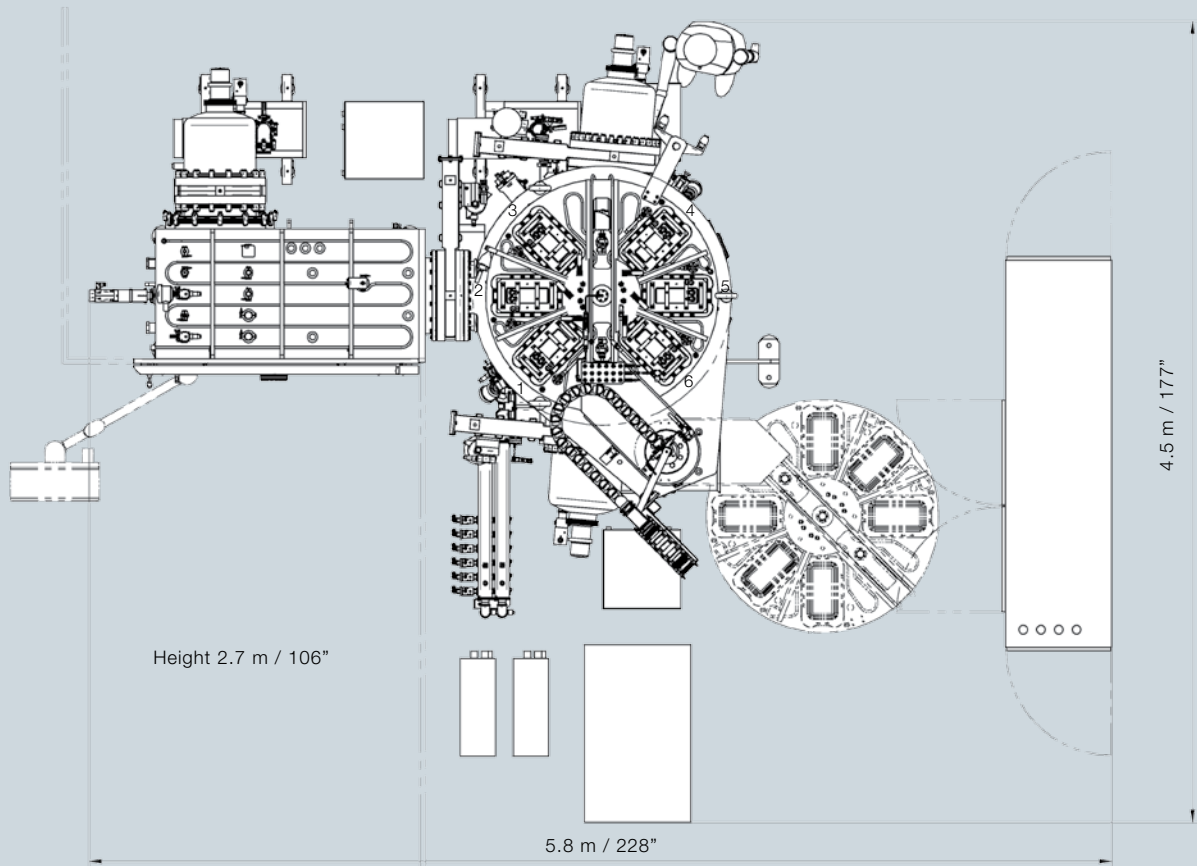
**Unmatched thickness
uniformity**

Excellent stability of sputter process and extreme levels of layer-thickness precision is a result of careful management of the substrate movement and minimized mechanical tolerances at the substrate holder. With additional double-rotation and varying speed profiles, the NESSY series bridges the gap to the subatomic uniformity values necessary in, for example, EUV optics applications.



Uniformity of molybdenum single layer measured by optical density. The data show ± 0.15 % over 450 mm diameter in the optimized case.

