

Solutions for large area coating.

Engineers and pioneers.



Over the years, the demands on glass have changed, from simple protection to design and comfort and then to high-performance functional elements with sophisticated optoelectronic coatings, dedicated to energy efficiency, optical appearance and a comfortable lifestyle. As a leading technology partner for thin-film coatings, Bühler develops and manufactures vacuum deposition equipment for a broad range of applications.





Bühler Leybold Optics – milestones at a glance:

- 1980** Leybold introduced the first silver-based, high-rate-sputtered Low-E coating.
- 1981** Leybold installed the first architectural glass coater capable of handling Jumbo size (6.0 x 3.3 m²) glass panes.
- 1986** Leybold introduced the first industrial-scale coater for depositing special high-tech coatings, such as ITO and SiO₂.
- 1987** Leybold installed the first vertical coater for automotive glazing with a carrier transport system at NIPPON SHEET GLASS, Japan.
- 1995** Leybold installed the world's largest, in terms of production capacity, architectural glass coating lines at GLAS TRÖSCH AG, France, and VEGLA, Germany, with annual production capacities of 8 million m² each.
- 2008** Leybold Optics installed the first Apollon system (today LEYBOLD OPTICS GLC series H) – the world's fastest Jumbo size glass coater.
- 2010** Leybold Optics installed a vertical inline TCO coater with integrated effusion cells for a 100 MW CIGS production facility.
- 2012** Bühler Leybold Optics installed the first industrial scale vertical glass coater for electrochromic layers in an architectural application.
- 2013** Bühler Leybold Optics installed China's largest Triple Low-E coating system.

Bühler solutions for glass coating. Stronger than ever before.



As an important step toward expanding the Advanced Materials division 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.

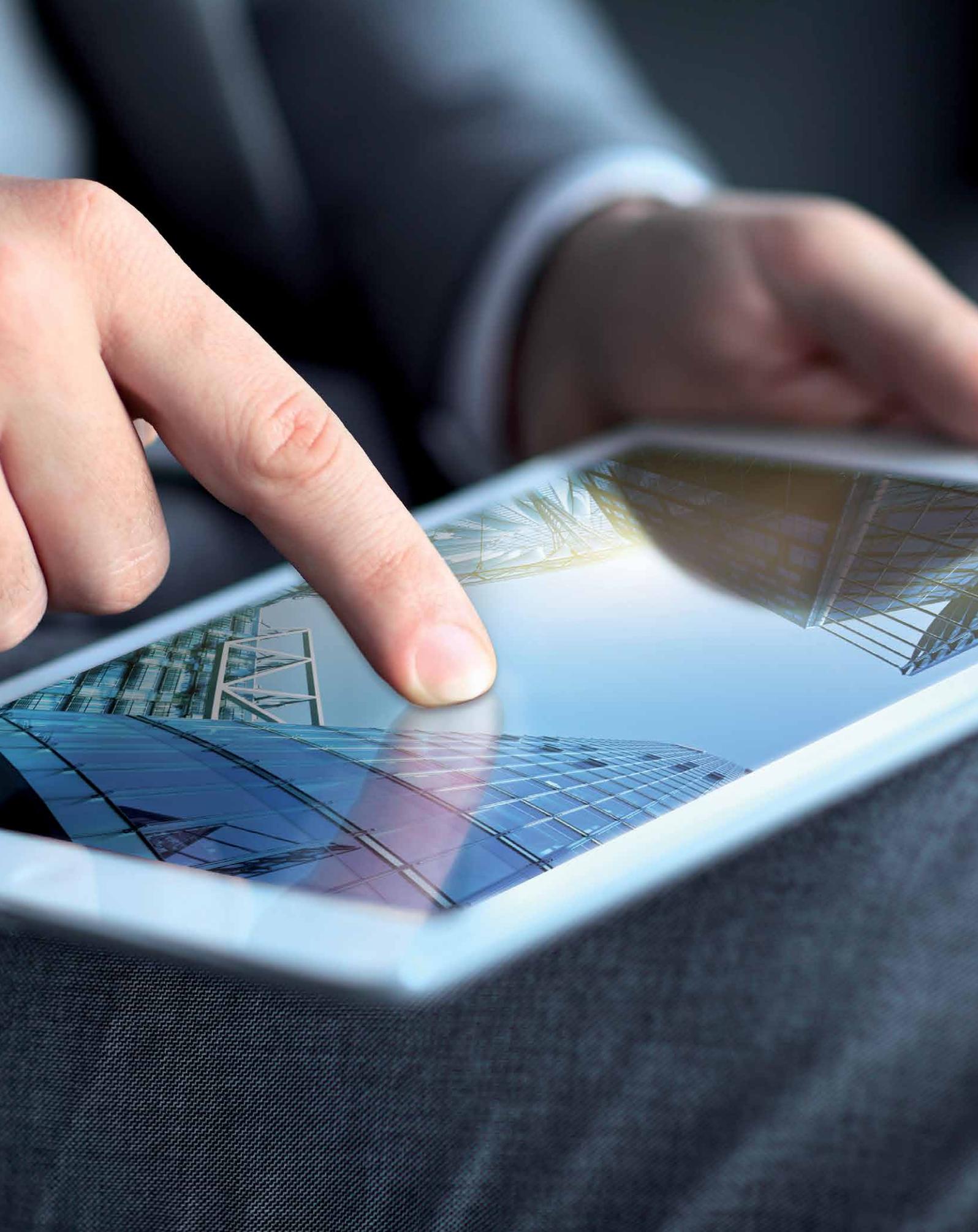
Within Bühler, we are stronger than ever and in an even better position to drive our most modern coating solution, process expertise and 1st class service and thus keep our leading role in optical thin-film vacuum deposition equipment. Over the next few years, we want to focus on our existing expertise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



Technology that brings you a step ahead. Bühler cathode technology.

Although Bühler Leybold Optics is active in developing all different fields of coating technologies, for example PECVD or evaporation methods, magnetron sputtering is still the technology of choice in large area coating. The company offers all relevant sputtering methods, including DC, DC pulsed (uni- and bipolar), MF and HF with rotatable and planar cathodes for the deposition of metallic, semiconducting and insulating films at high sputter rates.

