

VON ARDENNE 

COATING SYSTEMS FOR GLASS APPLICATIONS

ARCHITECTURAL GLASS | SMART GLASS
FLEXIBLE GLASS | AUTOMOTIVE GLASS

Our History & Experience

VON ARDENNE has a long tradition in glass coating. In 1955, the Manfred von Ardenne Research Institute was established in Dresden. It achieved a leading position in electron beam and plasma technologies and their application in vacuum coating. The institute paved the way for large-area coating and the manufacturing processes and systems we offer today.

In 1974, VON ARDENNE started to establish its expertise in **magnetron sputtering**. Since then, we have become a worldwide leading company in magnetron sputtering. This is due to more than 45 years of expertise in advancing the technology, the equipment and the components.

Another milestone was the **first inline sputtering system** for continuous coating of precious metal-free mirrors in 1983. The success of the project mainly depended on the new large-area planar magnetron. This system was the predecessor of the equipment used for the production of heat-insulating architectural glass today.

In 1993, the planar dual magnetron was used for the first time for architectural glass coating in an upgrade project. The breakthrough came in 1996 with the first inline coater for Jumbo formats.

For **process control**, VON ARDENNE was among the first to offer a plasma emission monitor. It enabled optical process control in an industrial environment. Many of our customers have used the first-generation PEM05, then the VAprocos and now the VAprocos2 process control system. These systems enabled them to use transition mode sputtering with planar and rotatable targets.

We have also developed an integrated solution for **optical measurement**: the ExSitu measuring system. Furthermore, we have launched our "online trimming & shimming service". It allows customers to adjust the coating uniformity of single magnetrons. It does that based on the ExSitu measurement data of single layers. And it predicts the best gas trim and magnet bar shimming. This calculation saves a lot of time compared to the previous trial and error approach.

In 2016, we built the prototype of a roll-to-roll vacuum coating system for the processing of **flexible glass**. Flexible glass is a relatively new substrate material with a unique combination of properties. It is available in rolls and suited for applications such as flexible electronics, photovoltaics and displays.

Today, VON ARDENNE has established itself as a vital supplier for the vacuum coating industry for more than 45 years. We offer a solutions for many applications, especially for flat substrates and large coating areas.

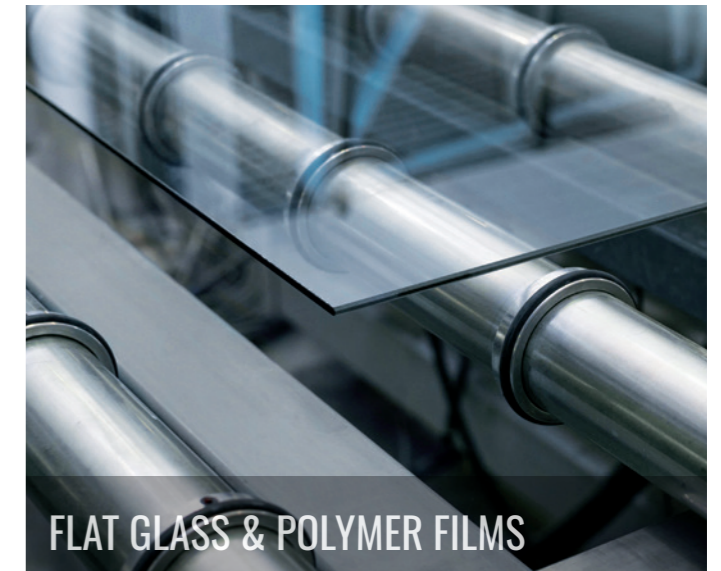
Equipment and Applications

Functional Coatings on Flat Glass or Web for Architectural Glass

With our **GC330H** and **GC254H** glass coating systems, we offer equipment suited for the production of a high-quality product portfolio of architectural glass for all global markets.

Whether it is Solar Control, Single, Double or Triple Low-E coatings: With VON ARDENNE equipment, you will achieve your required visible transmittance and infrared reflectance as well as the best optical performance.

We have delivered more than 70 of these coating systems to customers all over the world.

