

VON ARDENNE 

COATING SYSTEMS FOR PRECISION OPTICS

COATING SYSTEMS FOR PRECISION OPTICS

FROM R&D TO MASS PRODUCTION

With 60 years of experience with electron beam processes and 45 years in magnetron technology, both for industrial production and for research and development, VON ARDENNE is one of the leading providers of equipment and technologies in PVD thin-film technology and vacuum process technology. Thanks to this expertise, we have managed to supply over 500 vacuum coating systems to our customers all over the world. We are well prepared to turn your product property requirements into efficient and competitive coating solutions based on various modular assembly systems like batch, cluster, inline or drum coater configurations.

Precision optics have been in increasing demand for the last couple of years. This market will grow even further advanced by mega trends such as autonomous driving, the internet of things, virtual reality but also new solutions for communication technology, medical or measuring technology.

Applications



Sensors

Optical sensors are increasingly being manufactured. Depending on their application, they can vary tremendously. Currently, LIDAR (light detection and ranging) sensor technology for autonomous driving is a booming application.



Displays

The optical properties of displays can be specifically influenced. Depending on the application, these properties can be contradictory such as the reflection specifically created for head-up-displays and anti-reflection coatings for tachometers.



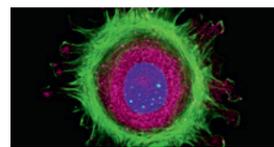
Automotive Infotainment

The infotainment technology in modern vehicles goes far beyond the classic radio and is increasingly becoming a crucial design feature for the car manufacturers and their makes with more and more new features.



Camera Systems

The number of camera systems produced every year has skyrocketed. Even though they are so small that they can hardly be seen, like those built into phones, they are packed with the most sophisticated thin-film technology.



Microscopes/ Binoculars

Even though they could almost be called "old" products, the coatings in microscopes and binoculars are crucial for the performance of these products. This is especially true for special technology combinations, such as luminescence microscopy.



Telescopes

The further away the objects are that shall be observed, the higher are the requirements for the applied thin-film technology. This is especially true for large and space telescopes.



Laser Optics

Laser applications have become indispensable for the industry, for instance in metal-cutting machines. A precondition for their use is durable and non-destructive optical systems.



Research & Development

The increasing number of applications requires extensive research and development, also for equipment manufacturing and key technologies, which must meet new requirements. Applications with new requirements are, for instance, lateral and vertical gradient layer technologies and the coating of free-form surfaces with specified local layer thickness distribution. This demand has created a dynamically growing scientific field.

A crucial prerequisite for precision optics to function is high-precision coatings that make use of the interference properties and, thereby, provide the desired characteristics. Thanks to its experience in developing and manufacturing vacuum coating equipment, the VON ARDENNE Group possesses a profound understanding of the physical processes that are necessary for vacuum coating and extensive expertise in how to use them for a multitude of different applications.

This knowledge is the basis for the development of many different equipment platforms, that are distinguished by the technology they use, their productivity and flexibility. VON ARDENNE coating technology solutions cover the whole spectrum of requirements, from research and development to pilot production to mass production.

Functions of the Layer Systems

- ... Anti-reflection
- ... Anti-scratch
- ... Bandpass filter with a very low angle shift and wide stopband
- ... Uncoupling of spectra/spatial reflectors/dichroics
- ... Filters for LIDAR applications
- ... Filters for facial recognition
- ... Highly reflective mirrors
- ... Cold-light mirror
- ... Edge filter with very steep edge
- ... Polarizing filter
- ... Ultra-thin bandpass filters in UV-VIS-IR range
- ... Rugate filters
- ... Special mirrors (e.g. EUV, X-ray)
- ... Beam splitter
- ... Anti-smudge (easy-to-clean)
- ... Notch filters

Materials

Depending on the product requirements, materials ranging from simple $\text{SiO}_2/\text{Si}_3\text{N}_4$ systems to complex combinations of various metals and oxynitrides can be applied.

Typical Layer Materials/ Coating Processes

- ... High refractivity:
 Si_3N_4 , Nb_2O_5 , TiO_2 , ZrO_2 , HfO_2 , Ta_2O_5 , Cr_2O_3 , amorphous Si
- ... Low refractivity:
 SiO_2 , Al_2O_3
- ... Layer compositions with variable refraction index:
 SiOxNy , TiOxNy , AlOxNy , HfZrOy
- ... Metallic layers:
Cr, Al, Si, Ag, Au
- ... Transparent conductive layers:
ITO, AZO

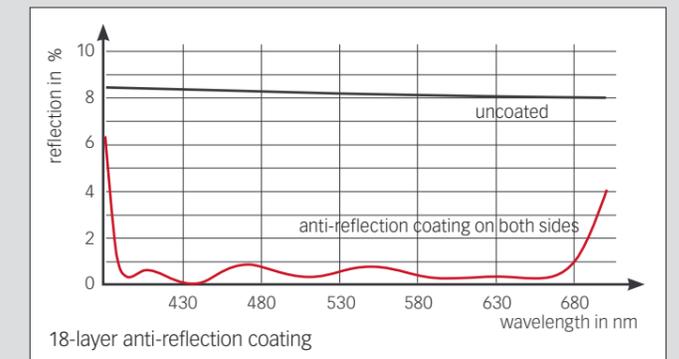
The Quality of our Layer Systems

Our layer systems as a whole stand for a high-precision product. Thus, every single deposited layer must meet very high requirements concerning their properties, such as uniformity, color fastness, low occurrence of defects, roughness and reproducibility.