NESSY

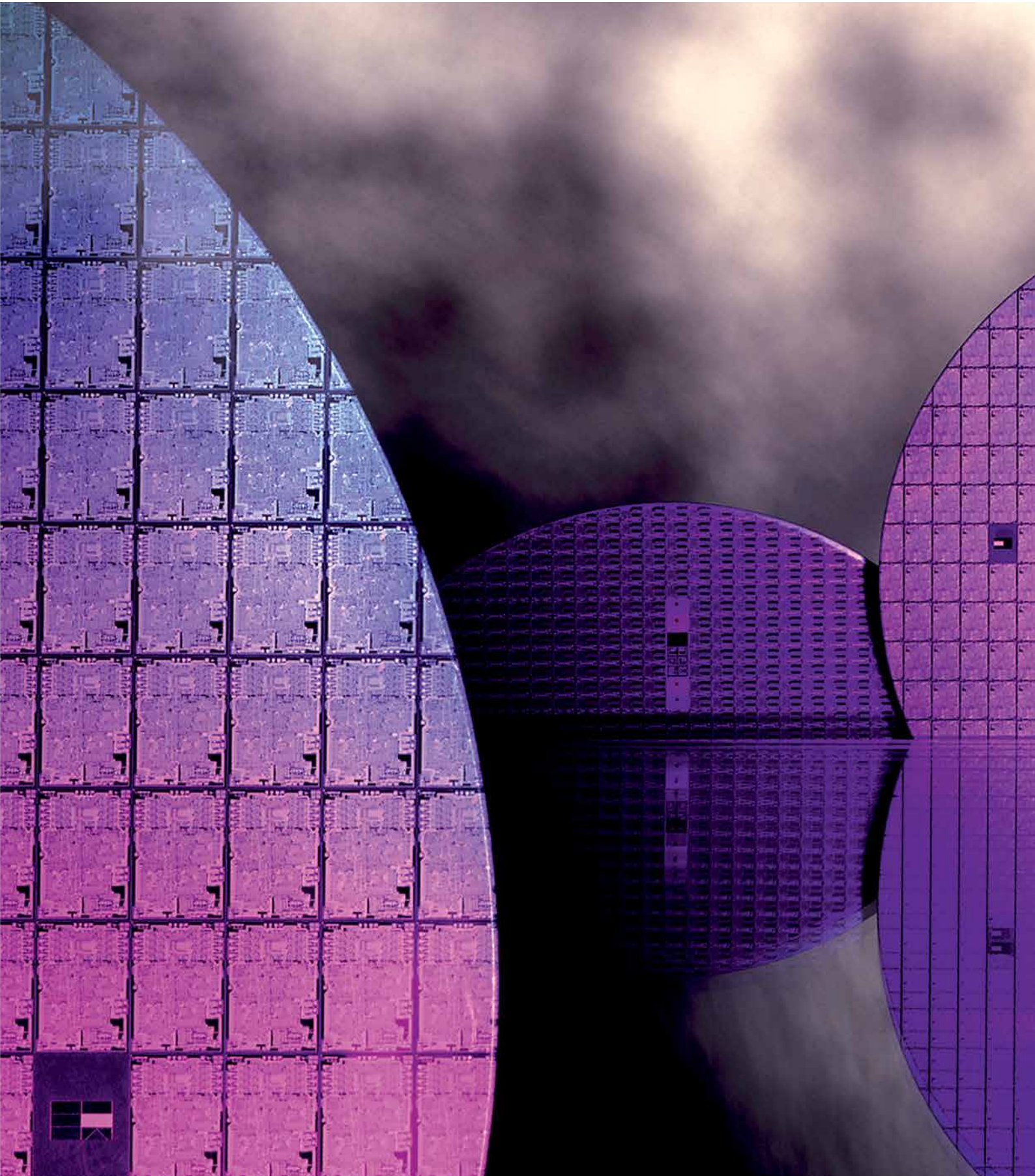


Technical data

Systems		NESSY 1200	NESSY 1900
Coating technology		DC or DC pulsed sputtering (optional: RF sputtering)	
Coating material		Mo, Si, Cr, Sc and different materials for diffusion-barrier layers and capping layers	
Sputter source		Up to 6 PK	Up to 6 PK
		250 mm x 100 mm	600 mm x 125 mm
Base pressure		9×10^{-9} mbar	9×10^{-9} mbar
Planetary-drive speed		0 - 5 rpm	0 - 5 rpm
Rotation-table speed*		0 - 500 rpm	0 - 500 rpm
Loading capacity (standard)		1 x \varnothing 200 mm / 8" max. 20 kg (incl. carrier)	1 x \varnothing 300 mm / 12" max. 30 kg (incl. carrier)
Loading capacity (optional)		n.a.	1 x $\leq \varnothing$ 660 mm / 26" max. 100 kg* (incl. carrier)
Floor plan layout **	Footprint	5.8 m x 4.5 m 228" x 177"	7.0 m x 6.5 m 276" x 256"
	System height	2.7 m / 106"	2.9 m / 114"
Site requirements	Electric power	94 kVA	94 kVA
	Line voltage	400 VAC, 50/60 Hz	400 VAC, 50/60 Hz
	System weight**	7500 kg	9700 kg

(*) For heavy substrates the rotation speed is limited

(**) System weight and dimensions can change in accordance with customer requirements



DEIMOS 5500.

High-quality coatings for astronomical mirrors.



1 Movable lower chamber-half

2 4 magnetrons for metal and dielectric layers

3 Wide opening for substrate exchange

4 For curved substrates up to Ø 4.5 m

DEIMOS 5500 – the new sputter coater for substrates up to Ø 4.5 m / 15 ft.

The DEIMOS 5500 vacuum coating system is designed for the coating of astronomical mirrors by means of sputter technology. Typically, aluminum (Al) and silver (Ag) targets are used to form protective and enhancing layers in order to achieve the highest reflectance and durability. Prior to processing, both the substrate and the chamber will be pre-cleaned by either mid-frequency (MF) or direct current (DC) glow discharge.

For easy substrate exchange, the lower chamber-half is mounted on a rail system so that it can be easily moved to a clear space to allow access for the substrate handling crane.

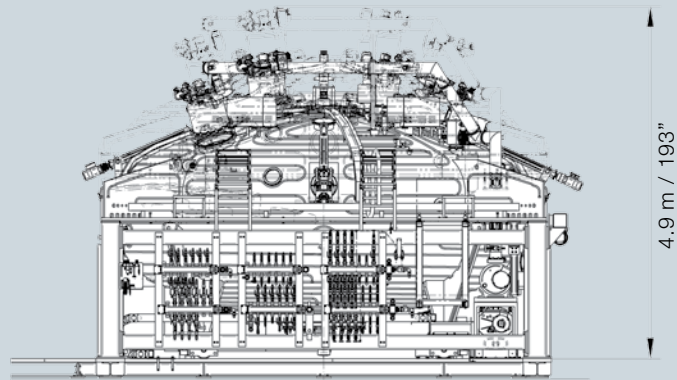
Key benefits:

- 4-magnetron assembly
- Highest reflection and coating durability
- Movable cathode inclination for perfect adaptation to substrate curvature and excellent layer uniformity
- Coating of curved substrates up to Ø 4.5 m / 15 ft.
- Protected and enhanced Al or Ag mirrors
- Pre-cleaning of chamber and substrate via MF or DC glow discharge
- Lower chamber-half on rails for easy substrate exchange