Bühler cathode systems

- Single and double planar cathodes
- Single and double rotatable cathodes
- Moving target planar cathodes

Depending on the machine platform, Bühler cathodes are available as horizontal drop-in and side-mounted or vertical hinged versions.

Exotic and hazardous materials

Bühler has built up extensive expertise in handling exotic target materials. Providing a safe design to work with potentially toxic or flammable materials is crucial for establishing a safe, reliable and responsible working environment.

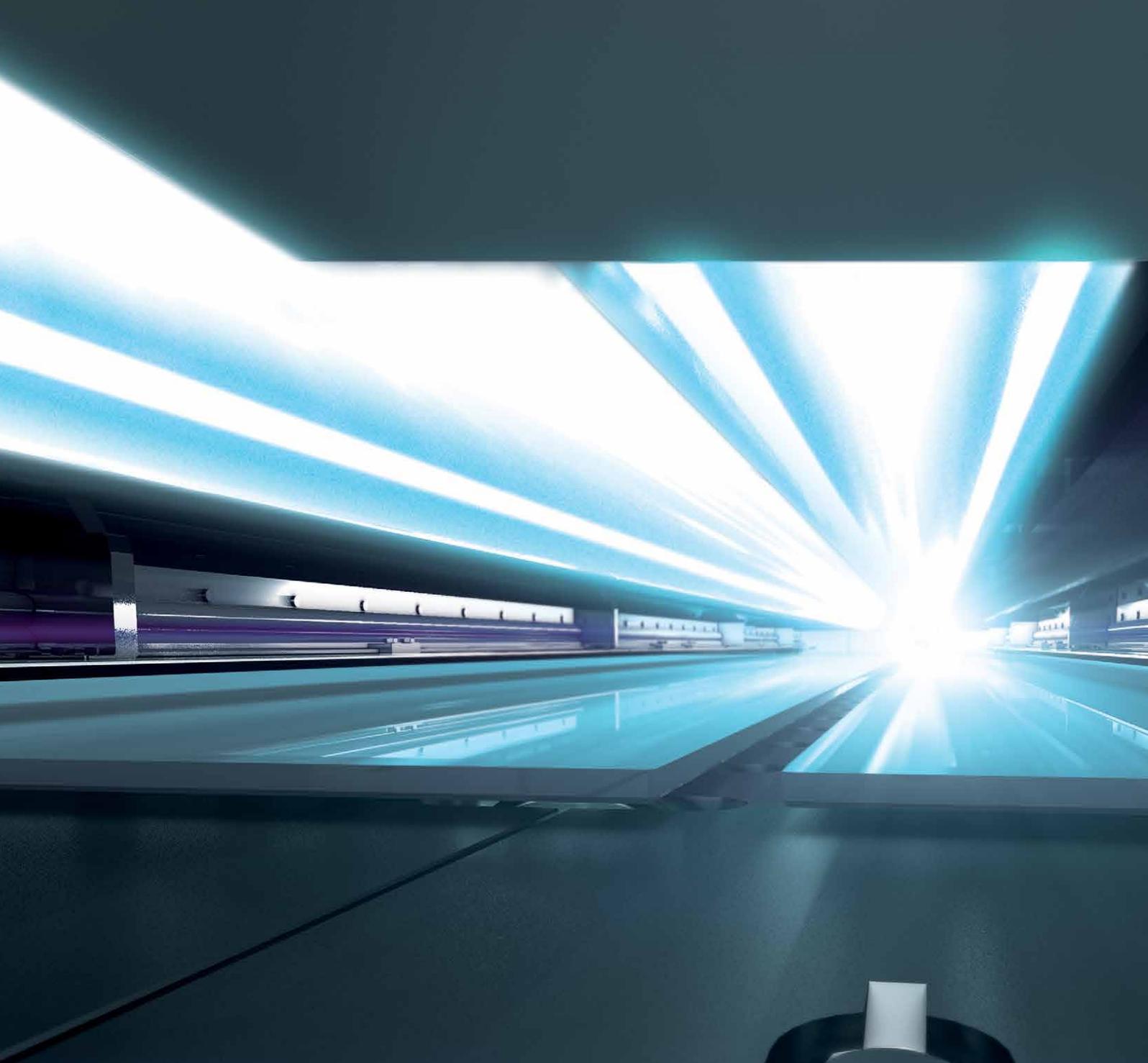
Bühler is always dedicated to creating the best solution for the requested process. Please challenge us.



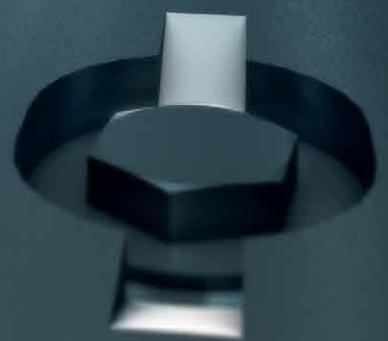
Bühler Leybold Optics top-pumping cathodes ensure process stability with optimized footprint characteristics.

Customer benefits

- Optimized magnetic configurations for excellent uniformity and utilization
- Optimized double planar geometry that allows the use of two standard single planar targets in parallel
- Top-pumping versions of all Bühler planar and rotatable cathodes available
- Advanced target moving system for extended utilization of crucial materials in a given layer stack
- Easy and quick maintenance



Whether rotary or planar geometry, Bühler creates efficient solutions, such as double planar cathodes that can be equipped in standard GLC series H coating compartments using two full-size standard single targets.





Technology portfolio for large area coating. Vacuum deposition equipment at a glance.