All process components that are used must meet the high VON ARDENNE quality standards. Thereby, it is ensured that the process stability can be maintained over long campaign times. Furthermore, contamination can be prevented, and it is ensured that the components do not exceed their designated lifetime.

Even in the engineering phase, the final optical properties are tuned and aligned with the process window. In quality control, the characteristic values are tested with the help of in-situ measurement. This allows for an integrated finetuning of the coating aiming for a perfect product.

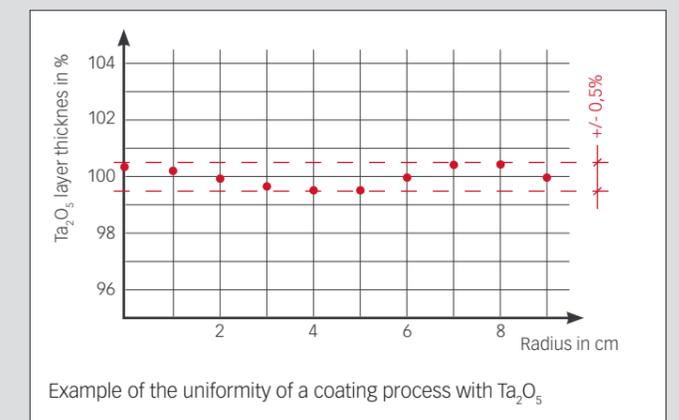
Subject to change without notice due to technical improvement.



Scanning electron microscope (SEM) image of a bandpass filter based on $\text{Al}_2\text{O}_3/\text{SiO}_2$ (81 layers)



SEM image of a rugate filter based on $\text{SiO}_2/\text{HfO}_2$ with sinus-shaped refractive index modulation and a refractive index travel varying across the sample (apodized design)



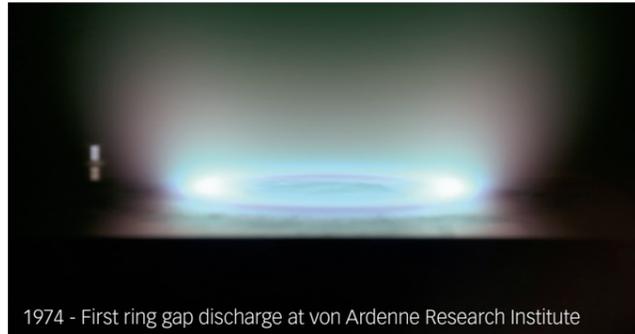
Key Components

The success of our modular process systems is based on their highly flexible and broad configuration range, our technological experience and know-how, and on our in-house developed and manufactured key components. Depending on the required tool configuration, a VON ARDENNE system may include one or more of the listed components. Due to their modular design, the systems can also be upgraded or retrofitted with these components after the initial system installation.

The main technology used for coating on VON ARDENNE equipment is magnetron sputtering. We develop and manufacture the necessary components such as magnetron sputtering sources in-house and have more than 40 years of experience with magnetron sputtering.

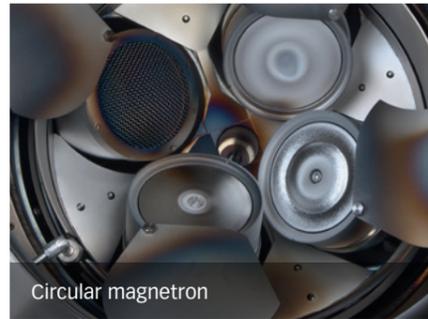
VON ARDENNE magnetrons are available for a wide range of applications. Thanks to many years of experience gained from designing

and installing advanced sputtering equipment, we can offer a complete portfolio of solutions from RF and AC to DC processes, planar to rotatable applications and even magnetrons with integrated turbopumps.

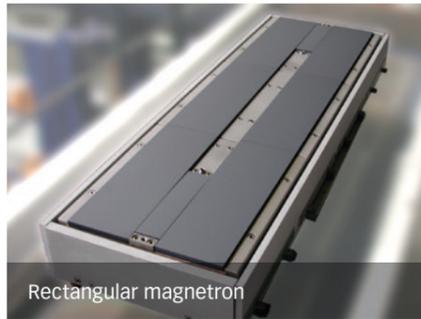


1974 - First ring gap discharge at von Ardenne Research Institute

VON ARDENNE Magnetron Sputter Sources



Circular magnetron



Rectangular magnetron

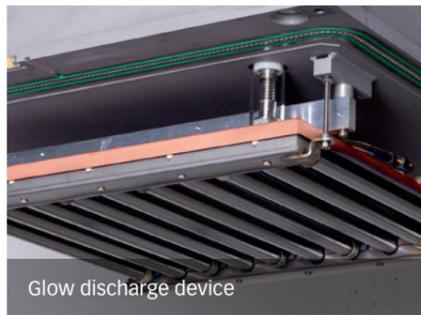


Cylindrical magnetron

VON ARDENNE Pre-Treatment Components



Inverse sputter etcher

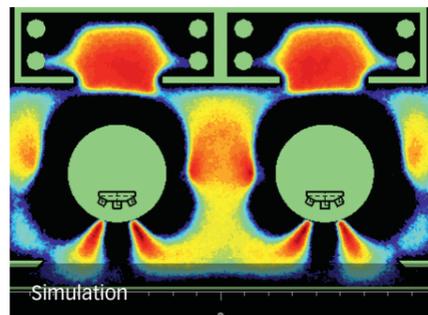


Glow discharge device



LION ion source

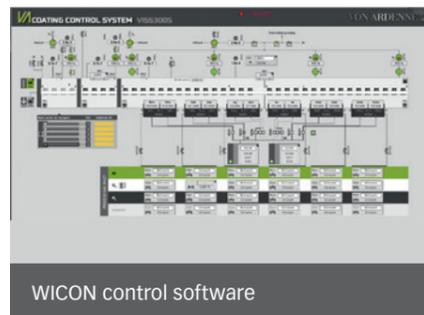
VON ARDENNE Simulation Software and Process Control Systems