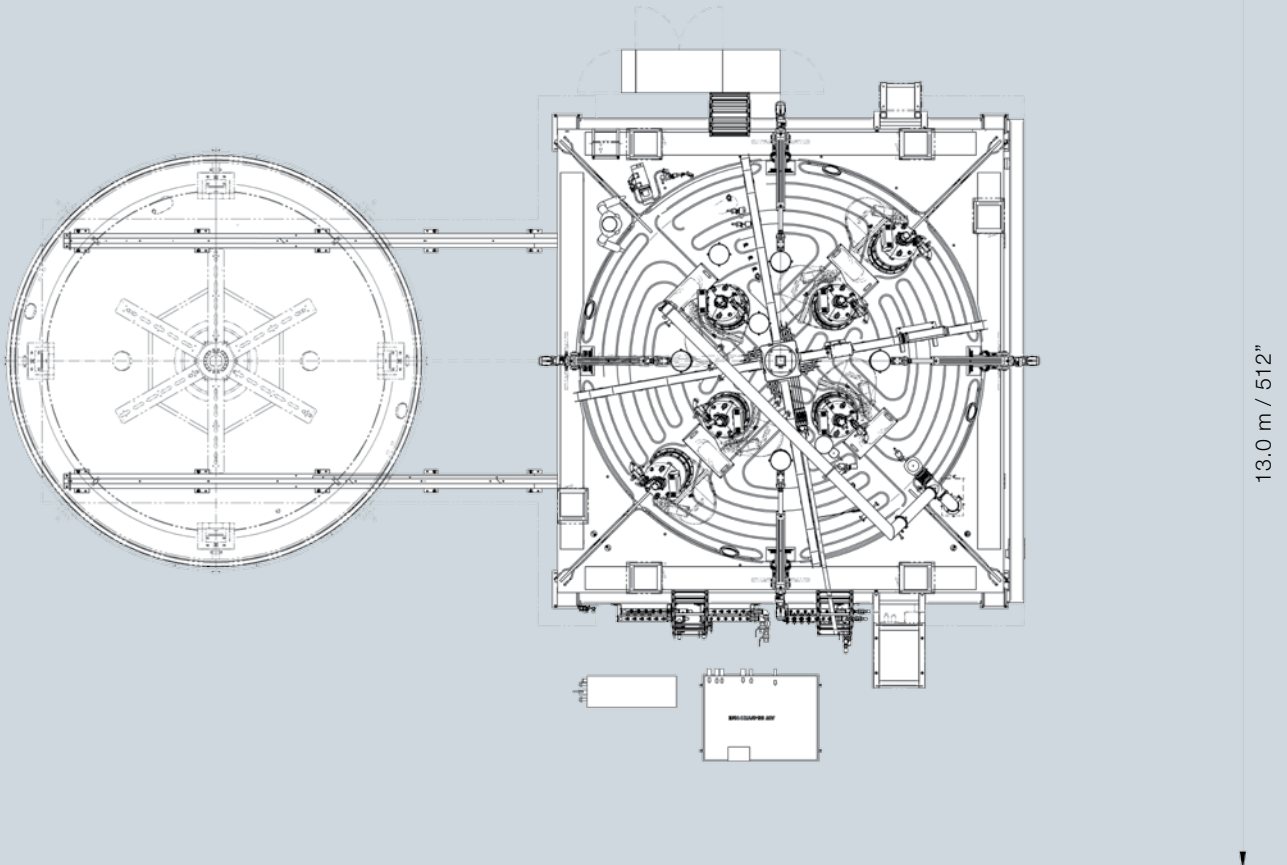
Technical data

General design features		Components	
Loading capacity	Up to 8 tons weight	Cathodes (4 pcs.)	LEYBOLD OPTICS
Max. substrate Ø	4.5 m / 15 ft.	Sputter target	Al, Ag, Nb, Si
Rate monitoring	4 x quartz-crystal head	Sputter power supply	DC and DC pulsed
Remote access	LAN / WLAN / air card	Uniformity	< ± 5 %

DEIMOS 5500



20.1 m / 791"



LEYBOLD OPTICS DLC.

The reference high-precision PECVD system.



- 1 In-situ optical monitoring system
- 2 Flat-rotatable substrate holder
- 3 Process chamber stainless steel Ø 550 mm
- 4 Substrates up to Ø 465 mm
- 5 RF generator with 13.56 MHz matchbox

LEYBOLD OPTICS DLC 600 – the diamond-like carbon coating system

The LEYBOLD OPTICS DLC 600 coater operates under high-vacuum conditions and uses plasma-enhanced chemical-vapor deposition (PECVD) technology. These machines are used by industry leaders for precision optics applications to produce mainly optical and thermal imaging systems. The Bühler Leybold Optics R&D and process team is your partner for customized processes.

Key benefits:

- Benchmark uniformity across entire coating area
- Excellent reproducibility via optical monitoring
- Wide variety of substrate sizes
- Suitable for flat and curved substrates
- Highest end-product quality

Applications:

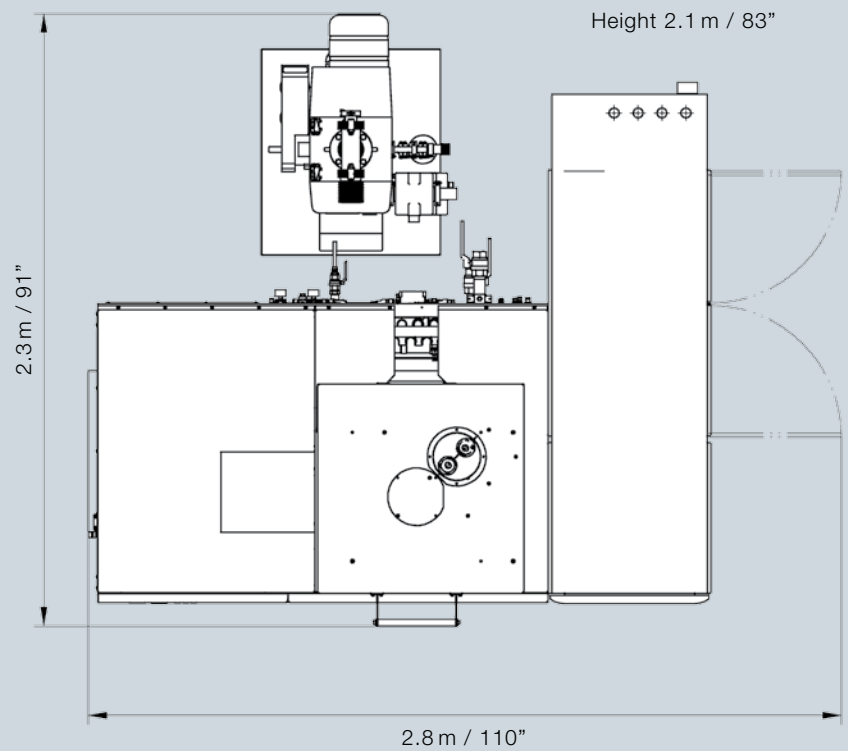
- Diamond-like carbon (DLC) layers
- Anti-reflective coatings
- Substrates: Ge, Si and others
- Optical imaging
- Thermal imaging
- Night-vision equipment
- Distance control