LEYBOLD OPTICS GLC series H

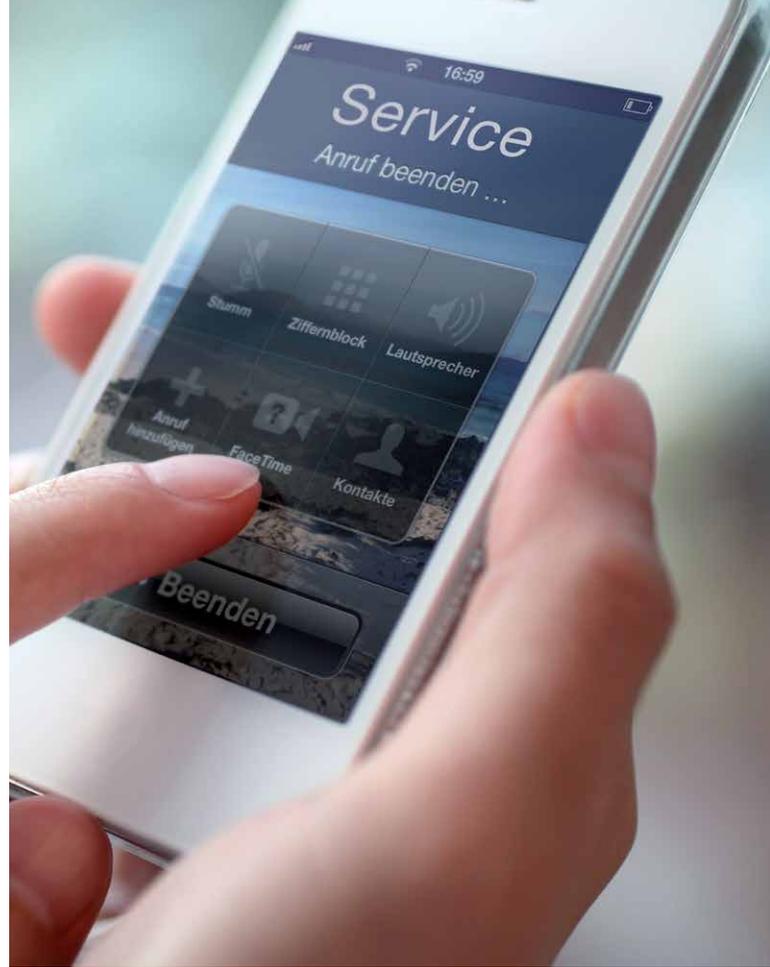
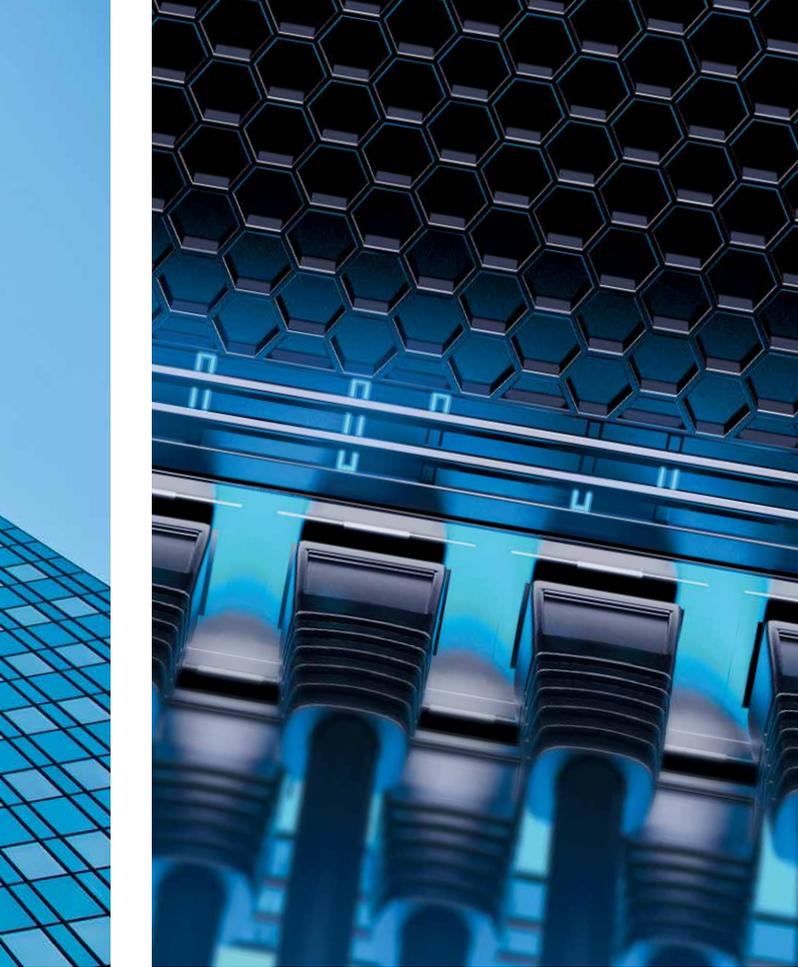
The LEYBOLD OPTICS GLC series H architectural glass coating machine is available for substrate widths of 2,590 and 3,300 mm, respectively, and can be flexibly configured to specific production needs.

The LEYBOLD OPTICS GLC series H sets the benchmark for high throughput production with optimized transport characteristics, while ensuring the highest flexibility for the production mix and the substrate batch configuration.

LEYBOLD OPTICS GLC 2000V

The LEYBOLD OPTICS GLC 2000V glass coating machine is specifically designed for architectural applications, but can be perfectly used for every large area coating process, especially where precision, special materials and particle impact on the substrate make the difference.

Maximum substrate sizes of 3,210 x 2,000 mm² can be processed on a carrier. The LEYBOLD OPTICS GLC 2000V can be equipped with substrate heating to conduct challenging processes with excellent results.



Bühler offers state-of-the-art solutions for thin-film applications. Technologies with high throughput for large-sized glasses or specialized coaters for the high-tech and telecommunications industry.

LEYBOLD OPTICS GLC series V

The LEYBOLD OPTICS GLC series V is a versatile vertical inline glass coating machine that is intended for challenging TCO processes with heated substrates, available in +/- 7° tilted versions.

The LEYBOLD OPTICS GLC series V can also be used optimally for all metallic sputter applications where low particle impact is mandatory. The substrate sizes can be flexibly configured ranging from 300 x 300 mm² up to 1,400 x 1,400 mm².