Simulation



VA PROCOS 2 process control system



WICON control software

Equipment Portfolio for Optical Applications

VON ARDENNE offers several equipment platforms for the sputter coating of substrates used in optics. The platforms have in common that their design is modular and that their functionality and productivity can be adapted to their specific tasks. They are configured according to the specifications of the customer. Apart from the available standard modules, we can offer special solutions for your requirements.

The platforms can be distinguished by their specific properties as they are designed for different applications.

The **OPTA X** is suited for the most sophisticated tasks. It enables the use of various technologies and creates excellent layer properties and stable layer stacks, especially for multilayer systems with a high number of individual layers.

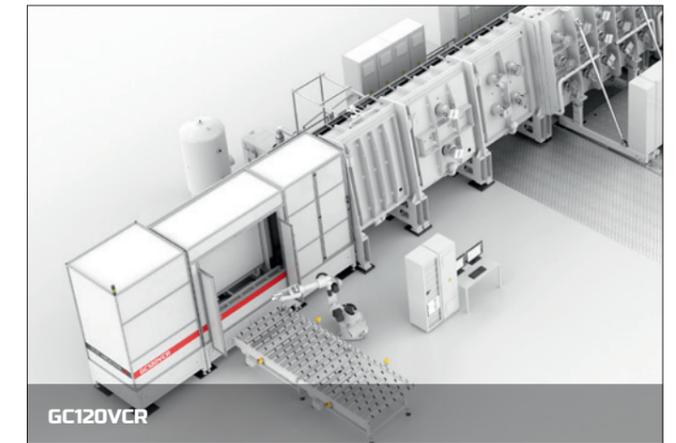
The inline systems **HISS**, **VISS** and **GC120VCR** are production systems for high-volume manufacturing with a limited number of layers. Their distinguishing features are the coating direction and their productivity, and they are available in different configurations ranging from single end to inline with an integrated carrier return system and automatic loading and unloading of the carrier. Therefore, they offer potential for a low cost of ownership.

The great advantage of the different platforms is their scalability. Because of that, they are suitable for fields of application ranging from research and development to the production of smaller series to high-volume production. Beyond that, the use of proven VON ARDENNE components facilitates the scaling and the process transfer even further.

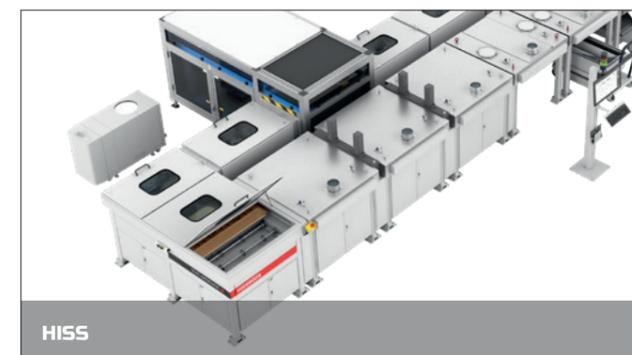
Equipment	OPTA X	HISS	VISS	GC120VCR
Precision	+++	++	++	++
Substrate orientation	horizontal	horizontal	vertical -7°	vertical -7°
Max. substrate size	280 mm x 320 mm	600 mm x 1100 mm	600 mm x 2400 mm	1200 mm x 1550 mm
Productivity	++	+++	+++	mass production



OPTA X



GC120VCR



HISS



VISS

OPTA X Rotary Disk Coating System

for Sophisticated Layer Systems

Configuration Examples



The **OPTA X** is our system for the most sophisticated layer systems, especially for optical multi-layer systems with a high number of layers. The coating is done horizontally, and different processes are available for an optimal coating: Meta Mode, CARS*, reactive and non-reactive sputtering.

The system has **five ports** that can be used to integrate magnetrons and/or plasma sources. In-situ measurement technology is also available for monitoring and adjusting the coating process.

The **OPTA X** is equipped with a modular **automatic handling system** that enables a safe loading of the system with various substrates that are passed through the system in customized carriers.

Depending on the process and productivity requirements, different module types, such as magazine load locks or pre- or post-treatment chambers, can be combined.

TECHNICAL DATA

Subject to change without notice due to technical improvement.