Technical data

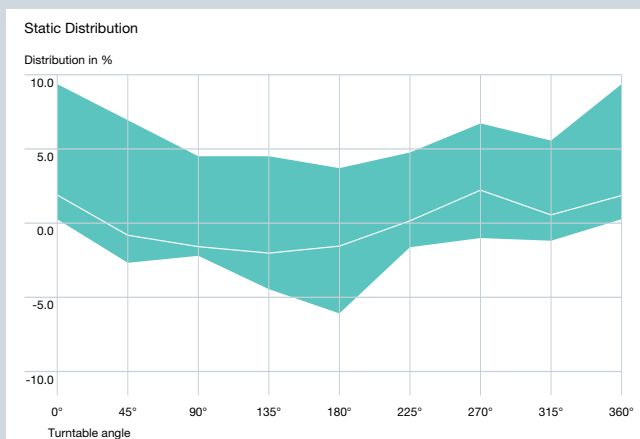
Coating technology	PECVD coating system (Plasma-enhanced chemical-vapor deposition)
Coating layer	Diamond-like carbon (DLC)
Capacity	Turntable with Ø 465 mm / 18.3"
Power supply (MF)	13.56 MHz
Standard anti-reflection (AR) processes*	
On Ge	Tav @ 8.0 - 11.5 µm
On Ge	Tav @ 3.5 - 5.0 µm
On Si	Tav @ 3.5 - 5.0 µm
Durability performance	Standard environmental tests (ML-...)
Layer monitoring	
Time control	Yes
Optical monitoring	LEYBOLD OPTICS OMS 5100
Site requirements	
Footprint	4.4 m x 3.3 m / 173" x 128"
Electric power	23 kVA
Line voltage	400 VAC, 3-phase, 50/60 Hz
System weight	1500 kg

(*) Other processes on request

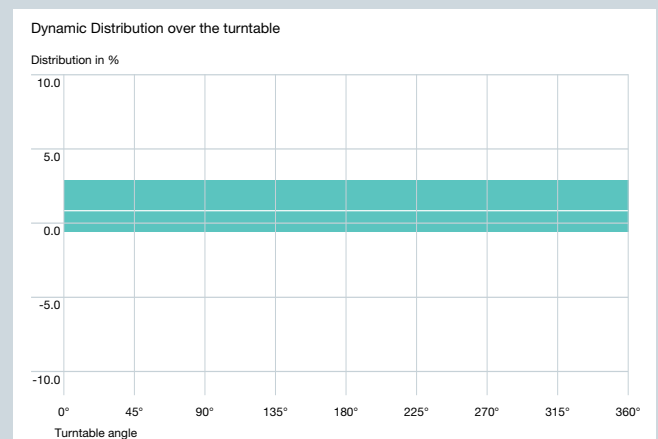
LEYBOLD OPTICS DLC 600



Uniformity characteristics



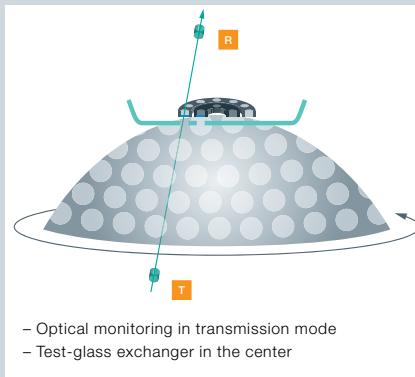
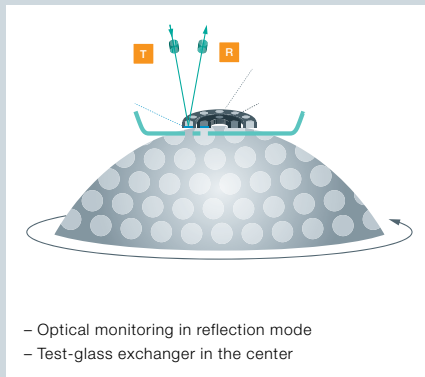
Measured optical properties across different sub-plate positions without rotation.



The operation in dynamic mode with rotating turntable shows perfect uniformity.

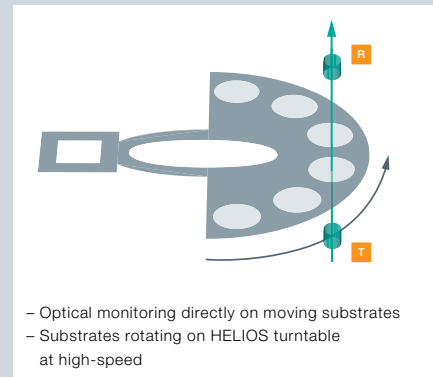
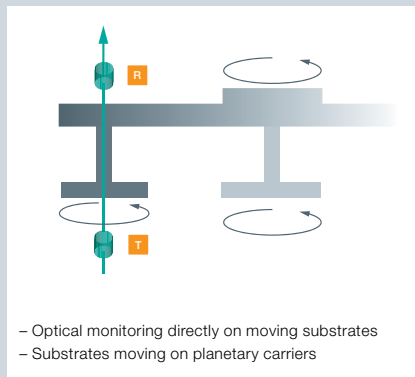
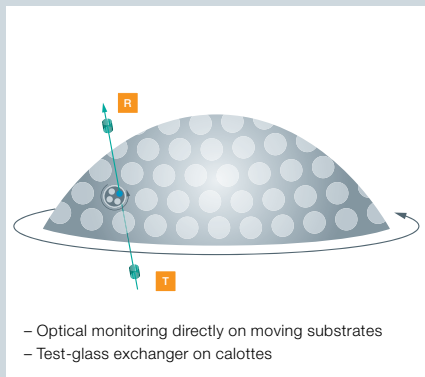
Leybold Optics – precision monitoring. Total process control for perfect product quality.