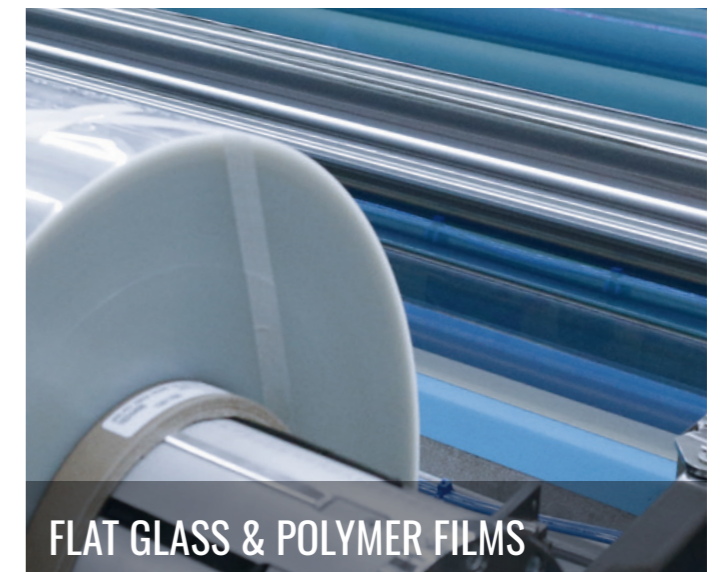


Functional Coatings on Flat Glass or Web for Automotive Glass

VON ARDENNE is the leading supplier of automotive glazing manufacturers when it comes to window coatings either on glass or web to create window film.

Sunlight protection coatings prevent the interiors of cars from heating up, thereby reducing the energy consumption. This is extremely relevant for electric vehicles: If the coating reduces the energy consumed by cooling, the battery lasts longer and the range of the vehicle is increased.

For automotive applications on flat glass, the **GC254H** glass coating system is a suitable platform. And our modular web coating systems are ideal for the high-volume production of window film.



Switchable Coatings for Architectural and Automotive Glass

For smart glass applications, such as electrochromic or other switchable glass, we offer equipment solutions that match the process defined by the customer. Among the applications are privacy glass, which can switch from transparent to opaque if necessary, electrochromic glass that offers sun and heat protection or dimmable windows in buildings and vehicles.

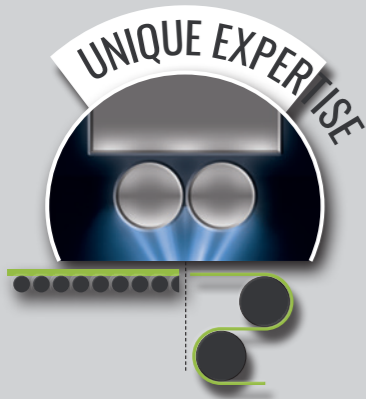
With these coating systems, for example a customized version of the **GC120VCR**, our customers can deposit the transparent conductive oxide layers. An example for such coatings is ITO, which is necessary to functionalize glass and turn it into smart glass.

Our customers can rely on our experience with coating systems and process technology for ITO thin-films for many different applications.



Our Strengths

Unique Combination of Process, Technology & Engineering Expertise



Process Components

- ... Planar or rotatable magnetrons with single or dual cathodes - designed and manufactured by VON ARDENNE
- ... T-series Magnetrons - the combination of sputtering and pumping in one component
- ... High-utilization WSM - excellent uniformity and target lifetime for very long coating campaigns
- ... In-house manufactured end blocks, magnet bars and magnet systems
- ... In-situ and ex-situ quality control equipment with exceptional performance and features
- ... All components are tested in our in-house vacuum test chambers

Process Technology

- ... More than 45 years of experience in vacuum coating technologies
- ... Industry-leading application know-how for Low-E, TCO and many other coating products
- ... In-house developed sputtering hardware & customized solutions
- ... Advanced process control systems based on optical measurement, process simulation and feedback control
- ... Ground-breaking anode solutions such as the Dual Anode System (DAS) for minimum substrate heat load
- ... Technology & Application Center with state-of-the-art sampling & testing facilities

Systems Engineering

- ... Proven machine platforms developed & improved during decades
- ... Innovative machine solutions for new applications and substrates such as flexible glass
- ... Expertise in transport design for rigid and flexible substrates of different thicknesses
- ... Substrate heating and cooling systems for optimized process control
- ... Sophisticated upgrade and retrofit engineering for VON ARDENNE systems and legacy equipment

Core Technology

Based on a Long Tradition

Industry-Proven, Reliable and Advanced Sputter and Magnetron Technology

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 45 years of experience with magnetron sputtering.