SUBSTRATE

Material	glass, polymers, metals
Size (L x W), max.	280 mm x 320 mm
Diameter	up to 200/300 mm
Thickness	70 mm

DEPOSITION SYSTEM

Deposition type	DC, pulsed DC, AC, CARS*, meta mode, reactive sputtering, RF
Magnetron type	planar, rotatable
Plasma source	inductively coupled
Substrate temperature range	RT / 300 °C
Substrate potential	floating
Number of independent process gases	4 (e.g. Ar, Ar/O ₂ , N ₂ , O ₂ , H ₂)

TRANSPORT

Type of transport	robot, carrier
-------------------	----------------

SYSTEM CONTROL & SOFTWARE

Hardware	industry PC/ SPS module
User interface	Windows 10 with control software/ Siemens SPS
MES link	SECS/ GEM

DIMENSIONS AND WEIGHT

Total system size (L x W x H)	at least 5 m x 5 m x 3 m
Total system weight	depending on configuration

OPTIONAL

Optical in-situ measurement, VA PROCOS process control system, plasma treatment of substrate, substrate heating, combination with other process chambers, additional load locks, more on request

OPTA X for Catalog Optics

Layer stacks (H/L)

... Ta₂O₅/SiO₂ (CARS*/Meta Mode)

Process-up configuration

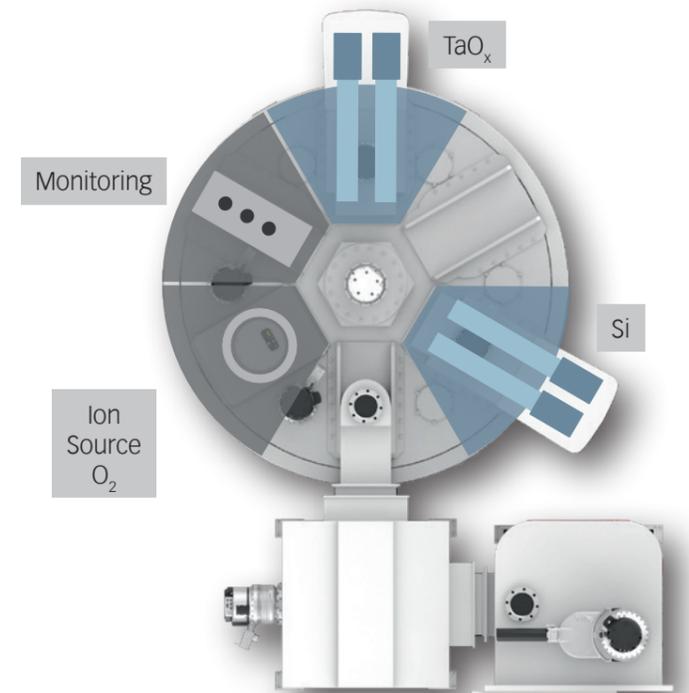
- ... 2 target materials
- ... 2 dual rotary cathodes
- ... 1 ion source

Process-down configuration

- ... Upon request

Features

- ... In-situ adjustable magnet bars (rotary targets)



OPTA X for Laser Optics

Layer stacks (H/L)

... Nb₂O₅/SiO₂ (CARS*/Meta Mode)

... HfO₂/SiO₂ (RF/Meta Mode)

Process-up configuration

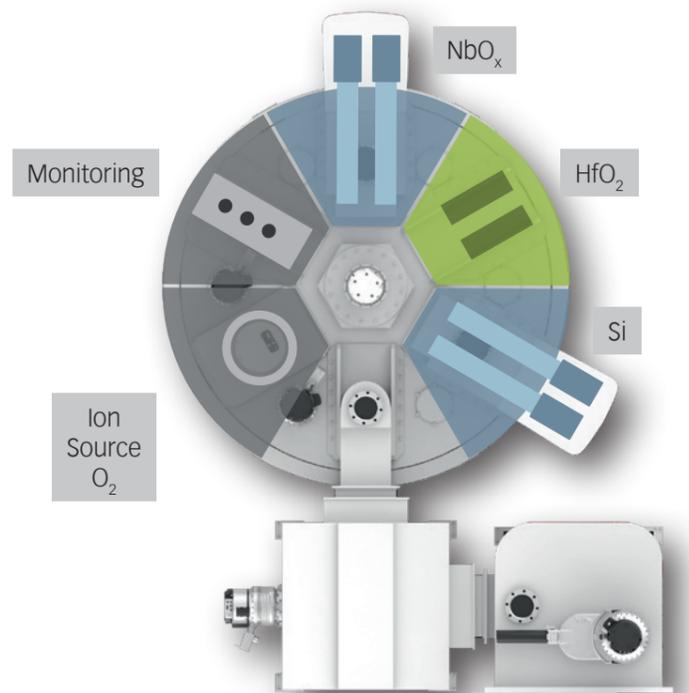
- ... 3 target materials
- ... 2 dual rotary cathodes
- ... 1 dual planar cathode
- ... 1 ion source