Stationary optical monitoring set-ups



T Transmitter
R Receiver

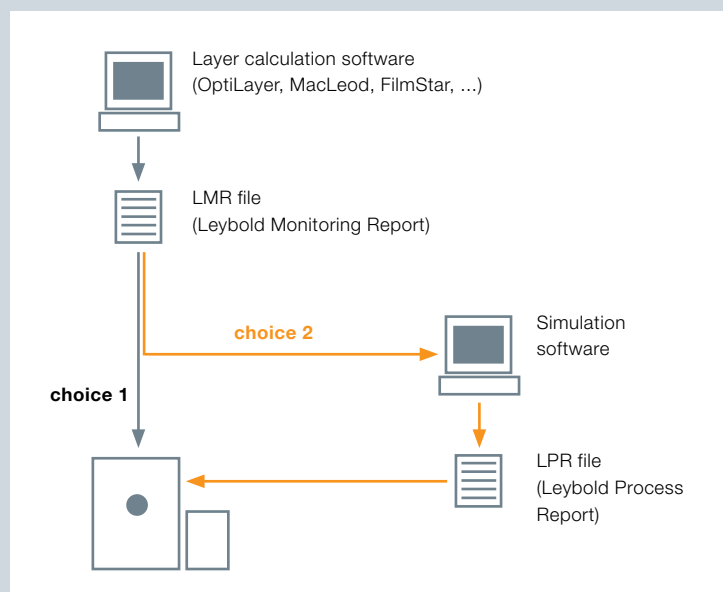
Intermittent optical monitoring set-ups



Bühler Leybold Optics has been setting setting benchmarks in optical monitoring for decades. Direct intermittent measurement – the breakthrough in optical monitoring – was introduced first by Leybold Optics and is used in the SYRUSpro and HELIOS series.

Film design and monitor run-sheet data are interfaced with the coating equipment using LMR or LPR files. Both file formats were invented by Leybold Optics, whereas LMR files are usually generated by most commonly used thin-film design software programs available on the market.

The systems are supported by simulation and pre-production analyzing tools, thus virtually eliminating the need for test- or calibration-runs.



Technical Data

	LEYBOLD OPTICS OMS 5100	LEYBOLD OPTICS WB-OMS	LEYBOLD OPTICS BBM
Detector type	Single (PMT, Si, InGaAs, PbS)	Diode array 1024 pixel	CCD array 2048 pixel
Dispersive element	Grating monochromator	Polychromator	Polychromator
Dynamic range	26 bit	16 bit	16 bit
Detector noise rms @ 400 nm	0.0025 %	0.03 %	0.4 %
Detector noise rms @ 1000 nm	0.001 %	0.05 %	0.4 %
rms detector noise best case	0.001 %	0.01 %	0.3 %
Continuous measurement for stationary measurement	Optional: light chopper up to 80 Hz	--	--
Intermittent measurement	Triggered by incremental sensor	Triggered by incremental sensor	Triggered by incremental sensor
Min. data acquisition time	0.8 ms	1.1 ms	2 ms
Time jitter for measurement	< 0.05 ms	< 0.1 ms	< 2 ms
Optical resolution (FWHM)	0.5 nm - 8.8 nm controllable	3.5 nm	1 nm Optional: NIR 5 nm
Useful wavelength range with halogen lamp	330 nm - 2500 nm	400 nm - 1000 nm	380 nm - 1050 nm Optional: NIR 380 nm - 1700 nm
Useful wavelength range with deuterium lamp	200 nm - 360 nm	--	250 nm - 380 nm

Data evaluation and software features

	LEYBOLD OPTICS OMS 5100	LEYBOLD OPTICS WB-OMS	LEYBOLD OPTICS BBM
In-situ monitor	Intensity vs. time @ single wavelength	Intensity vs. time @ single wavelength plus Transmittance vs. wavelength	Transmittance vs. wavelength
Thickness control	End-point control by monochromatic strategies (Turning-point, online corrected trigger-point)	End-point control by monochromatic strategies (Turning-point, online corrected trigger-point).	End-point control by calculated thickness
Re-engineering of thickness errors	Offline based on slow spectral scan between the layers	Offline	Online
Re-optimization of remaining layers	Offline based on slow spectral scan between the layers	Offline based on saved spectra	Offline based on saved spectra Optional: online available

Key benefits of the systems

	LEYBOLD OPTICS OMS 5100	LEYBOLD OPTICS WB-OMS	LEYBOLD OPTICS BBM
Highest stability and accuracy		Monochromatic and broadband monitor in one system	Easy-to-use. No monitor run sheet required
Premium product with unique reproducibility		High flexibility of end-point control	High light-sensitivity
High degree of error compensation for many layer systems		Re-engineering capability	Re-engineering capability
High tolerance to systematic errors (Calibration, dispersion n,k)		Powerful and easy-to-use graphical user-interface (GUI)	Re-optimization capability

LEYBOLD OPTICS APSpro – plasma sources. Most powerful device in the market.



LEYBOLD OPTICS APSpro

Bühler Leybold Optics' proprietary technology APS (Advanced Plasma Source) was introduced in 1992 and delivers maximum performance and productivity paired with its unique ability to produce shift-free optical coatings. In contrast to other sources in the market, low- and high-index materials can be applied with sufficient densification but without additional heating – even for SiO₂. While the main applications of the plasma-ion-assisted deposition (PIAD) process lie in coating materials such as metal oxides and nitrides, it can, however, also be used in coating pure metals and non-metal oxides.