VON ARDENNE Magnetrons

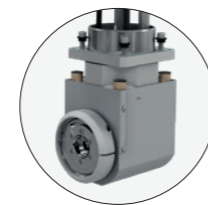
VON ARDENNE magnetrons are available for a wide range of applications. Thanks to many years of experience gained from designing and installing advanced sputtering equipment, we can offer a complete portfolio of solutions from RF and AC to DC processes, planar to rotatable applications and even magnetrons with integrated turbopumps such as the RDMT.

Sputter Components and Technology



Magnet Bars

VON ARDENNE magnet bars feature industry-leading field homogeneity and high target utilization for best coating results and longer campaign times. They are available in various field strengths and with fine tuning options.



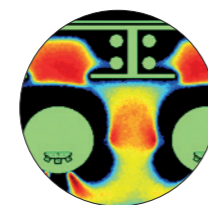
XC200 End Blocks

The new XC200 is available for upgrades and retrofits for all coating systems. It covers a wide range of specifications and is easy to maintain. Due to its compact design, it offers high durability for continuous production.



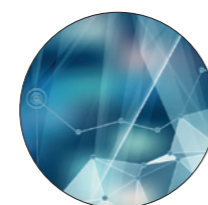
Process Control

VA PROCOS 2 is a modular process control system that is specially designed for the stabilization of reactive sputter processes in the critical transition mode.



Dual Anode Sputtering

Dual Anode Sputtering (DAS) is an industrially proven coating technology. It can be applied for highly-resistive target materials such as intrinsic tin oxide (i-ZnO). The DAS method guarantees a good availability of the anode as it is cleaned periodically, even when dielectrics are sputtered.



VA INDIGO

Advanced software solutions are available for automated process control, complex recipe handling, e-learning, spare & wear parts handling as well as AR-assisted support.



SSM MAGNETRONS



RSM MAGNETRONS



WSM MAGNETRONS



RDM MAGNETRONS

Advantages & Benefits of VON ARDENNE

Flexible Process Compartment Concept

The process chambers can be configured individually based on the flexible VON ARDENNE compartment system. They have a scalable design and can be configured according to the requirements of our customers.

The configuration can be easily changed at any time. This enables an easy adjustment to end-customer needs over the lifetime of the tool.

All compartments are identical to provide a maximum of flexibility.

Measuring Systems, Quality Inspection and Trimming & Shimming Software

In-Situ Measurement

Combines the results from different coating steps within the coater and helps monitor the coating process for quality control

Trimming & Shimming Software

Web-based, enables the quick optimization of the thickness uniformity of single thin layers

Recording of Process Data

Our PROCESS DB SQL data base records the process data of coating systems 24/7 allowing for detailed data analysis and correlations.

Ex-Situ Measuring System

Quality assurance and quality monitoring for coatings on glass

Vaprocos2 Process Control System

Controls the reactive magnetron sputtering of compound layers

Proven Layer Stack Competence

We have more than 45 years of experience with depositing functional layers on large-area glass substrates. This experience is based on more than 70 VON ARDENNE glass coating systems installed all over the world. Furthermore, we have excellent sampling facilities and simulation software to demonstrate, develop and improve layer properties.

Simulation-Driven Product Development

Plasma process and magnetic field simulation for excellent film growth, optical simulation for outstanding film properties

Transport System

The compact tool design features a short roller-to-roller distance. This enables the safe transport of glass sheets as thin as 2 mm without further changes and even 1.6 mm with minor transport system adjustments.

VON ARDENNE glass coaters are especially suited to process typical substrates for architectural glass and thin automotive glass at the same time on the same tool.