LEYBOLD OPTICS DIS series V

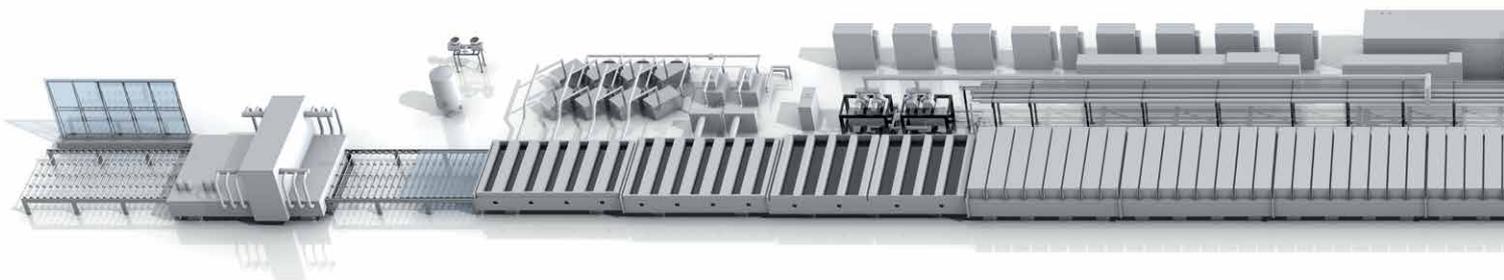
The LEYBOLD OPTICS DIS series V, a highly flexible platform for multi-chamber, vertical inline-sputter machines, is optimized for the classic display coating applications, such as touch screen panels, ITO coatings for color filter products or anti-reflection coatings on substrates of up to Gen 10 (3,130 x 2,880 mm²). Highest target utilization through move-target technology, lowest particle impact via a completely contact-free carrier transport system and minimized footprint with a rotation chamber concept for substrate return are just a few of the features that make LEYBOLD OPTICS DIS series V unique in the display world.



LEYBOLD OPTICS GLC series H.

Flexible production solution with excellent quality.

Energy conservation is a key element to save resources, to contribute to a stable climate and to ensure economic growth. The ever rising demand for high performance optical layer stacks and the multiplicity of different layer characteristics require a flexible, reliable and highly productive machine concept. LEYBOLD OPTICS GLC series H is the first choice for the architectural glass industry when high throughput and excellent quality of coating layers are required.



Loading

Washing

Entrance Area

Process Area

The LEYBOLD OPTICS GLC series H glass coating platform from Bühler leaves nothing to be desired. Its modular design concept covers all current glass formats and coating processes – from anti-reflective coatings to Low-E, solar control and other advanced functional coatings. State-of-the-art technology “made in Germany” without compromises in quality and performance make this system the ideal solution for producing functional coatings for state-of-the-art architectural glazing with the highest precision, stability and throughput.

The sophisticated design and the proven choice of high-quality equipment ensure reliability at low investment costs and optimal cost of ownership for coated glass production. Especially when it comes to maintenance, LEYBOLD OPTICS GLC series H sets the benchmark for the shortest downtime and optimized workflow management.

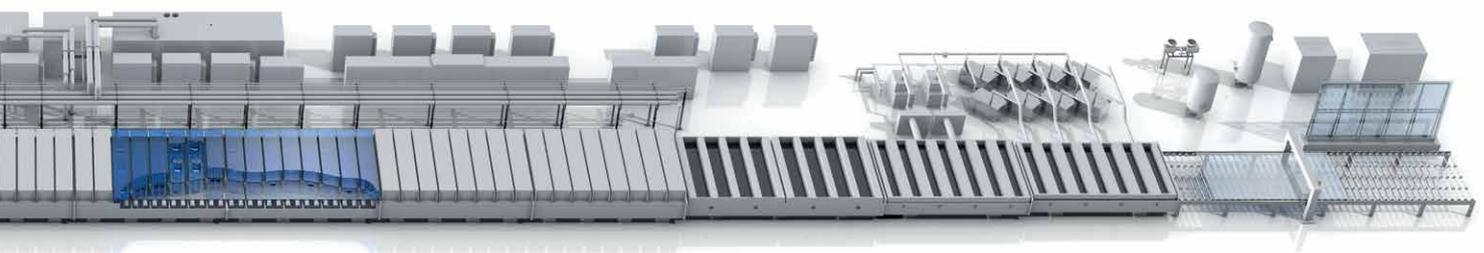
Applications:

- SLE/DLE/TLE coatings
- Low-E sun coatings
- Solar control coatings
- AR and mirror coatings



Customer benefits:

- The system saves target material and maintenance time and yields highest utilization
- Stable processes and excellent gas separation with fewer TMPs and less power consumption
- High rates of reactive sputtering with lowest target oxidation and decreased overall process gas consumption
- High uptime and fast maintenance cycles
- Extended campaign times
- Hydraulic lids for L-, B- and T-chambers (available as an option)
- Flexible PLC approach (Beckhoff, Siemens, Allen-Bradley)



Process Area

Exit Area

Quality Inspection

Unloading

Substrate specification: The LEYBOLD OPTICS GLC series H provides the highest degree of freedom, allowing configuration of the machine to individual production needs.

	LEYBOLD OPTICS GLC 2590H (US size)	LEYBOLD OPTICS GLC 3300H (Jumbo size)
Maximum width	2,590 mm	3,300 mm
Maximum length	4,200 mm	6,100 mm
Extended length	5,400 mm	7,800 mm
Thickness range	2–19 mm	2–19 mm
Cut sizes	300 x 800 mm ²	300 x 800 mm ²



Bühler Leybold Optics flexible drive system can be adapted to fit the customer's individual product mix with regard to the minimum glass length.

LEYBOLD OPTICS GLC series H. High performance technology for glass coatings.