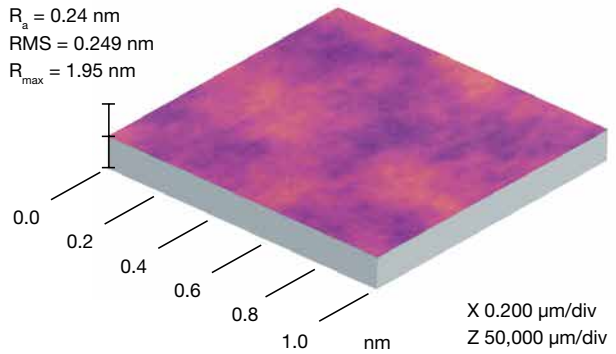
Key benefits:

- Perfect, shift-free spectral performance
- Dense and extremely smooth films
- High deposition rates
- High refractive-index layers
- Wide-angle characteristics
- Enormous library of established processes

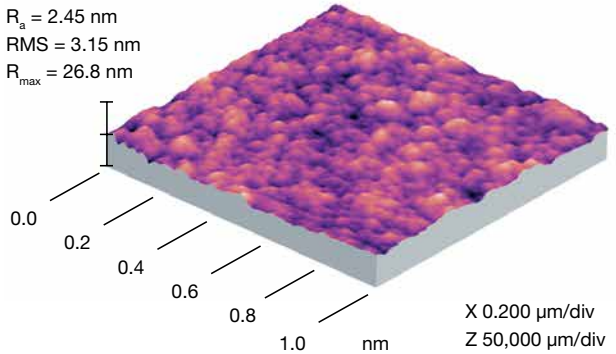
Technical data APSpro

Discharge current	Typical 65 A (max. 100 A)
Discharge voltage	≤ 200 V
Discharge power	≤ 15 kW
Bias voltage	55 - 200 V
Heater power	1.8 kW
Process gas	O ₂ / Ar flow controller
Ion current density	1300 µA/cm ² @ 450 mm
Ion energy	20 - 250 eV

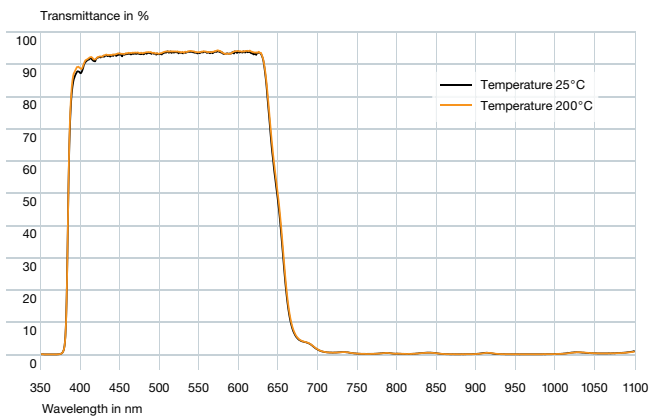
Strikingly better layer smoothness with LEYBOLD OPTICS APSpro



Standard surface roughness with conventional coating



Perfect shift-free characteristics



Optical filter created with APSpro at different temperatures.

LEYBOLD OPTICS LION – RF plasma sources.

Ideal for high-performance coatings.



LEYBOLD OPTICS LION

The LEYBOLD OPTICS LION RF source is based on the electron cyclotron wave resonance principle (ECWR). It is completely integrated in our control systems and dedicated for use in large coating systems like the SYRUSpro 1350 and SYRUSpro 1500. These ion sources combine optimum process operation with ease-of-use and low production cost. Moreover, a single grid (mesh) allows for easy and quick maintenance.

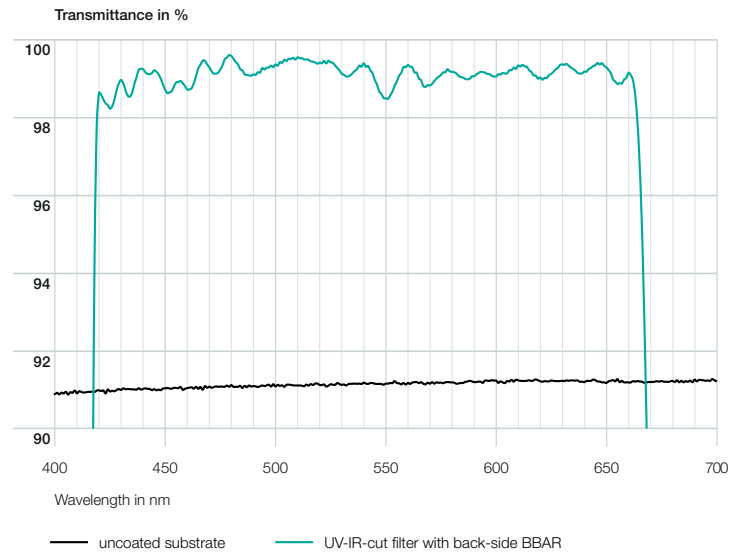
Key benefits:

- Ideal for large chambers
- High power to cover large areas
- High deposition rates
- Layers with very low losses
- Low absorption and scattering
- Easy maintenance
- Low running cost

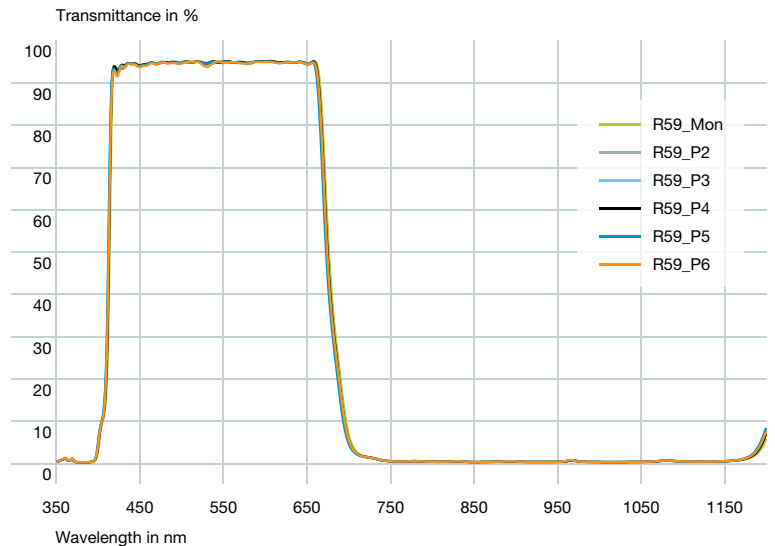
Technical data LION

Free grid-diameter (aperture)	300 mm
RF power	≤ 6.5 kW
Total ion current	≤ 3A
Ion energy	90 - 900 eV
Typical gasses	O ₂ / Ar / N ₂
Matching network	Computerized auto-matching
Ion extraction	Single grid (mesh)

IR-cut-filter



Uniformity



Excellent uniformity over Ø 1400 mm dome (< ± 0.5 %)

Leybold Optics – evaporator units. High-performance components.