Scalability

VON ARDENNE provides advanced PVD coating equipment, key components and technology expertise for all scales of production, from R&D tasks to high-volume manufacturing.

Our laboratory-scale coating systems and pilot production tools use the same key components as our systems for industrial production at a smaller scale. Thus, our customers can test their applications under laboratory conditions and save time when they scale their business.

Technology & Application Center

VON ARDENNE operates many in-house coating tools and offers sampling, developing and testing of customized layer stack solutions.

Vertical Inline System

- ... Heated system
- ... Plasma pretreatment
- ... Planar and rotatable magnetrons
- ... Carrier based substrate transport

Horizontal System for Sputter-Up Processes

- ... Heated system
- ... Plasma pretreatment
- ... Carrier based substrate transport

Horizontal Inline Coating System

- ... Inline washing and coating system
- ... Ex-situ measuring station
- ... Planar and rotatable magnetrons
- ... Roller-based substrate transport



Horizontal inline coating system at the VON ARDENNE Technical Application Center

Advanced Layer Systems for Low-E & Solar Control

For more than 50 years, the glass industry has been striving to increase the comfort of buildings, to minimize the transmission of heat into the interior and the heat loss through the windows by means of coated glass. Since the beginning of the oil crisis in 1973 and the resulting drastic price increase for fossil fuels, energy saving and efficiency have become increasingly important. The development of the corresponding technologies has been accelerated by the growing awareness of the climate change caused by greenhouse gas emissions.

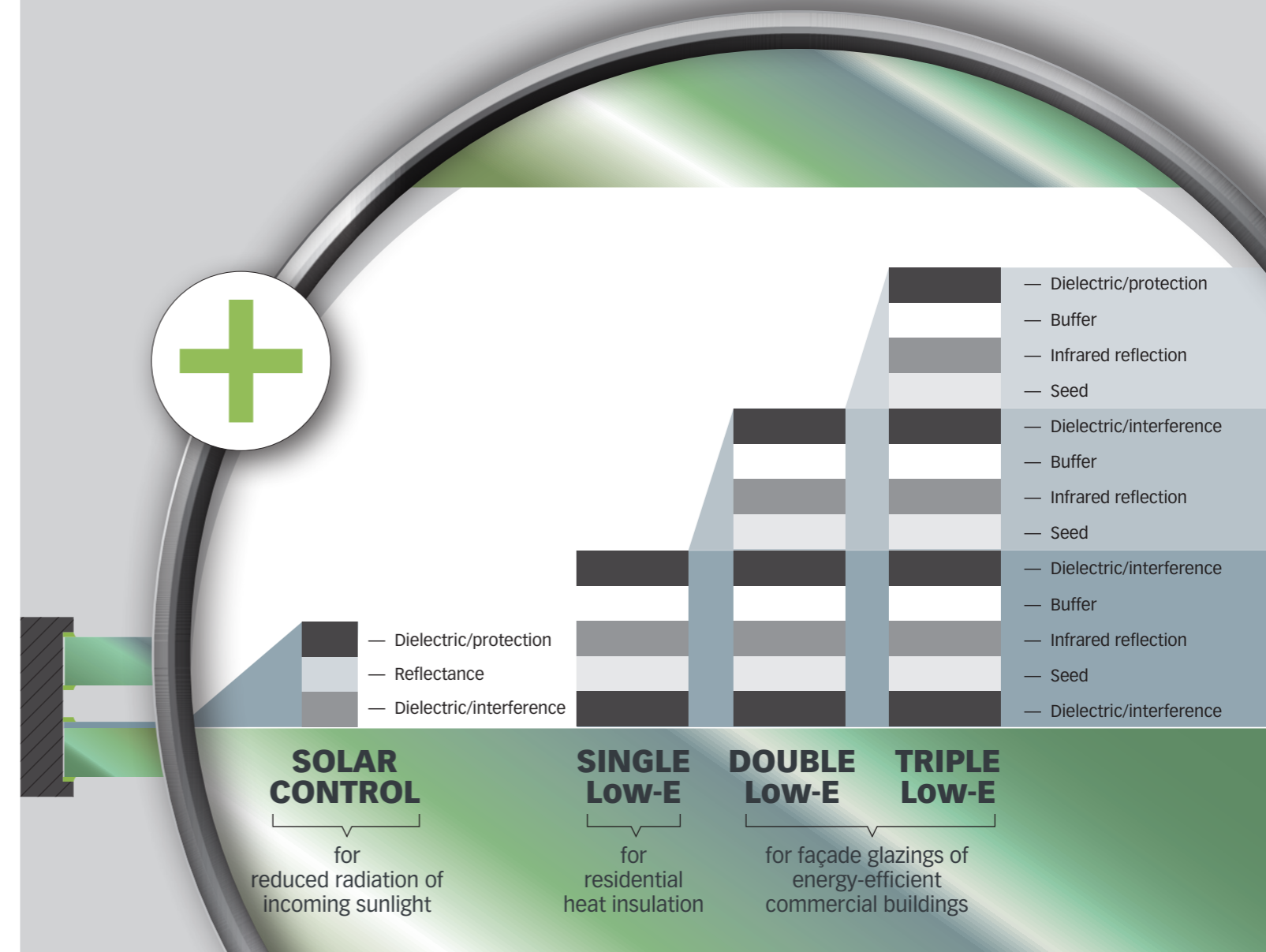
After thermal coating methods such as thermal evaporation had initially dominated in the early years, magnetron sputtering became prevalent in the 1970ies.