Process-down configuration

- ... Upon request

Features

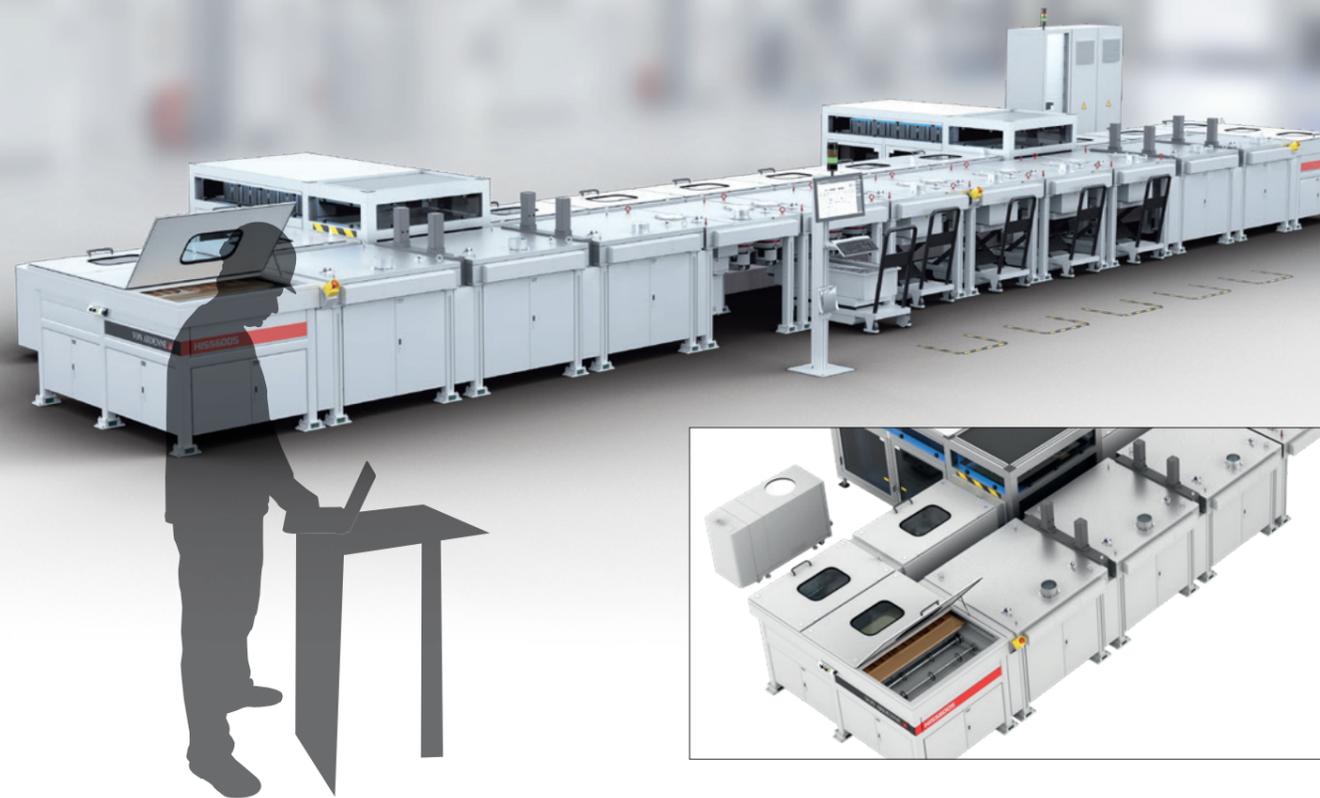
- ... On-carrier subrotation possible
- ... In-situ adjustable magnet bars (rotary targets)
- ... Exchangeable shaper



*Fraunhofer IST

HISS Horizontal Coating System

Flexible, Scalable Inline System for Medium Productivity



The **HISS** is a modular vacuum coating system with a carrier-based substrate transport. It is the perfect choice if you are looking for highly flexible production equipment with a small or medium throughput equipped with proven technology.

Thanks to its modular design, the **HISS** can be configured according to your needs. We offer various basic configurations of the system such as the single-ended version for a smaller production scale.

The system offers a **high process flexibility** as the process chamber can be configured with planar or rotatable magnetrons. Ion pre-treatment or heating and cooling units are available upon request. All auxiliary chambers, like entry/exit, buffer and transport chamber, can be upgraded in a similar manner.

The **flexible and dynamic design** of the system with standardized subcomponents enables custom-made configurations. That means that the system can be adapted to new processes or requirements. Therefore, our customers are able to act very dynamically and can adapt to the evolution of their product.

TECHNICAL DATA

Subject to change without notice due to technical improvement.

SUBSTRATE	
Material	glass, polymers, metals
Coating width	400 mm or 600 mm
Length	up to 1100 mm
DEPOSITION SYSTEM	
Deposition type	DC, pulsed DC, AC, RF
Magnetron type	planar, rotatable
Plasma source	glow discharge device, inverse sputter etcher (ISE) or ion source
Sputter arrangement	up, down
Substrate temperature range	RT/ 300 °C
Substrate potential	floating
Number of independent process gases	4 (e.g. Ar, Ar/O ₂ , N ₂ , O ₂ , H ₂)

TRANSPORT	
Type of transport	carrier-based, optional: carrier return system, stocker
Loading	optional: automatic loading and unloading by robot