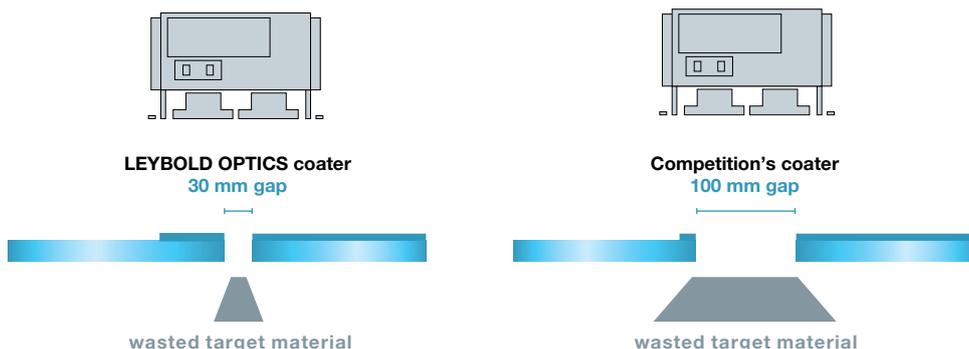
LEYBOLD OPTICS GLC series H offers highest flexibility, extended production capacity, accuracy and high-performance process results. With its advanced concepts for minimizing costs, LEYBOLD OPTICS GLC series H contributes to the economic success of glass manufacturing.

Advanced gap management

Managing the gap between two consecutive substrates or batches has a major impact on the utilization of raw

material and hence the cost of ownership of the coater. By reducing the gap down to 30 mm, the amount of wasted target material can be lowered significantly compared to the competitor's solution with a 100 mm gap.

On top of saving target material, the LEYBOLD OPTICS GLC series H minimizes the time for cleaning, extends the overall campaign time and provides more stable plasma conditions by avoiding large process gas pressure fluctuations in the larger gap phases.



Bühler Leybold Optics advanced gap management saves target material and minimizes the necessary cleaning efforts by reliably reducing the gap between two consecutive glass panes down to 30 mm.

LEYBOLD OPTICS GLC series H – flexible production range:

	5-zone system				3-zone system			
	Mechanical cycle time [sec]	Production capacity p.a. [mm ²]*	Mean product-mix cycle time [sec]**	Product-mix capacity p.a. [mm ²]*	Mechanical cycle time [sec]	Production capacity p.a. [mm ²]*	Mean product-mix cycle time [sec]**	Product-mix capacity p.a. [mm ²]*
LEYBOLD OPTICS GLC 2590H	20	12.6	21.6	12.2	60	4.2	61.1	4.2
	45	5.6	45.9	5.6	90	2.8	98.4	2.7
LEYBOLD OPTICS GLC 3300H	30	18.0	33.2	16.8	60	9.0	63.4	8.6
	45	12.0	48.4	11.3	90	6.0	155.6	4.2

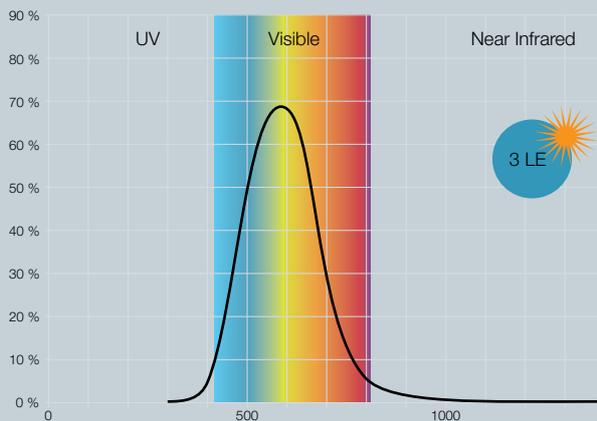
* Assumptions: 8,040 production hours p.a. / 100 % loading factor / 95 % system uptime / 99 % product yield
 ** Product-mix: 10 % SLE-Sun / 40 % SLE / 30 % DLE / 20 % TLE

Technical information:

Key figures of the system

- Annual production capacity: Standard 2.8–18 million m²
- Fastest mechanical cycle times: 20 sec US size / 28 sec Jumbo size
- Campaign time: 3–4 weeks as standard
- Standard coating uniformity: Down to ± 1.0 %
- Champion results for uniformity: Rotary ± 0.5 % / Planar ± 0.6 % on Jumbo size

Bühler series – layer stacks



- | | |
|--------------------|-------------------------|
| 3LE – Triple Low-E | LES – Low-E sun |
| 2LE – Double Low-E | SC – Solar control |
| 1LE – Single Low-E | A-LE – Automotive Low-E |

Options (examples)

- λ symmetric control
- Hydraulic chamber lids
- Flexible roller distance
- Ion source pretreatment
- Top-pumping cathodes
- Service valve

Process environment

- Improved process stability through 850 mm wide compartment design
- Outstanding gas separation
- 5-, 7- or 9-fold trim gas distribution to ideally suit your process needs
- Reduced process gas consumption due to advanced gas flow
- Management close to the substrate surface

Process results for triple silver Low-E

Transmittance VIS (tempered) 75 %

Neutral appearance

$-4 \leq a^* \leq 0$

$-5 \leq b^* \leq -1$



LEYBOLD OPTICS GLC 2000V.

High temperature vertical inline coating.

The ever-growing demand for particle-free coatings on large area substrates, combined with substrate heating for challenging materials and layer stacks, is setting the pace for future equipment manufacturing. LEYBOLD OPTICS GLC 2000V is a process technology for electrochromic window coatings and any other application in the field of large area coating.

LEYBOLD OPTICS GLC 2000V from Bühler is the most modern inline vertical glass coating machine on the market today.

Although initially designed for the challenging application of electrochromic window coatings, this machine perfectly fits any application in the field of large area coating. Substrate heating of up to 350 °C with excellent temperature uniformity, advanced transport features and high-performance process environments are just a few of LEYBOLD OPTICS GLC 2000V's highlights.