In 1974, we have started to establish our expertise in magnetron sputtering. Since then, we have become a worldwide leading company in magnetron sputtering. We owe this success to our more than 45 years of expertise in mastering and further developing the technology, the equipment and the components.

Our expertise in magnetron sputtering keeps growing. And we incorporate it into the development of layer stacks and the corresponding deposition processes. This ensures excellent layer properties. It is vital that the coatings are flawless, especially for modern architecture with large glass façades.

This is true no regardless of what climate zones and requirements the energy efficient glass coatings are needed. No matter if it is Solar Control, Single, Double or Triple Low-E coatings: you will create the visible transmittance and infrared reflectance you need with VON ARDENNE equipment. And you will achieve the best optical performance.

Beyond that, a high uniformity is crucial for the quality of the layer systems. VON ARDENNE coating systems achieve a thickness uniformity of ± 0.8 percent for Triple Low-E layer systems. This is achieved at a maximum long-term stability for an efficient production process. On top of that, the mechanical stability of the layers is excellent. This is an ideal precondition for further processing.



GC330H & GC254H Modular Coating Systems

For Architectural Glass Applications Including 100", Jumbo & Super Jumbo



With our **GC330H** and **GC254H** glass coating systems, we offer equipment to produce a high-quality product portfolio of architectural glass for all global markets.

We provide our inline systems in customized configurations suitable for all common glass sizes including 100", Jumbo and Super Jumbo format.

VON ARDENNE Process Chambers

The sputtering chamber consists of a customized number of universal compartments with a standard width of 780 mm. All compartments are identical to provide for maximum flexibility.

Proven Sputtering Technology

The technology used for glass coating on VON ARDENNE equipment is magnetron sputtering:

High rates, excellent uniformity: By magnetron sputtering, all required layers can be manufactured at high rates and a coating uniformity of $\pm 0.8\%$.

Over 45 years of experience: We develop and manufacture the necessary components such as magnetron sputtering sources in-house.

Planar Magnetrons with Exceptional Target Utilization and Uniformity

We have sold more than 350 planar magnetrons for a wide range of different applications. They are available for retrofits and as adaption for new coating lines. Furthermore, we can provide them as complete process lids with and without direct pumping.

The product family consists of three different types of magnetrons: the wide single magnetron WSM, the High-Utilization Planar Magnetron HU-WSM and the Planar XT for planar applications on wide areas and SSM and HU-SSM for smaller areas.

Measuring Systems & Quality Inspection

In-situ measurement: Combines the results from different coating steps within the coater and helps monitor the coating process for quality control

Recording of process data: Our PROCESSDB SQL data base records the process data of coating systems 24/7 allowing for detailed data analysis and correlations.