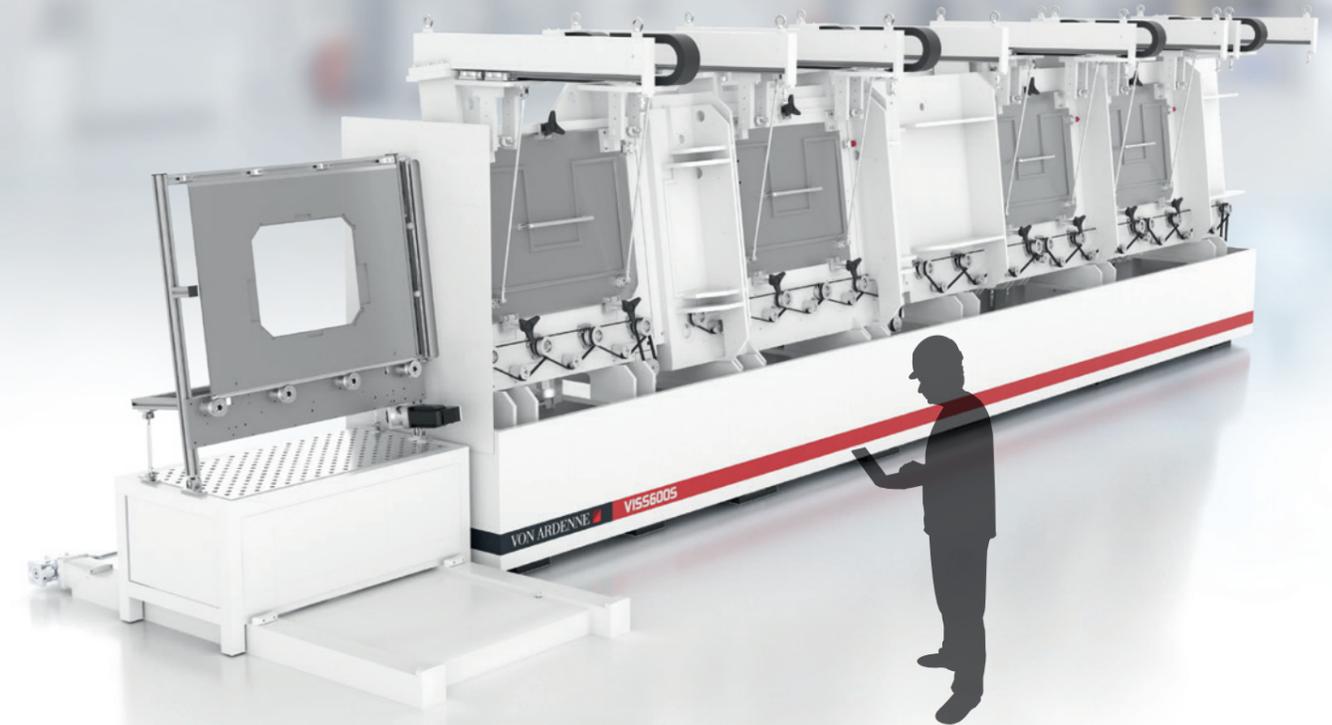
SYSTEM CONTROL & SOFTWARE	
Hardware	industry PC/ SPS module
User interface	Windows 10 with WICON control software
MES link	SECS/ GEM

DIMENSIONS AND WEIGHT	
Depending on version (400/600) and configuration	

OPTIONAL	
Plasma pre-treatment, process technology, VA PROCOS process control system, optical in-situ measurement, easy-to-clean module (ETC), more on request	

VISS Vertical Coating System

Highly Flexible Inline System



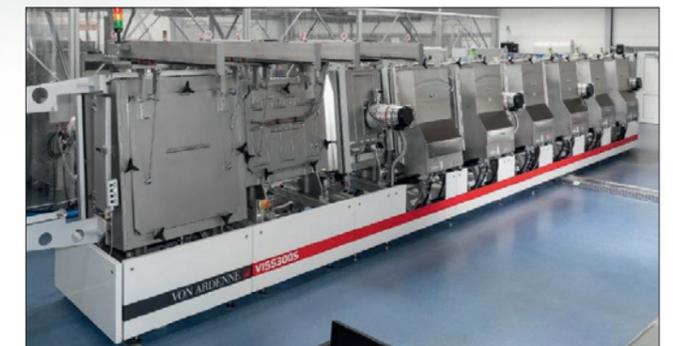
The vertical in-line sputter system **VISS** is an appropriate, modular solution for vertical deposition processes when scaling up from laboratory use to production. The tool is available either as a single end inline or for continuous processing and is uniquely suited for scaling up to substrate sizes of up to 600 mm x 2400 mm.

The substrates are transported by a carrier system, which is tilted vertically by seven degrees. The substrates can be loaded without touching their front side.

TECHNICAL DATA

Subject to change without notice due to technical improvement.

SUBSTRATE	
Material	glass, polymers, metals
Size (L x W)	max. 600 mm x 2400 mm
DEPOSITION SYSTEM	
Deposition type	DC, pulsed DC, AC, RF
Magnetron type	planar, rotatable
Plasma source	glow discharge device, inverse sputter etcher (ISE) or ion source
Sputtermodus	vertical
Substrate temperature range	RT
Substrate potential	floating
Number of independent process gases	4 (z.B. Ar, Ar/O ₂ , N ₂ , O ₂ , H ₂)



TRANSPORT	
Type of transport	carrier-based, optional: carrier return system, stocker
Loading	optional: automatic loading and unloading by robot

SYSTEM CONTROL & SOFTWARE	
Hardware	industry PC/ SPS module
User interface	Windows 10 with WICON control software
MES link	SECS/ GEM

DIMENSIONS AND WEIGHT	
Depending on version (400/600) and configuration	

OPTIONAL	
Plasma pre-treatment, process technology, VA PROCOS process control system, optical in-situ measurement, easy-to-clean module (ETC), more on request	

GC120VCR Vertical Coating System

Industry-Proven Production System with a Small Footprint

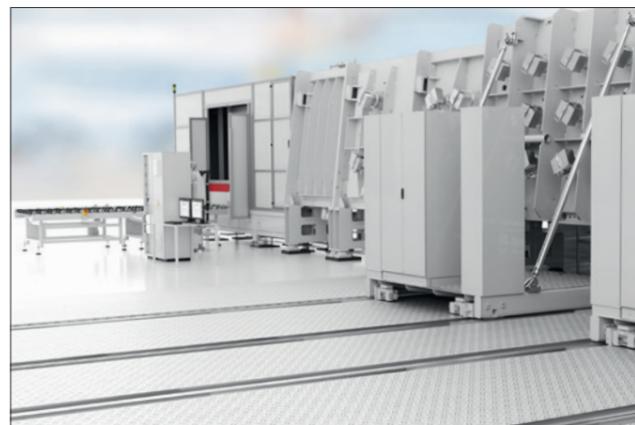


The **GC120VCR** is a vertical inline coating system for the deposition of metal and oxide thin-film multilayer systems on flat glass substrates or other materials.