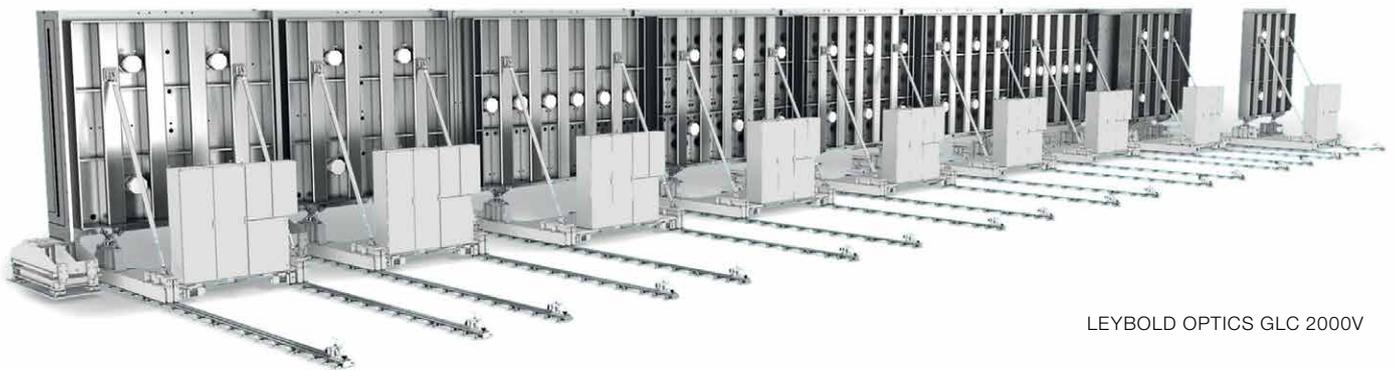
The revolutionary chamber design with opening tracks allows for an optimized maintenance procedure and contributes to the overall efficiency of this high-performance production solution.

Applications:

- TCO coatings (ITO, AZO, etc.)
- SLE/DLE/TLE coatings
- Low-E sun coatings
- Solar control coatings
- AR and mirror coatings

Customer benefits

- Lowest particle impact due to vertical system configuration
- Excellent temperature control over the substrate surface
- Vertical chambers can be completely opened on a rail track system
- Fast maintenance due to excellent accessibility
- Designed for highest precision and the use of special target materials



LEYBOLD OPTICS GLC 2000V

Technical information:

Key figures of the system

- Substrate size (length/width): 3.21 m / 2.0 m
- Substrate temperature: Up to 350 °C on the substrate
- Standard coating uniformity: Down to $\pm 1.5 \%$

Options (examples)

- Thermoscanner for complete substrate temperature mapping
- Carrier for multiple small substrates

- Up to five positions for optical measuring over the glass width

Process environment

- Unique cathode lid design for excellent accessibility and easy maintenance
- Contact-free magnetic carrier guiding on top
- Adjustable conductance tunnel width



LEYBOLD OPTICS GLC series V. Unique tilted design for challenging processes.

This flexible vertical inline sputter coater is specially designed for upright or +/- 7° tilted operation and substrate heating up to 350 °C. The LEYBOLD OPTICS GLC series V is a technical milestone for challenging processes like transparent conductive oxides for electronic or optical applications. The system is the first choice for high-performance low-particle impact production with excellent coating layer quality.

LEYBOLD OPTICS GLC series V from Bühler is a versatile inline coating machine for all vertical sputter processes. The tilted design option is extremely beneficial when it comes to reducing particle impact or even for utilizing gravity to hold a substrate in a 7° tilted carrier during process.

The carrier can be designed to hold multiple small substrates, like smartphone displays, or single substrates with a size of up to 1,400 x 1,400 mm². The system can be equipped with a housed carrier return track to avoid particle impact from the surrounding atmosphere or to

retain dust from potentially hazardous sputter material from emitting into the production facility.

The LEYBOLD OPTICS GLC series V family, ranging from 400V to the 1700V, is suitable for all TCO and metal coatings.

Applications:

- Anti-reflective coatings
- TCO coatings
- Touch panel products

Customer benefits

- Versatile platform for a broad range of substrate sizes
- Low particle impact on the substrate thanks to 7° tilted design
- Optional housed carrier



LEYBOLD OPTICS
GLC 1400V

Technical information:

Key figures of the system

- Individual cathode length: 400 to 1,700 mm
- Substrate sizes: From 300 x 300 mm² up to 1,400 x 1,400 mm²
- Substrate thickness: Depending on carrier design
- Coating technology: DC planar move-target / MF rotary cathodes
- Substrate heating: Up to 350 °C on the substrate
- TCO materials: ITO, AZO and many more
- Single glass carrier design

Options

- Optional substrate pretreatment: Linear ion source
- Multiple substrates carrier design

Process environment

- Carrier design straight upward, +7° or -7° tilted
- Hinged cathodes for easy and fast maintenance



LEYBOLD OPTICS DIS series V.

A powerful solution for all display applications.

Highest target utilization, lowest particle yield, and a straightforward way of exchanging the targets: **LEYBOLD OPTICS DIS series V** is Bühler's production solution for the display industry. The system can process large substrates in sizes of up to Gen 10 (2.88 m x 3.13 m). Depending on the requirements, a contact-free transport system is available, using magnetic linear motor drives. Excellent quality of the coating layers is a key benefit of the **LEYBOLD OPTICS DIS series V**.

LEYBOLD OPTICS DIS series V initial design is rooted deeply in the display industry, where particle impact is making the difference. With a one-sided load and unload module and a carrier rotation module at the end of the system, this machine is perfectly designed for clean-room applications, as the LEYBOLD OPTICS DIS series V can be set up in a gray room, accessing the clean room only with its loading module.

Another major advantage of this approach is the folded design of the machine, which allows for an optimized

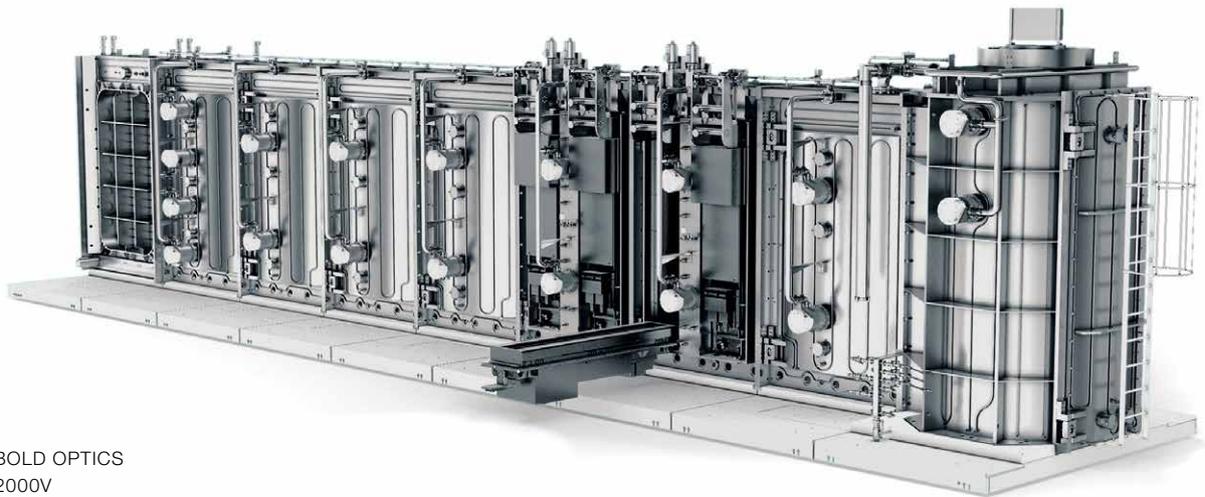
footprint, as the return track can also be equipped with cathodes and heaters. These unique features make this production solution a smart choice for every vertical in-line sputter application that requires substrate heating and excellent process results, like TCO or carbon coatings.