Thermal-resistance evaporators

Bühler Leybold Optics offers a wide variety of models featuring different numbers as well as volumes of boats. As a result, maximum flexibility combined with optimum equipment configuration can be realized for every application in machines of the SYRUSpro and ARES series.



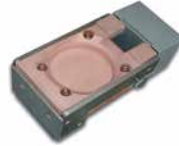
Low-power thermal-resistance source, (e.g. for hydrophobic top layers)



High-power, highly-flexible single-boat thermal evaporator



High-volume triple-boat evaporator (optional: twin-boat model)



Low-volume electron-beam gun, featuring a precisely controlled energy source.



High-power LEYBOLD OPTICS HPE 12/10 with a variety of porringer sizes and forms.



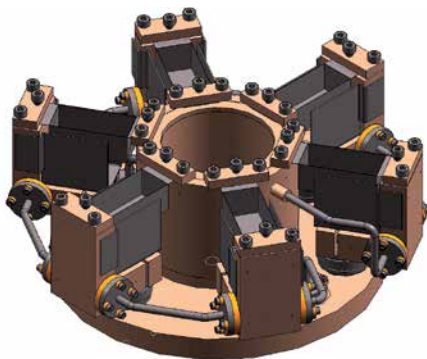
High-volume LEYBOLD OPTICS HPE 12 with up to 20 pockets and a large ring groove.

Electron-beam guns – LEYBOLD OPTICS HPE series

Based on decades of experience in thin-film technology the LEYBOLD OPTICS HPE series is well known for the reliable evaporation of a large range of coating materials such as oxides, fluorides, metals and sulfides. As such, it is the ideal choice for ophthalmic and precision optics, electronics and optoelectronics applications.

Overview LEYBOLD OPTICS thermal evaporators

System	Operation power	Evaporator boats
Lower-power thermal-resistance source		
Single-source	7 V / 600 A	1
High-power thermal-resistance source		
Single-source	3.5 V / 1200 A	1
Twin-source	3.5 V / 1200 A	2
Triple-source	3.5 V / 1200 A	3
High-volume thermal-resistance source		
Hexagon source	3.5 V / 1200 A	6



High-volume system

Hexagon source with six large-volume boats. A revolver mechanism places the active source always in the same position – thus ensuring optimum uniformity. The very large volume makes the hexagon source especially well-suited for infrared applications.

Technical data LEYBOLD OPTICS HPE series

System	HPE 6	HPE 12/10	HPE 12
Beam power (max. output)	10 kW	10 kW	10 kW
Acceleration voltage (typical)	8 kV	8 kV	8 kV
Main deflection angle	270°	270°	270°
Operating vacuum (typical)	$< 5 \times 10^{-4}$	$< 5 \times 10^{-4}$	$< 5 \times 10^{-4}$
Filament voltage/current	10 V / 32 A	10 V / 32 A	10 V / 32 A
Cooling water			
Consumption rate	10 l/min	10 l/min	10 l/min
Inlet temperature (max.)	25 °C	25 °C	25 °C
Inlet pressure	5 - 6 bar	5 - 6 bar	5 - 6 bar
Return pressure (max.)	0.5 bar	0.5 bar	0.5 bar
Dimension (overall)			
Width	126 mm	176 mm	320 mm
Length	380 mm	394 mm	569 mm
Height	144 mm	144 mm	144 mm