As a leading developer and manufacturer of vacuum coating equipment for large-area applications, VON ARDENNE has incorporated its broad knowledge and expertise in PVD technologies into the **GC120VCR** platform. The reliability of this system is well proven in the industry.

Due to its vertical and carrier-based design, the **GC120VCR** has a **small footprint** and requires **fewer maintenance intervals**.

The **maintenance-friendly design** of the system enables easy access to the magnetron environment for target exchange and maintenance.



TECHNICAL DATA

Subject to change without notice due to technical improvement.

SUBSTRATE	
Material	glass, polymers, metals
Dimensions (W x L), max.	1280 mm x 1650mm (others on request)
Thickness	1.8 mm (1.4 mm) to 4 mm (others on request)

DEPOSITION SYSTEM	
Deposition type	DC, pulsed DC, AC
Magnetron type	planar, single or dual rotatable
Sputter arrangement	vertical
Substrate temperature range	RT / 200 °C / 400 °C
Substrate potential	floating
Number of independent process gases	up to 4 (Ar, O ₂ , N ₂ , X)

TRANSPORT	
Type of transport	inline, carrier-based
Orientation of substrate	vertical, LEL, SEL
Transport speed	≤ 3.5 m/min
Cycle time	30 s

SYSTEM CONTROL & SOFTWARE	
Computer hardware	PLC, Siemens S7
User interface	VON ARDENNE user interface
MES link	according to specifications

SYSTEM DIMENSIONS	
Total system size (L x W x H)	customized x 13 m x 3.5 m
Total system weight	depending on configuration

Our Strengths

In-House Technology & Application Center

- ... Sample coatings of customer applications
- ... Development of customized layer stacks
- ... Product & process verification and optimization
- ... Testing of new technologies and components

Close Partnership

VON ARDENNE entertains a close network of partners for even more profound R&D work and to identify future technologies. It consists of:

- ... Fraunhofer Institutes such as IPMS, FEP and ISE
- ... Institutes of the Helmholtz Association (Jülich, Berlin)
- ... Universities (Dresden, Kiel, Sheffield)
- ... Companies such as FAP GmbH, scia Systems GmbH

Professional Simulation Support

We offer professional simulation technology to ensure best process quality with regards to plasma, heat and cooling. Furthermore, our simulation tools help demonstrate, develop and improve layer properties and define or optimize processes, details and the performance of our systems.

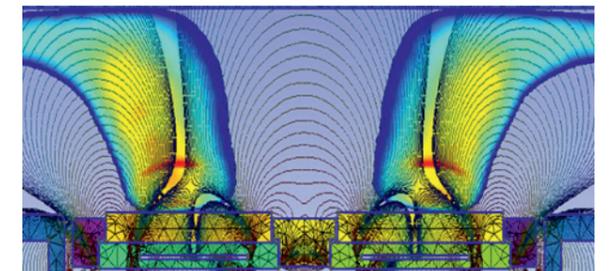


Sheffield
Hallam
University

Fraunhofer
IST

Fraunhofer
IPMS

Fraunhofer
FEP



Global Project Experience

VON ARDENNE equipment is used in over 50 countries. We have established an installed base of hundreds of coating systems worldwide, ranging from small tools to equipment for large-area coating applications for several markets.



Comprehensive Service Portfolio

- ... VON ARDENNE services hubs around the world
- ... On-site service (on request)
- ... Remote access from our technology department (if required)
- ... Regular technical and technological trainings offered
- ... Spare & wear part warehouse close to customers
- ... Lifecycle extension of wear parts