Applications:

- AR coatings for LCD products
- ITO coatings for color filters
- Touch panel products

Customer benefits

- Excellent target utilization
- Lowest particle contamination
- High production capacity
- Flexible multi-chamber tool
- Easy and fast maintenance
- Optimized target exchange
- Optimized footprint



LEYBOLD OPTICS
DIS 2000V

Technical information:

Key figures of the system

- Flexible mechanical cycle time:
Starting from 22 sec
- Substrate sizes: Gen 5 up to Gen 10
- Substrate thickness: 0.4–5.0 mm
- Coating technology: DC planar move-target / MF rotary cathodes
- Substrate heating: Up to 350° C on the substrate
- Optional substrate pretreatment: Linear ion source
- TCO materials: ITO, AZO and many more

Options

- Planar cathodes with extended utilization by moving target technology
- Magnetic linear motor for reduced particle impact during transport

Process environment

- Multi-zone heating elements for optimized temperature uniformity
- Separate gas distribution zones
- Hinged cathodes for easy maintenance



LEYBOLD OPTICS GLC series H lab. Flexible solutions and excellent quality.

Cost efficiency, excellent quality of the coating layers, and an outstanding process versatility are the key features of this R&D lab-coater concept. The chosen target width of 878 mm is a balanced measure between R&D process development and the transferability of the results onto the large scale.

The transferability of research and development results to large-scale production is the key for business success.

Bühler Leybold Optics delivers equipment for substrate sizes ranging from as small as eye glasses up to substrate sizes of 39.6 m². For research & development requirements, Bühler offers solutions that help to master the challenge of scaling up processes from small equipment to production scale systems.

LEYBOLD OPTICS GLC series H lab is a dedicated large area coating R&D system with a geometry perfectly balanced between material economics and process result transferability.

Applications

- R&D tool for multiple processes in architectural and automotive glass
- Low-E/AR/color filter coatings
- Co-sputtering for new material combinations

Customer benefits

- Highest cost efficiency
- Flexible layer stack through multi-path concept
- Material mixing by means of co-sputtering with variable ratio
- Substrate heating for challenging coating processes and materials
- Ion source for substrate pretreatment (e.g. for acrylic substrates)



LEYBOLD OPTICS GLC series H lab

Technical information:

Key figures of the system

- Substrate length: 1,000 mm
- Substrate width: 500 mm
- Substrate thickness: 3–19 mm
- Special thickness: 0.2–3.0 mm with carrier plate
- Uniformity: +/- 1 % in center area of 400 x 400 mm²

Options

- Ion beam source for substrate etching and deposition
- Optical inline measurement device
- Active gas separation

Process environment

- Substrate heating up to 250 °C
- Hot sputter position

Bühler upgrades, retrofits and services. Field-proven state-of-the-art design.

As a partner of the industry, Bühler Leybold Optics is committed to delivering the best solution for the customer. Sometimes this is not a new coater, but an intelligent upgrade that utilizes your existing coating solution and reshapes it to be capable of satisfying today's process requirements.

Bühler offers all process-related services, such as:

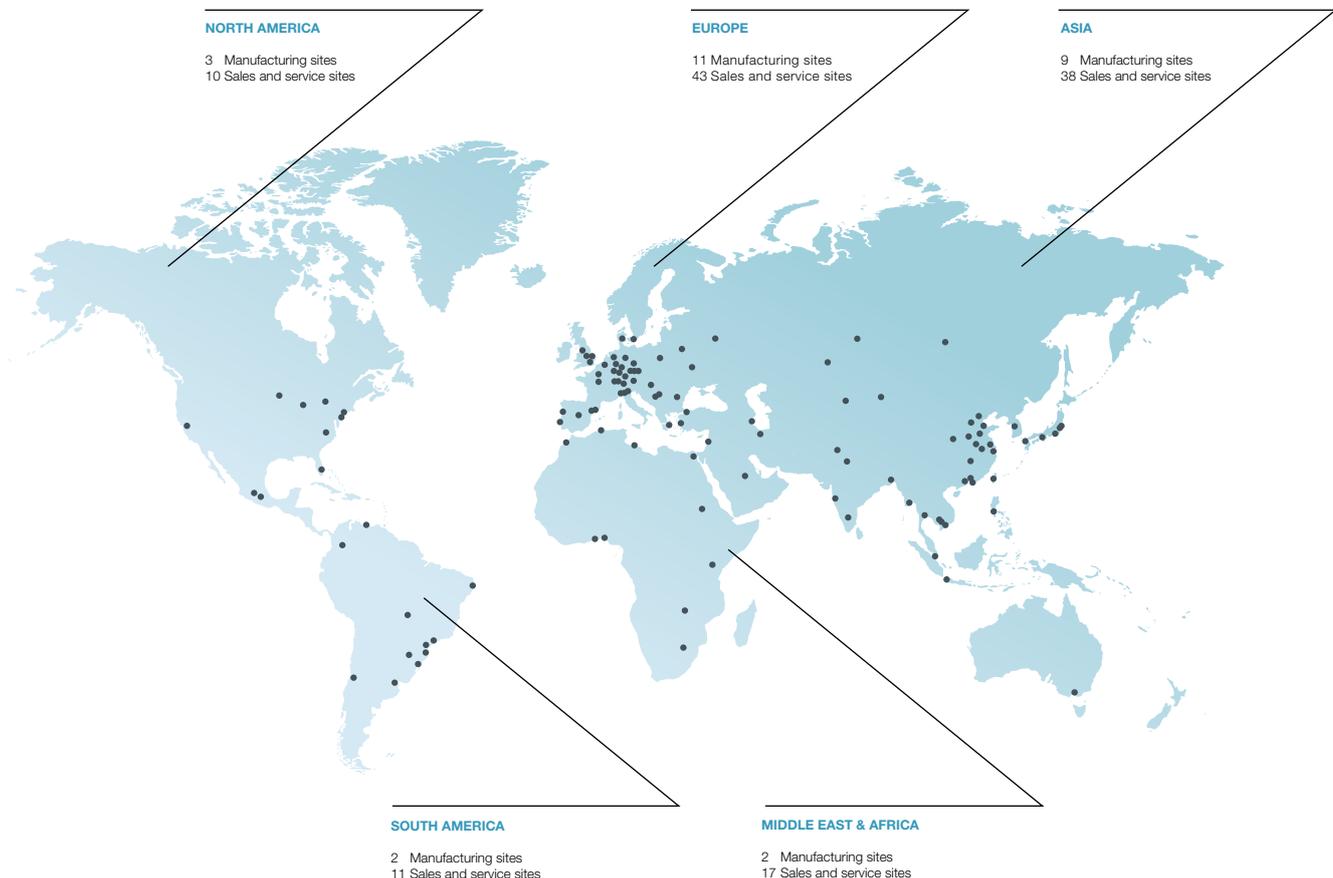
- Layer stacks for the different fields of large area coatings
- Development of new layer stacks according to specific customer requests
- Simulation support (optical, mechanical, thermal and magnetic properties)
- Process start-up at customer site