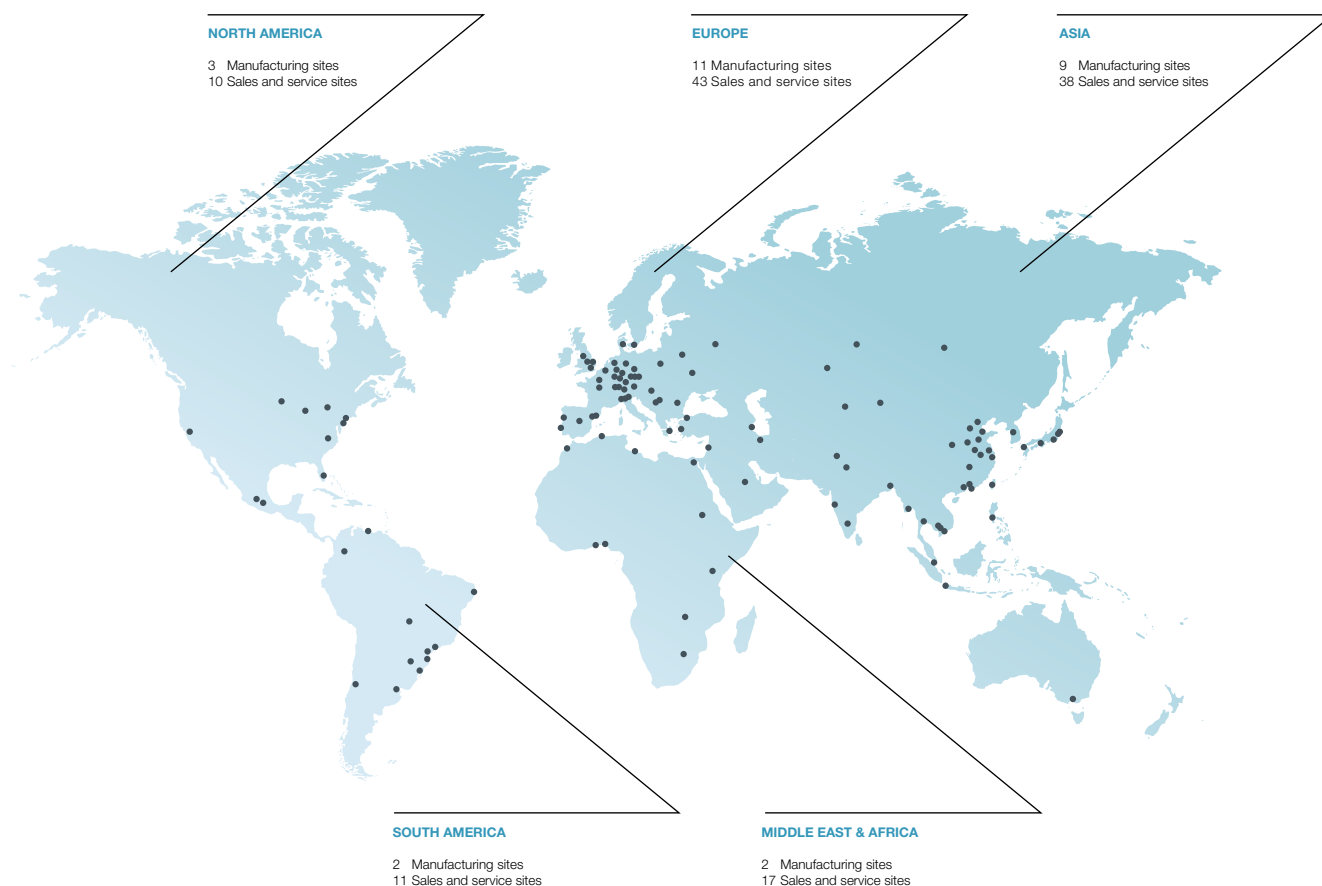
Key benefits of LEYBOLD OPTICS evaporator units:

- Large variety of evaporation materials
- Wide deflection angle of 270°
- Programmable range of evaporation patterns
- Crucible types: ring groove, single- or multi-pocket
- Indirect, direct or intensive cooling capabilities
- Quick exchange of cathode and crucible
- Long lifetimes of cathodes and filaments
- Service connections to atmosphere



Customer support and services. Always on hand to sustain your business.

Global presence of Bühler



Bühler Leybold Optics' relationship with its customers does not end once the machines start production — it is a continuation and an extension of a close partnership. Wherever Bühler Leybold Optics machines are, one of the worldwide centers of competence is close to your site. The company therefore ensures that you receive the right support so that your machines deliver perfect product quality and benefit from high uptime.

Bühler's worldwide customer service as well as the fast delivery of replacement and wear-and-tear parts are just two important aspects of customer support. Preventive maintenance and inspection together with machine re-conditioning and upgrading round off the after-sales services. Contact information for Bühler's worldwide

services can be found on the company's homepage: www.buhlergroup.com.

Bühler Leybold Optics' service commitment to customers guarantees fast identification of parts, components or consumables, tracked and logged to ensure readiness for shipment within one day so that fast delivery to any country in the world is possible.

Bühler is a specialist and technology partner for precision optics coating solutions. With its expertise and over 150 years of experience, Bühler continuously rolls out unique and innovative solutions for its customers, helping them achieve success in the marketplace. The Bühler Group operates in more than 140 countries and has a global payroll of over 10,000.



HELPDESK

- Always available during German, US and Asian business hours: contact the Helpdesk of your local service or at headquarters. The phone numbers are:
EUROPE: +49 6023 500 777 (or +41 71 955 1900)
USA: +1 919 657 7100
CHINA: +86 (10) 67803366-537
- Problems are analyzed promptly via remote diagnosis

FITNESS CHECK

Preventive maintenance and inspection

- Full check of all machine functions
- Comprehensive, customer-specific maintenance service for continued optimal productivity and cost savings when repairs are needed
- Monitoring of the maintenance cycle allows timely appointment scheduling

FLEXCARE / TOTALCARE

Customer service and consultation

- Flexible and adapted to your needs, these service contracts consist of an annual contingency allowance of hours, selectable in different packages – BRONZE, SILVER and GOLD
- Qualified service engineers worldwide
- Quick response times through local resources and close cooperation with suppliers

REPLACEMENT PARTS AND ACCESSORIES

- Worldwide replacement-part-management network, shipment of main parts in one day
- Guaranteed original parts for safe production and highest uptime
- Proven quality for accessories for best qualitative products
- The parts are manufactured by Bühler Leybold Optics or by first-class material specialists like UMICORE with highest availability

RENOVATION OF MACHINES AND ASSEMBLIES

- Software optimization
- PLC and HMI exchange
- Full exchange of electric cabinet and PLC and HMI exchange
- Improved cycle times
- For Leybold Optics products and other machines

OVERHAUL AND UPGRADES

- Upgrade to new components
- Machine extensions
- Improved performance and longer equipment life
- Used machines with «buy back option» for all Leybold Optics products and other machines

RELOCATION OF MACHINES

- Relocation of one machine or a full production site to another production location
- From a precision optics coater to a full production lab

TRAINING

Thoroughly trained and motivated personnel will raise the quality standard that you achieve in utilizing Bühler equipment and will ensure your long-term success. Would you like to increase your employees' level of training to the latest standards in maintenance and operations? To achieve this, Bühler offers you various training courses in a specialized Training Center. In a group of five persons and more, training can be tailored to specific requirements.

- Safety and regulations
- Basics of vacuum technology
- Basics of coating tools
- Basic theoretical training in equipment and technology
- Practical training in preventive maintenance
- Practical training in machine operation
- In-depth training on EB-Gun, Ion source, optical or physical measurement units and process analysis, leak detection, etc.

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