Ex-Situ measuring system: Quality assurance and quality monitoring for coatings on glass

TECHNICAL DATA GC330H

Subject to change without notice due to technical improvement.

SUBSTRATE

Material	flat glass
Size Jumbo (W x L), other options possible	3300 x 6000 mm
Size Super Jumbo (W x L), other opt. poss.	3300 x 7800 mm
Thickness	1.6 mm to 19 mm

DEPOSITION SYSTEM

Base pressure in sputtering chamber	$\leq 5 \times 10^{-6}$ mbar
Cycle time	≥ 20 s

UTILITY & SUPPLY

Utility requirements	between 0.5 and 5 MVA, depending on application and throughput
Mains connection	400 VAC, 50 Hz or 480 VAC, 60 Hz

TECHNICAL DATA GC254H

Subject to change without notice due to technical improvement.

SUBSTRATE

Material	flat glass
Size (W x L), other options possible	2540 mm x 3810 mm
Thickness	1.6 mm to 19 mm

DEPOSITION SYSTEM

Base pressure in sputtering chamber	$\leq 5 \times 10^{-6}$ mbar
Cycle time	< 18 s

UTILITY & SUPPLY

Utility requirements	between 0.5 and 5 MVA, depending on application and throughput
Mains connection	400 VAC, 50 Hz or 480 VAC, 60 Hz

GC120VCR Vertical Glass Coating System

Industry-Proven Production Tool with a Small Footprint



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

As a leading provider of vacuum coating equipment for large-area applications, we have incorporated our broad knowledge and expertise into the **GC120VCR** platform. The reliability of this system is well proven in the industry.

Small Footprint

The **GC120VCR** does not need much floor space and requires fewer maintenance intervals due to its vertical design.

High Yield at Low Defect Rate

It is also thanks to the vertical orientation that low film defect rates can be achieved during production campaigns. In-situ and Ex-situ optical measurement equipment can be integrated in order to measure film properties in a continuous manner.

Good Maintainability

The optimized machine design enables easy access to the magnetron environment for target exchange and maintenance. Due to its vertical door opening concept, no overhead crane is required to maintain the system.

TECHNICAL DATA

Subject to change without notice due to technical improvement.

TARGET

Materials	metals, ceramics
Utilization	planar > 30 %, rotatable > 80 %

SUBSTRATE

Material	glass
Dimensions (W x L), max.	1280 mm x 1650 mm (others on request)
Thickness	0.5 mm to 4 mm (others on request)
Pre-treatment	linear ion source or plasma glow discharge

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	-7 °/ 0°/+7° vertical, LEL, SEL
Transport speed	≤ 3.5 m/min
Cycle time	30 s

CLEANING OF MAGNETRON CHAMBERS

Cleaning principle	mechanical exchange of shields
Cleaning cycle	7 to 35 days, depending on configuration

UTILITIES & SUPPLY

Automated substrate loading and unloading	on request
Carrier storage racks	on request
Phase	3 phases
Voltage	230 V, 400 V, 480 V
Frequency	50 Hz to 60 Hz
Power consumption	depending on configuration
Cooling system	separate cooling circuit with heat exchanger
Cooling supply	primary cooling water supply by customer
Venting medium	ambient air, compressed dry air or N ₂
Process gases	central supply by customer or local by gas cabinet

SYSTEM CONTROL & SOFTWARE

Computer hardware	PLC, Siemens S7, AB Rockwell
User interface	VON ARDENNE user interface
MES link	according to specifications

SYSTEM DIMENSIONS

Total system size (L x W x H)	customized × 15 m × 3.7 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



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.



CLOSE PARTNERSHIP

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

- ... Fraunhofer Institutes such as IPMS, FEP, IST and ISE
- ... Institutes of the Helmholtz Association (Jülich, Berlin)
- ... Universities (Kiel, Dresden, 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.



COMPREHENSIVE SERVICE PORTFOLIO

- ... VON ARDENNE service hubs around the world
- ... On-site service
- ... Remote access by our technology department
- ... Regular technical and technological trainings
- ... 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.



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