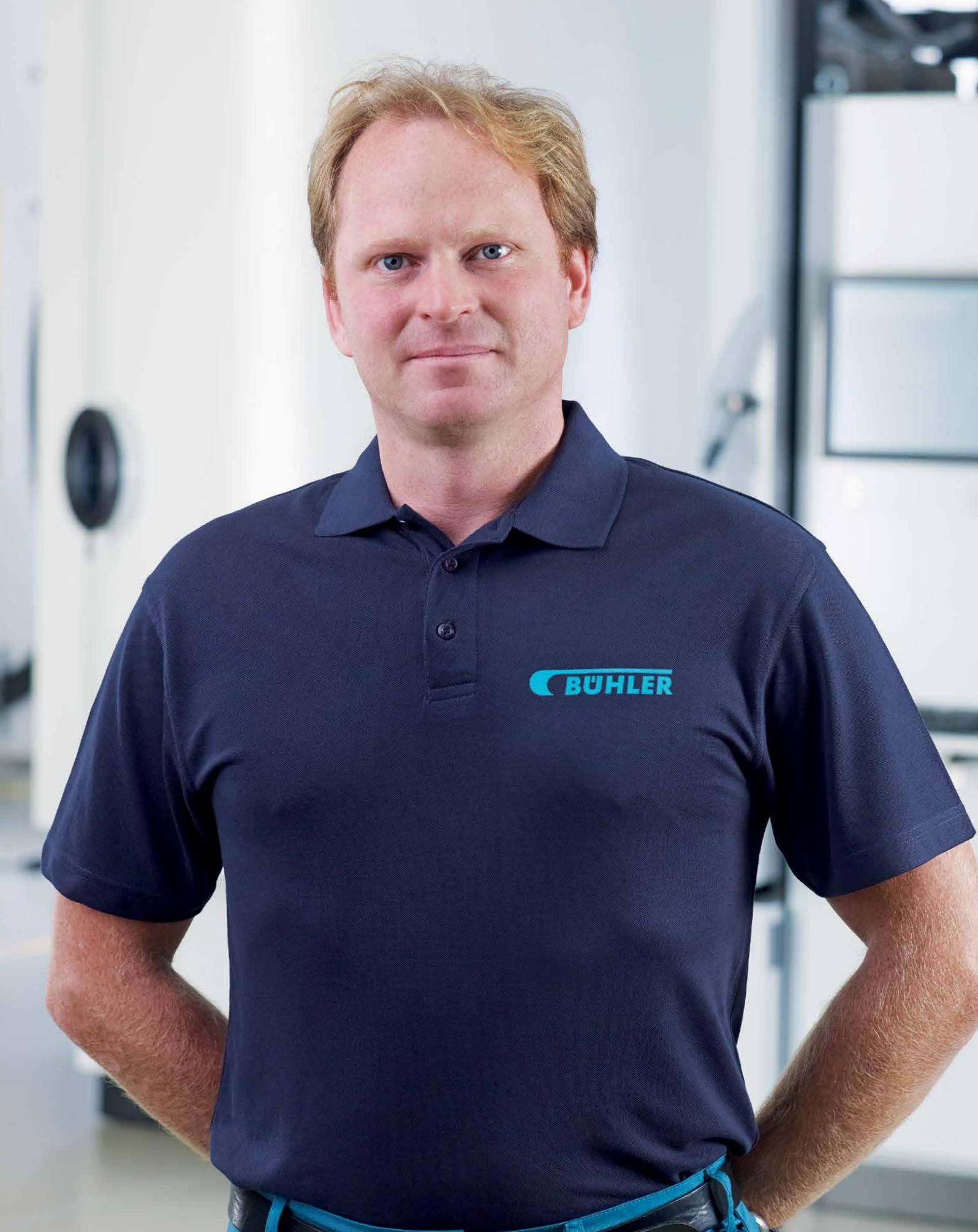
Customers can rely on the extensive process know-how of Bühler experts and the group's global presence in more than 140 countries. 90 affiliates and branch offices worldwide make Bühler available to its customers whenever needed.

Customer benefits

- Low initial investment for upgrades and retrofits
- Proven solutions for glass coating machines
- Improved quality and throughput of retrofitted production systems

Global presence of Bühler





Bühler services ensure that the systems will remain productive and operate reliably in the long term.

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