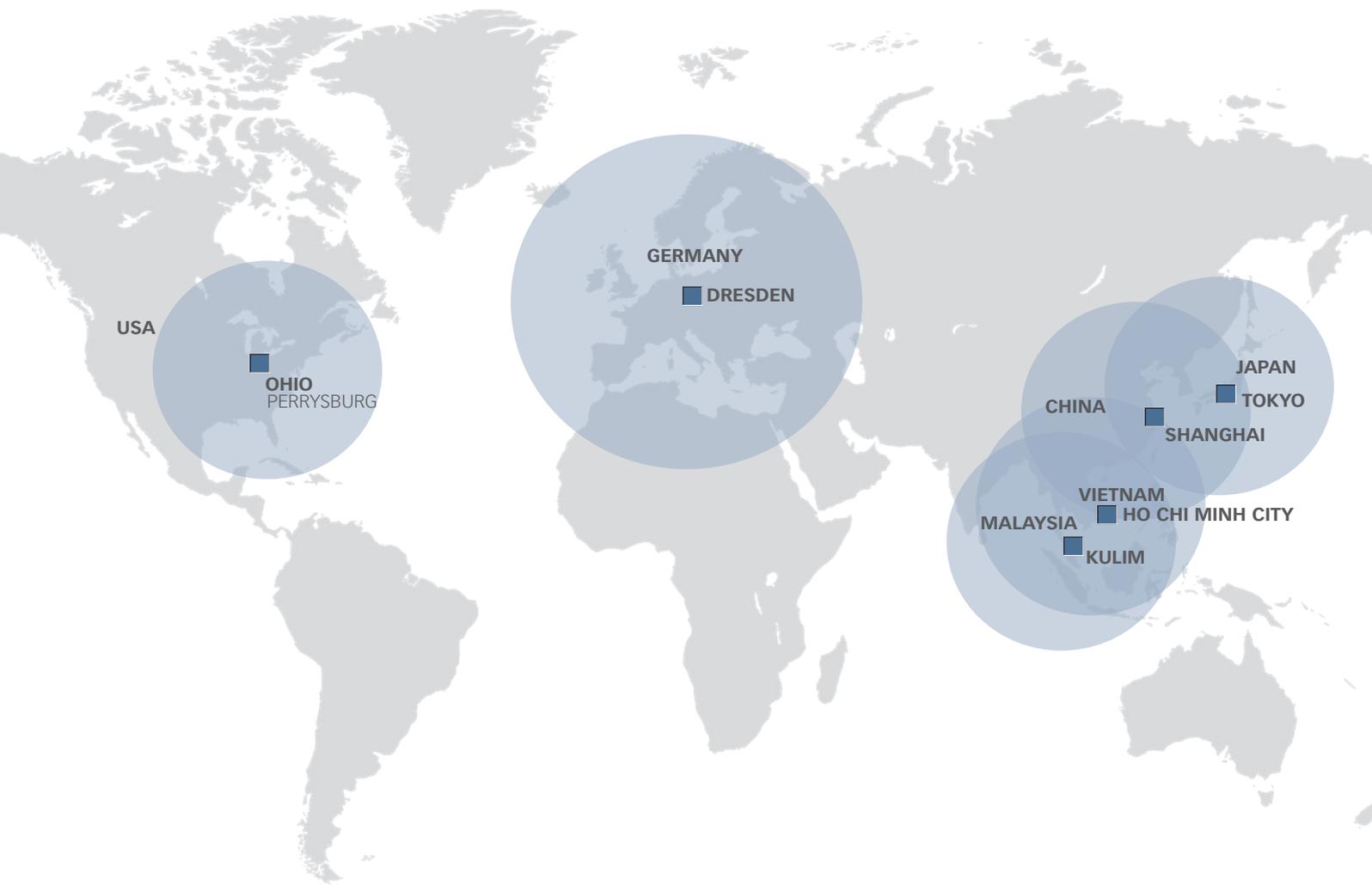


Upgrades & Retrofits

As soon as your business is growing, your VON ARDENNE equipment will grow accordingly - thanks to its modular design and the upgrades we provide. We will also supply you with the necessary technology upgrades if you decide to change your applications.

Furthermore, when your equipment is ageing, we will retrofit your systems with new components, no matter if they are VON ARDENNE or third-party machines.





PRODUCT
TOPICS



PRODUCT
INDEX



COMPONENTS



www.vonardenne.biz

WHO WE ARE & WHAT WE DO

VON ARDENNE develops and manufactures industrial equipment for vacuum coatings on materials such as glass, wafers, metal strip and polymer films. These coatings give the surfaces new functional properties and can be between one nanometer and a few micrometers thin, depending on the application.

Our customers use these materials to make high-quality products such as architectural glass, displays for smartphones and touchscreens, solar modules and heat protection window film for automotive glass.

We supply our customers with technologically sophisticated vacuum coating systems, extensive expertise and global service. The key components are developed and manufactured by VON ARDENNE itself.

Systems and components made by VON ARDENNE make a valuable contribution to protecting the environment. They are vital for manufacturing products which help to use less energy or to generate energy from renewable resources.



SALES
CONTACTS



SERVICE
CONTACTS

WORLDWIDE SALES AND SERVICE

VON ARDENNE GmbH (headquarters) | Am Hahnweg 8 | 01328 DRESDEN | GERMANY

Sales: ☎ +49 (0) 351 2637 189 | sales@vonardenne.biz

Service: ☎ +49 (0) 351 2637 9400 | support@vonardenne.biz

VON ARDENNE Vacuum Equipment (Shanghai) Co., Ltd. | ☎ +86 21 6173 0210 | 📠 +86 21 6173 0200 | sales-vave@vonardenne.biz; support-vave@vonardenne.biz

VON ARDENNE Malaysia Sdn. Bhd. | ☎ +60 4408 0080 | 📠 +60 4403 7363 | sales-vama@vonardenne.biz; support-vama@vonardenne.biz

VON ARDENNE Japan Co., Ltd. | Tokyo office | ☎ +81 3 6435 1700 | 📠 +81 3 6435 1699 | sales-vajp@vonardenne.biz; support-vajp@vonardenne.biz

VON ARDENNE North America, Inc. | Ohio office | ☎ +1 419 386 2789 | 📠 +1 419 873 6661 | sales-vana@vonardenne.biz; support-vana@vonardenne.biz

VON ARDENNE Vietnam Co., Ltd. | ☎ +60 124 23 7353 | sales-vavn@vonardenne.biz; support-vavn@vonardenne.biz